THE

AMERICAN JOURNAL

OF

SCIENCE AND ARTS.

CONDUCTED BY

PROFESSORS B. SILLIMAN AND B. SILLIMAN, JR.,

AND

JAMES D. DANA.

SECOND SERIES.

VOL. III.—MAY, 1847.

NEW HAVEN:

PRINTED FOR THE EDITORS BY B. L. HAMLEN,

Printer to Yale College.

Sold by H. DAY, *New Haven.*—LITTLE & BROWN, and W. H. S. JORDAN, *Boston.*—C. S. FRANCIS & Co. and WILEY & PUTNAM, *New York.*—CAREY & HART, *Philadelphia.*—N. HICKMAN, *Baltimore, Md.*—WILEY & PUTNAM, *London.*—HECTOR BOSSANGE & Co., *Paris.*—NESTLER & MELLE, *Hamburgh.*

CONTENTS OF VOLUME III.

NUMBER VII.

SCIENTIFIC INTELLIGENCE.

NUMBER VIII.

NUMBER IX.

SCIENTIFIC INTELLIGENCE.

ERRATA.

Page 55, over figures, for *half*, read *twice*.—P. 96, *dele* first foot note.—P. 103, 13 lines from bottom, *for* 272, *read* 275.—In part of the edition, p. 116, 9 lines from bottom, for '*clearer*,' read *deeper*.—P. 117, 2 lines from top, *for* "Its specific gravity," *read* The specific gravity of this acid.—P. 139, 21 and 22 lines from top, for 395 and 399, read 3·95 and 3·99.—P. 147, 22 lines from top, for *Concorado*, read *Corcovado*. 18 lines from bottom, for *Borgard*, read *Bongard*.—P. 148, 2 lines from top, for *Balandier*, read *Berlandier*.—P. 149, 7th line from bottom, and p. 150, 21 lines from top, for *promising*, read *persevering*.—P. 299, 12 lines from bottom, for *Pennsylvania*, read *Transylvania*.—P. 301, 23 lines from bottom, for *catoptric*, read *dioptric*.

Vol. i, p. 427, under *Electric excitement of paper*, for *stone*, read *stove*.

THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

Art. I.—*On Zoöphytes*, No. III; by James D. Dana.*

26. In our preceding chapter on Zoöphytes we briefly noticed the characteristics of the Hydroidea, one of the two grand divisions of these animals. A digestive cavity, a mouth, and a circle of fleshy arms or tentacles around the mouth, were mentioned as the sum-total of many of these simple organisms. Fixed in general to some support, they eat, and grow, and bud out their young as plants their flowers and leaves. Thus they form the fine feathery fronds and moss-like tufts so common among these lower polyps, and whose branchlets are made up of minute flower animals in place of leaflets, exquisite in beauty and arrangement. They have delicate horny or membranous coralla when any at all, and take little part in the formation of reefs.

Order II. Actinoidea.

The next order to which we now pass, comprises all the ordinary coral zoöphytes, the branching and foliate Madrepores, the massive Astræas and Meandrinas, the slender sea fan, and also the common Actinia. Among them are flowers of all hues and sizes. The Actiniæ may well be called the Asters, Carnations, and Anemonies† of the submarine garden; the Tubipores and Alcyonia form literally its pink beds; the Gorgoniæ and Melitæas are its flowering twigs; the Madrepores its plants and shrubbery; and Astræas often form domes amid the grove, a dozen feet or more

---

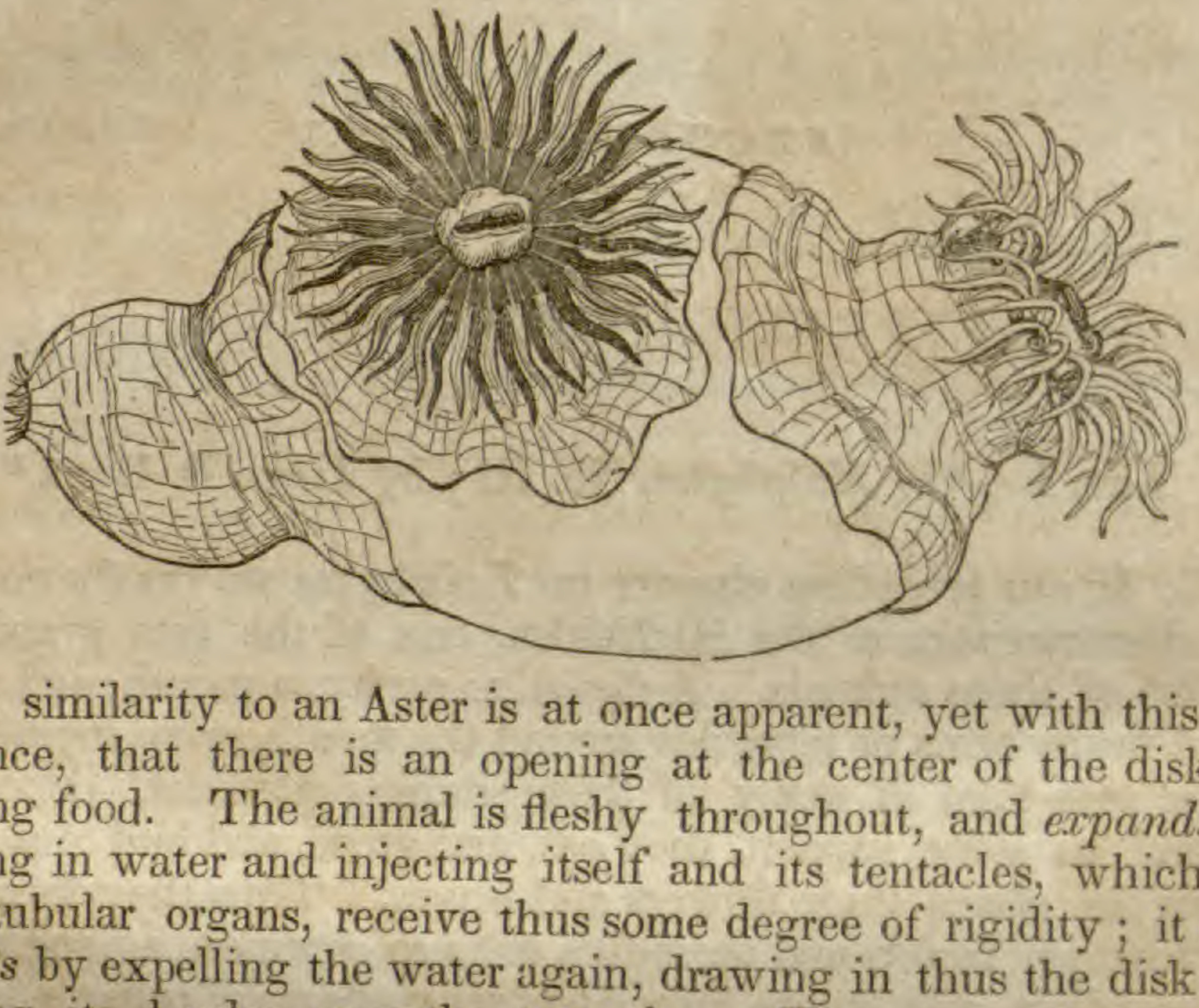
* Abstract of the Exploring Expedition Report on Zoophytes by the writer; continued from vol. ii of this Journal; see p. 64 for No. I, and p. 187 for No. II.

† Sea-Anemone is the common name.

in diameter, embellished with green or purple blossoms which stud the surface like gems; while other hemispheres of Meandrina appear as if enveloped in a network of flowering vines.

27. It is impossible in any figures or sketches to convey an idea of the combined effect, where the various species are growing together. The resemblance in form to flowers* may however be appreciated from a few figures. In the following an Actinia is represented in its different conditions, expanded and closed.

Fig. 12.



The similarity to an Aster is at once apparent, yet with this difference, that there is an opening at the center of the disk for taking food. The animal is fleshy throughout, and *expands* by taking in water and injecting itself and its tentacles, which being tubular organs, receive thus some degree of rigidity; it *contracts* by expelling the water again, drawing in thus the disk and rolling its border over the tentacles. The water passes out partly through the mouth, often in part through a puncture at the tips of the tentacles, and in some species through pores in the sides of the animal.† The next figures represent coral animals, resembling, as is seen, in every essential particular, the Actinia above, and differing internally in nothing except the power of secreting lime. Fig. 13 as well as 14 are both of the size of life, and the latter shows the average size of the polyps through the large genus Astræa. The former is a single animal from a large hemispherical group (a Mussa) consisting of fifty or sixty such polyps; and when alive, the whole forms a magnificent

* The gorgeous character of many Actinias may be appreciated from the colored figures on the first five plates of the atlas to accompany the volume on Zoophytes, by the very skilful pencil of Mr. J. Drayton, one of the artists of the Expedition. The animals of one or more species of nearly every genus of coral zoophytes are figured and colored on the other plates of the volume. The volume will not be ready for delivery, for some months.

† This last peculiarity has been supposed to belong only to tuberculate species; and Ehrenberg has founded on it, the genus Cribrina. But Dr. Wyman observed that these pores existed in the A. marginata of the Boston harbor, which has a perfectly smooth and semi-transparent skin.

cluster of animal flowers. The latter is from a small specimen of Astræa: were its disks and tentacles of some bright shades of color, and the small hemisphere enlarged to a diameter of twelve

Fig. 13.

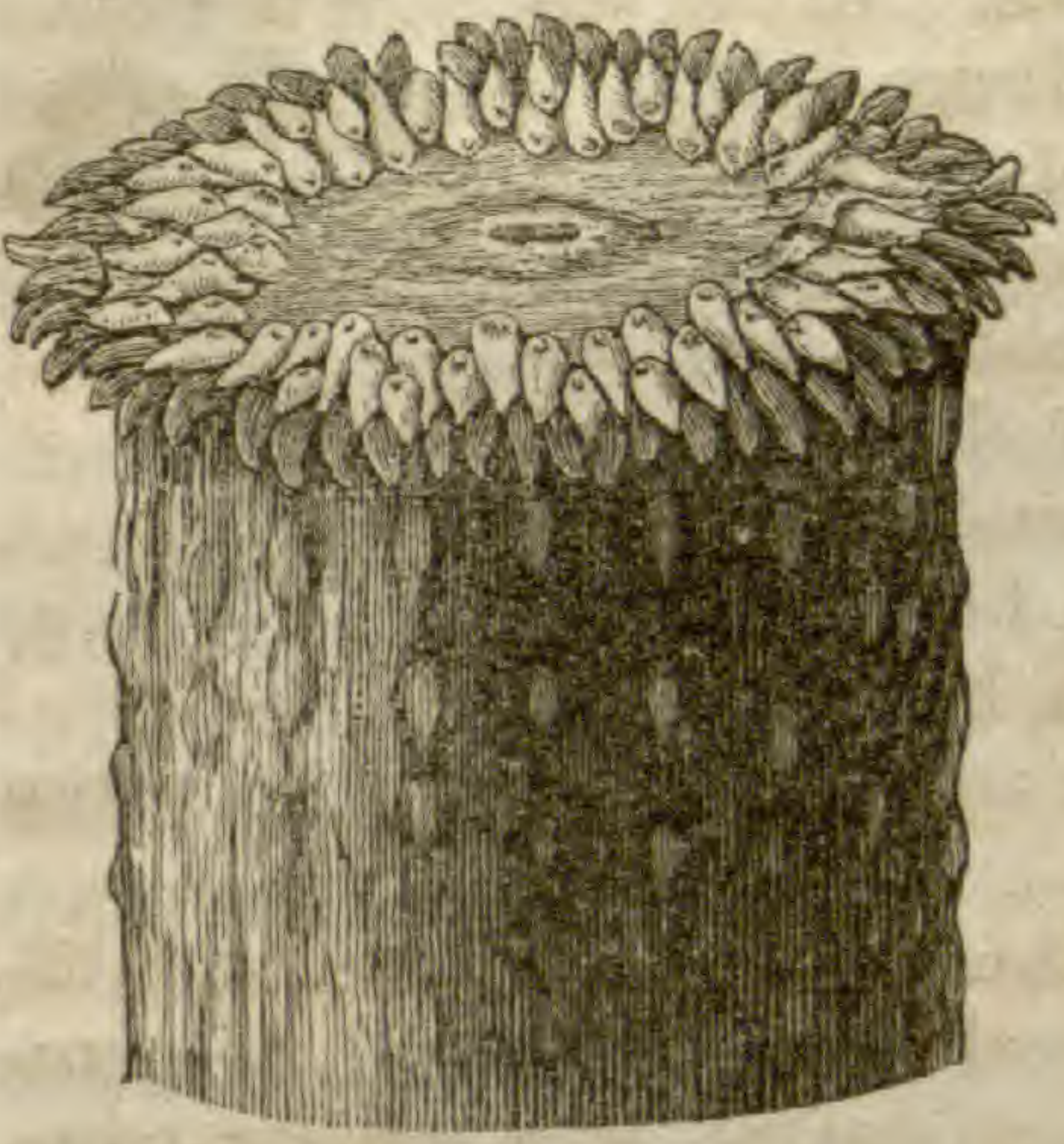
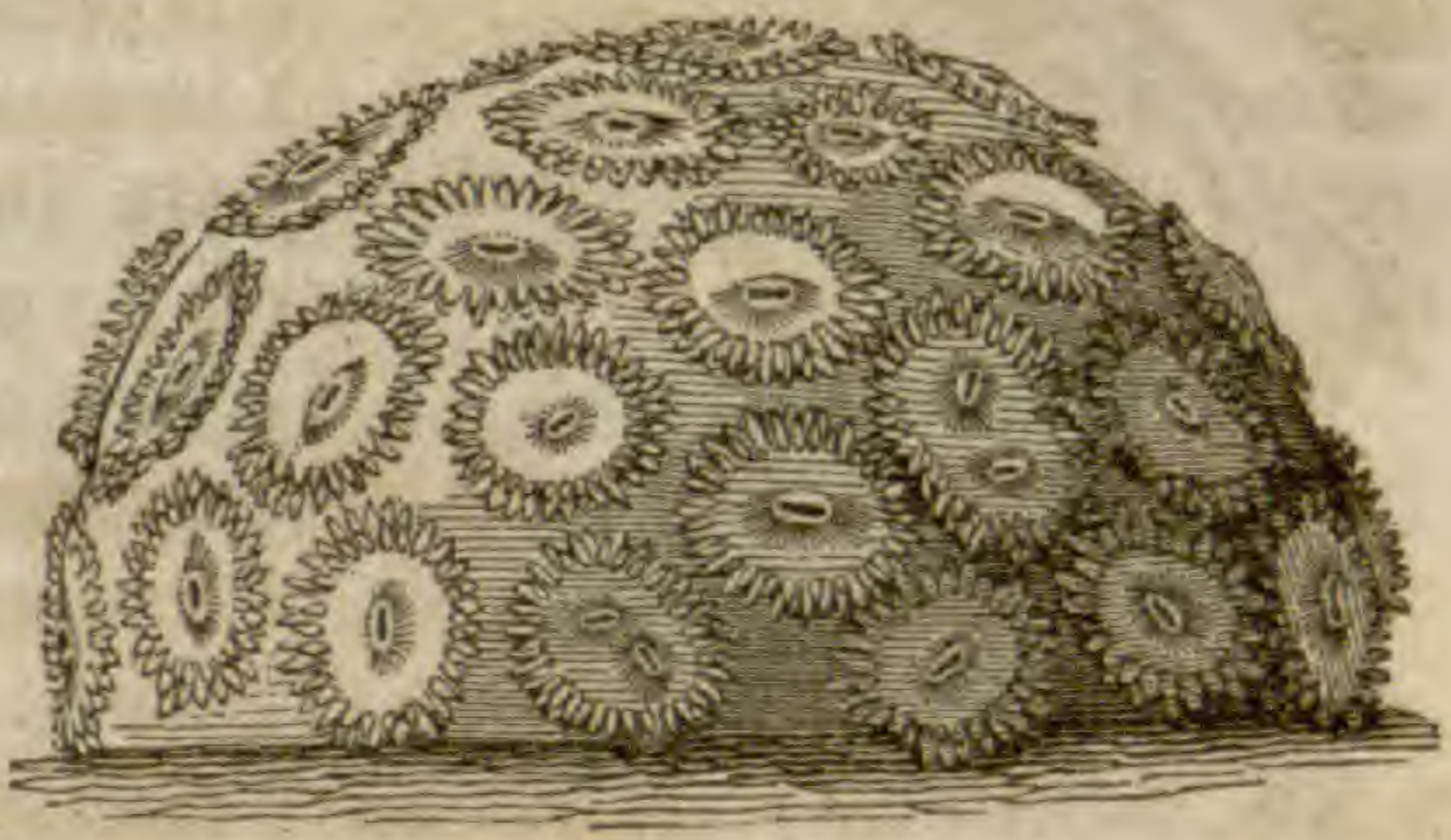


Fig. 14.



feet, it would then give some idea of the domes of the coral reef, to which we have made allusion above. Fig. 38 on a following page is another variety. Figures 15 and 16 represent a *Madre-*

Fig. 16.

Fig. 15.

pora and a *Dendrophyllia*, of natural size; and they bear out the remark that a branch is literally a spike of flowers. Figure 17 also sustains our comparison of the Alcyonia to clumps of

Fig. 17.

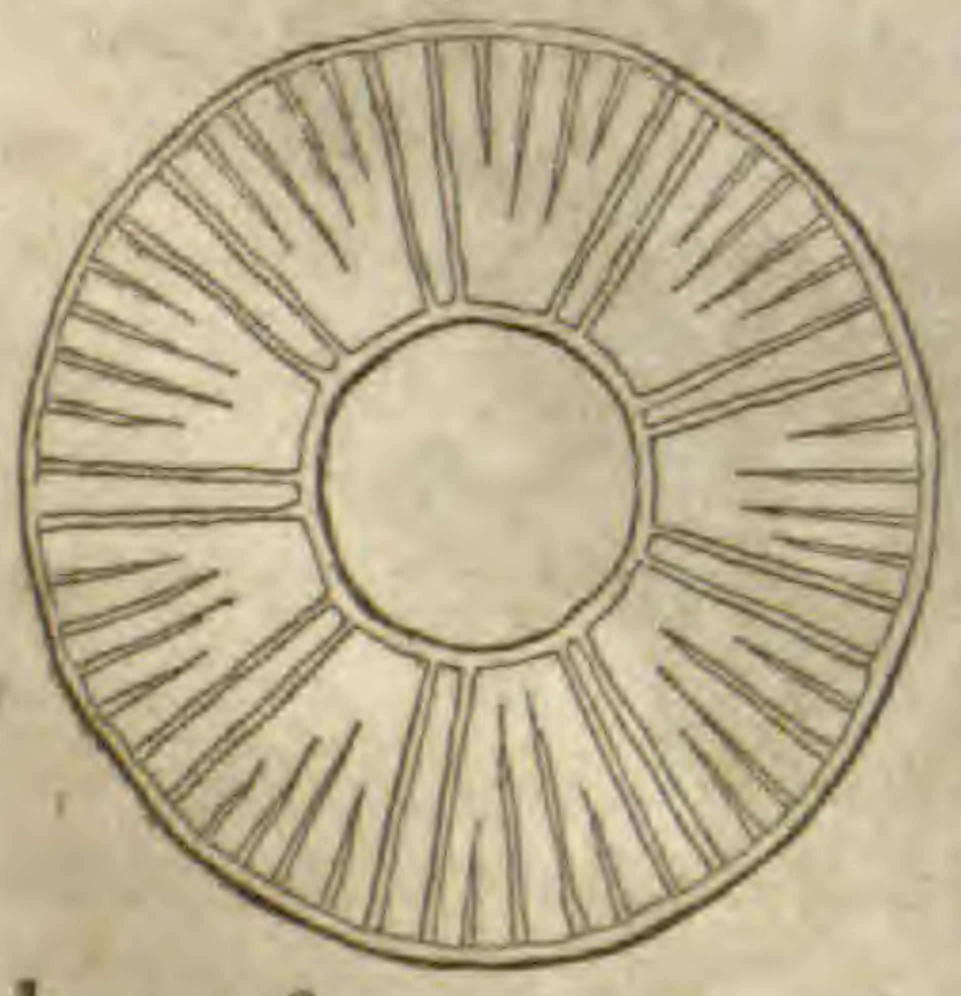
pinks, although but a single branch, and without the delicate tinting which characterizes these flower-animals. In the annexed figure (18,) a polyp of a *Tubipora* is represented enlarged. A large cluster, as it appears in the water in full expansion, is closely like a bunch of lilac blossoms, both in shade of color and in the size of the polyp flowers.

Fig. 18.

28. All these animals have the same general structure, and differ from the Hydroidea in the internal septa, possessed of genital functions, which divide the visceral cavity into radiate compartments, (§ 11.) They sometimes have a coriaceous or leathery exterior; and *instead of living in coral, the coral is contained in them.* In figure 13, the existence of coral is no more apparent externally, than in the fleshy Actinia. The tentacles are very various in number and size; they are sometimes long for prehension, and at others are nearly or quite rudimentary, being fitted only to aid in aeration.

29. In the interior of the Actinia, within the general visceral cavity, there is a cylindrical stomach which is attached to the under side of the disk, and is about two-thirds the length of the animal. The cavity around the stomach is divided by the fleshy septa alluded to; they unite this organ to the sides of the polyp and by their muscular action aid in its contraction. The compartments formed between them communicate each with a tentacle, (unless a part of the normal number of tentacles be obsolete.) Two large septa in many cases alternate with others which are narrower. This is shown in the annexed cut of an ideal transverse section in which the inner circle represents a section of the stomach, and the radiating lines, sections of the septa extending from the sides of the polyp.* The septa are continued below the stomach, and at bottom are prolonged inward so as to meet. The cavity of the stomach has a free communication with the visceral cavity, being closed below only by muscles under the control of the animal.

Fig. 19.



* The septa in this figure are much less numerous than in the Actiniæ, but are correct in representing the general arrangement.

The food, which consists of small crustacea and any thing that falls in their way, is acted upon by the gastric juices in the stomach, and the insoluble portions ejected by the mouth. The chyloid fluids formed by the digestive process then pass below into the visceral cavity, and are distributed throughout it to be absorbed and assimilated by the interior surface and through the pores or cavities connected with it. The water which is received on expansion has the same course, and contributes along with the exterior waters to aeration; and thus aeration and assimilation go on together without any special organs for these functions. Excrementitious matter is probably ejected along with this water.*

Fig 20.

30. The septa have been stated to have genital functions, and this is their principal object. Part are ovarian and part spermatic. The spermatic are margined with an extremely delicate white cord-like or capillary organ, long and much convoluted, (lower part of figure 26*a*;) and the ovarian, (which appear in general to be the narrower of the septa,) bear clusters of ova at the margin, (fig. 20.)

The spermatic nature of these white cords, was first suggested by Dicquemare,† and afterwards established by Wagner.‡ Their singular radiated spiculigerous structure was also made out by our acute microscopist, Prof. Bailey of West Point,§ and subsequently the actual forms of their spermatozoa, and of three distinct kinds of spiculiform organs were developed with great skill by Dr. Jeffries Wyman of Boston. The structure is illustrated by the following figures, which are all by Dr. Wyman excepting figure 21 from a camera lucida sketch by Dr. A. A. Gould of Boston. Figure 21 shows the ordinary appearance of a cord under pressure when highly magnified. Figure 22 is a section showing the spiculiform organs, and the filaments which extend on slight pressure. Figure 23 represents the spermatozoa;

Fig. 21.

Fig. 22.

Fig. 23.

Fig. 24.

and figures 24, *a*, *b*, *c*, the three kinds of spiculæ with their filaments. The body of *b* is transparent; the filament is furnished

* Hence the mouth *is not* the only passage for the proper excrements, though it ejects the refuse indigestible matter from the stomach.

† Phil. Trans. Abridg., xiii, 639, 1775.

‡ Ann. des Sciences Nat., viii, (1837,) 282, from Wiegman's Archives, ii, 215, (1835.) See also Milne Edwards, Ann. des Sci. Nat., xiii, (1840,) 196.

§ Jour. of Boston Soc. Nat. Hist., iv, 252.

with short hairs, and has an obtuse extremity. The body of *c* appeared to be filled with granulous matter; the filament is enlarged, as in *b*, but is naked, and terminates in a very delicately attenuated extremity. These several forms were seen again and again from various individuals, and lately the researches have been repeated with the same results. The spermatozoa were observed to have motion.*

These cords had been considered biliary vessels by some writers and also as ovarian, before their spermatic character was ascertained. Their structure is finely figured by A. de Quatrefages† but without distinguishing the different kinds of spiculiform bodies or apparently appreciating their nature.

31. The clusters of ova lie in the visceral cavity, or its compartments, and sometimes are found in the tentacles as detected by Dalyell in frequent amputations of these organs, a fact easily understood since the compartments and tentacles communicate openly with one another. But according to the best authority, and observations in the Expedition by Mr. Couthouy, they leave the internal cavity through the stomach and mouth, sometimes as ova and sometimes as young animals. When first produced the polyps swim free, and have but few tentacles; they afterwards attach themselves, and the tentacles go on increasing in number correspondingly (or in some fixed relation) with the visceral lamellæ, until the adult number is attained.

Figs. 26*b*. 26*a*.

32. In the Zoanthidæ, there is a pair of organs resembling *branchiæ*, (fig. 26*a*, upper part,) attached by a common duct to the edge of each visceral lamella just below the stomach. In fig. 26*b*, part of the margin is shown enlarged, with the vibratile cilia as they were seen in motion. The spermatic cord of the same lamella is represented in the lower part of figure 26*a*. These branchia-like organs were first observed by Lesueur, who called them *arcuated* organs. These figures are from dissections of a Palythoa by the writer. (See plate 30 of the work on Zoophytes.)

These animals are as prolific, and repair an injury as easily, as the Hydroidea. Fragments of an Actinia are as sure to grow to a perfect animal, as chippings from a potato to a potato-plant. And they have been put in boiling water without serious injury.

---

* These investigations were first published in the Report on Zoophytes by the writer. They were made on the *Actinia marginata* of Lesueur, which is common in the harbor of Boston. Dr. Wyman also detected great numbers of minute spiculæ (as here figured enlarged) in the coats of the stomach, general integuments of the body, and near the extremities of the tentacles.

Fig. 25.

† *Sur les Edwardsies*, Ann. des Sci. Nat., xviii, (1842,) 65.

33. The various species of Zoophytes having the above general characteristics, differ in the arrangement, number and character of the tentacles, and the size of the stomach as compared with the whole visceral cavity. In some Zoanthidæ the stomach is not over one-fifth the length of the internal cavity. Certain Actiniæ have part or all of the tentacles furnished with suctorial vesicles for clinging; and in others they are minutely divided or lobed and look like the most delicate embroidery. In a few species (Actinectæ) there is a vesicular float contained in a cavity in the base of the animal to fit it for a sea life, and through these species the zoophytes approach the Porpita among Acalephs. These are only family, generic, or trivial distinctions; but on another point, the Actinoidea are naturally divided into two Suborders.

34. A part of them have *uniformly eight tentacles, and these are fringed with minute papillæ, each papilla having a puncture at apex.* These are called the ALCYONARIA; they include the Alcyonia, the Xeniæ, (fig. 17,) Gorgoniæ, and Tubipores, fig. 18; the cells of their coralla are distinguished when calcareous by *being simple tubes without rays.*

In others, and here fall the Madrepores and most stony corals in addition to the Actiniæ, the *tentacles are without the papillæ of the Alcyonaria, and the number is six, twelve, or more.* These are the ACTINARIA. *The cells of their calcareous coralla are radiate,* the rays rarely becoming obsolete.*

Internally the Alcyonaria have eight visceral lamellæ. In one species of Tubipora examined by the writer, six of them were spermatic and two ovarian. Milne Edwards found that in a Veretillum six of the lamellæ were spermatic above and ovarian below, bearing analogy with a gynandrous plant.

35. The *Actinaria* are farther subdivided into the tribes Antipathacea, Madreporacea, Caryophyllacea, and Astræacea.

The *Antipathacea* have six tentacles; they form a horny axis but no calcareous coralla.

The *Madreporacea* have twelve tentacles; they form calcareous coralla having *the cells small, six to twelve rayed,* with the rays seldom obsolete.

The *Caryophyllacea* and *Astræacea* have more than twelve tentacles, and the *cells of their coralla have more than twelve rays.* Their distinctive characters will be pointed out in the sequel.

Secretion of the Corallum.

36. We have already insisted sufficiently on the fact that live coral is not a hive of polyps, as the words polypary and polypidom imply, but on the contrary is a result of animal secretion.†

---

* They are obsolete in some Favosites. Yet certain allied species (Favistellæ) in our American rocks have twelve distinct rays to the cells.

† This character of their secretions was first pointed out by Ehrenberg in his Memoir on the corals of the Red Sea, (Abhand. der König. Akad. der Wissensch. zu Berlin, 1832.)

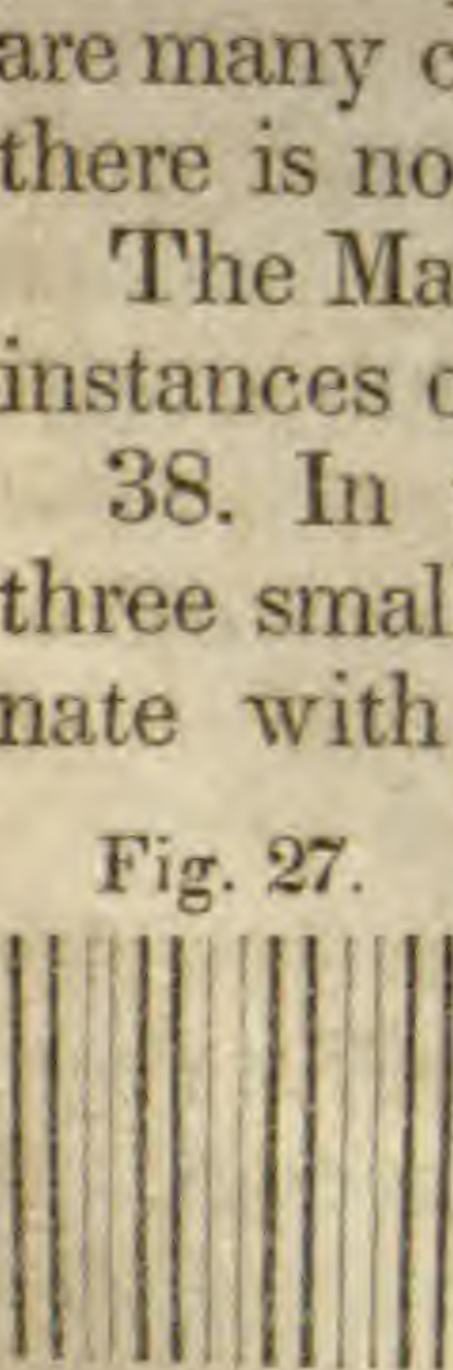
The secretions producing it are of two kinds, either *basal and epidermic* or *internal.* The former are either *calcareous* or *horny, rarely siliceous;* and with the exception of the Antipathi, they are confined to the Alcyonaria. The latter are *calcareous.*

37. *Internal secretions.*—These take place through the inner tissues of the polyps; and as the internal cavity of these animals is radiated with compartments, it is natural that the cells of their coralla should be radiated likewise. Each compartment in fact corresponds to a calcareous lamella, these lamellæ being formed between two fleshy lamellæ. The existence of cells on the surface of a corallum is owing simply to the fact that the upper and central portions of the polyp do not secrete lime, while the sides and parts of the fleshy lamellæ do; the consequence is that there is a surface concavity in the corallum, into which the disk of the polyp falls on contraction. There can be no such thing as a disappearance of the polyp in the cell, for the coral as we have said is wholly within the exterior skin of the polyp; yet the tentacles and disk may disappear; and this they do also in the *fleshy* Actinia. Conceive of a fleshy Actinia secreting lime throughout the tissues of its sides, (excepting the exterior skin,) and between its fleshy lamellæ, and the reader will correctly comprehend the relation of coral to the animal. The calcareous secretions may thus form a solid structure penetrated by the animal tissues; and when separated from the animal there will be cellules where the animal tissues remained; and under a microscope a thin polished plate would show other animal fibres wholly enclosed in the coral. The animals represented in figures 12 and 13, differ in this single particular,—that in the latter this very process has taken place as described, and in the former it has not. There are many corals without surface-depressions or cells, and in these there is no semblance even of a retreat of the polyp.

The Madrepores, Astræas, Caryophyllias, and Cyathophylla are instances of this mode of coral secretion.

38. In the cells of most Caryophylliæ, Dendrophylliæ, &c., three smaller calcareous lamellæ (the middle one broadest) alternate with one larger lamella. This results from the arrangement of the *fleshy* lamellæ of the polyp, as shown in figure 19, and more correctly in the annexed figure, exhibiting the position of these lamellæ as seen through the skin of the Actinia examined by Dr. Wyman. There are two stouter lamellæ with *one broader* interval alternating with two thinner lamellæ and *three narrower* intervals, thus corresponding exactly with the calcareous lamellæ, the larger calcareous lamella belonging to the broader interval. This arrangement of the fleshy lamellæ may be seen in the external markings of many Actiniæ. This explains what has been considered a very singular structure in

Fig. 27.



corals. On this account the number of lamellæ (and correspondingly of tentacles) is usually some multiple of *four*, when the whole number exceeds twenty-four; and it is generally also a multiple of *six*. Below this, the lamellæ if over six are commonly large and small alternately, or one alternates with two others that are alike; and the number is a multiple of *six*. These are therefore all parts of one system. The Alcyonaria appear to belong to a different system, since they have *eight* equal tentacles and lamellæ.

39. The importance of number and size as a specific distinction is therefore obvious. In the species of a single genus or family, there is a relation admitting of limited variations, between the diameter of the polyp and the number of its visceral lamellæ, and therefore of its calcareous lamellæ when coralligenous. As the number of tentacles and internal lamellæ of a polyp increase as it enlarges, so it is with the lamellæ of the corallum; but the adult number is fixed.

40. In the *Alcyonaria*, the internal secretions are in disseminated grains or spiculæ, and when a solid tube is formed, it proceeds from the aggregation of these grains. The difference in the microscopic structure of these spiculæ and the coral of the Actinaria has been stated in this Journal, i, ii Ser., 284. There are many species that are wholly fleshy, others in which the grains are few and the zoophyte is therefore still flexible; and others that are firm and solid from their numbers and union. In the Tubipora the tubes are thus solid except at tip where they are still flexible; and as they grow upward, the tube at the same rate stiffens above through the increasing calcareous secretions. In this Sub-order, the skin appears often to take part with the inner tissues in these secretions.

41. *Basal epidermic secretions.*—These secretions go on either alone or in connection with internal secretions, but always when together the two form separable layers. Thus the crust of a Gorgonia, which consists of a layer of fleshy polyps with internally secreted lime, peals off readily from the horny axis, which is the result of *basal secretions*. The polyps have their bases inward, and of course an axis should result from their united secretions. This axis is very similar in nature to the horn or nails of animals, which are alike epidermic, and to the fibrous *byssus* of certain molluscs. It is also calcareous at times as in the common red or noble coral of commerce; for this material forms the axis of a zoophyte, and is covered, when alive, with a layer or crust of brilliant polyps. This fact accounts for its being solid in texture without the cells of ordinary coral.

A concentric structure may sometimes be distinguished in these axes; and at times the centre (the first secretions of the younger or apical polyps of a branch) is open cellular. In some species the whole axis is made up of spiculæ, or consists of a material resembling cork in texture.

42. In the Melitæas the polyps grow obliquely upward, and their bases are directed downward instead of inward. The foot secretions form a layer at base, of this cork-like material; upon this, the other secretions make a layer of lime; then a new budding takes place, and the new polyps begin another layer at base. Thus an alternation of the two kinds is produced, and the branches of the zoophyte are jointed.

43. With regard to the chemical constitution of calcareous corals, the results of Mr. Silliman's investigations for the Treatise on Zoophytes are already given in this Journal.* The occurrence in them of fluorine and phosphoric acid, was first detected by Mr. Silliman. The former was made to record the fact of its existence in coral during his investigations, by various etchings on glass, the specimens of which are of high interest.

44. The source of the ingredients of coral must be looked for in the food of the polyps, and in the ocean's waters which are constantly bringing new portions of these mineral materials over the coral reefs through the action of the waves and the great marine currents.† There is no foundation whatever, as far as my investigations among reefs go, for the hypothesis that carbonic acid springs occur in the vicinity of growing corals; and farther, there is convincing evidence to the contrary. Moreover, it matters not whether the lime in sea-water be in the condition of a sulphate or carbonate, since the elaborations of life may decompose and recompose according to the nature of the animal functions.

Reproduction by Buds.—The Compound Structure.

45. We have been considering in the preceding pages on the Actinoidea, the characters of the *simple* polyp, its structure, reproduction by ova, and its coral secretions. The *compound* structure exhibited by most coral-zoophytes, is a result of the additional function of budding, and essentially in the same way as in the Hydroidea. By this simple means, all the various forms of zoophytes result.

Many of the various shapes which these zoophytes assume, are familiarly known. Madrepore shrubs and trees, and the sea-fan and other Gorgoniæ from the West and East Indies, are common in collections. The hemispheres of *brain-coral* (Meandrina), and also of *star-coral* (Astræa), are often met with. It is

---

* See this Journal, i, ii Series, 189; and also for some geological deductions therefrom, *ibid*, ii, 88.

† The occurrence of fluorine in sea-water was suggested by Mr. Silliman, as a result of his investigations; and it has since been proved by actual analysis by Mr. G. Wilson of Edinburgh. (See this Journal, ii, ii Series, 115.)

very generally supposed that these are by far the most frequent, if not the only shapes presented; but, on the contrary, the varieties are extremely numerous, as we have already intimated. Some species grow up in the form of large leaves rolled around one another like an open cabbage, and *cabbage-coral* would be no inapt designation for such species. Another foliated kind consists of leaves more crisped and of more delicate texture, irregularly clustered;—*lettuce-coral* would be a significant name. Each leaf has a surface covered with polyp-flowers, and was formed by the growth and secretion of these polyps. Clustered leaves of the acanthus and oak, are at once called to mind by other species; a sprouting asparagus-bed by others. The mushroom is here imitated in very many of its fantastic shapes, and other fungi, with mosses and lichens, add to the variety.

Vases of Madrepores are common about the reefs of the Pacific. They stand on a cylindrical base, which is enveloped in flowers when alive, and consist of a network of branches and branchlets, spreading gracefully from a centre, covered above with crowded sprigs of tinted polyps. The vases in the collections of the Expedition, at Washington, will bear out this description, although but the lifeless coral.

The domes of Astræas are of perfect symmetry, and often grow to a diameter of ten or twelve feet without a blemish. The ruder hillocks of Porites are sometimes twenty feet across. Besides these, we might describe columns, Hercules' clubs, and various strange shapes which are like nothing but themselves.

It is an enquiry of much interest, how these various forms proceed from the budding process.

46. Buds grow from some part of the parent, generally appearing first as a small protuberance upon its side, and afterwards perfecting into a complete young animal with its mouth and tentacles. The nature of the union between the young and parent has been explained in the preceding volume of this Journal, p. 190, § 13. Each of the compound zoophytes above alluded to, commenced from a single polyp and was thus formed; bud followed bud, and so the germ grew up into the coral tree or dome. Calculating the number of polyps that are united in a single Astræa dome, twelve feet in diameter,—each covering a square half inch,—we find it exceeding one hundred thousand; and in a Porites, of the same dimensions, in which the animals are under a line in breadth, the number exceeds five and a half millions; there are here, consequently, five and a half millions of mouths and stomachs to a single zoophyte, contributing together to the growth of the mass, by eating, and growing, and budding, and connected with one another by their lateral tissues and an imperfect cellular or lacunal communication. There is hence every variety, as to number, among compound zoophytes,

down to the simple polyp, which never buds at all, and has, for its corallum, a simple calicle;—it may be a tiny goblet, with a stellate cell, as in the Cyathina—a cylindrical cup, as in some Dendrophyllias—or a radiated disk, as in the Fungias and Cyclolites.

47. *Modes of Budding.*—Buds may be either *lateral* or *terminal;* that is, they may form from the sides of the parent, or from the disk or margin adjoining the disk. Lateral budding requires no farther explanation in this place. It is illustrated in figure 32, where the cells of young polyps are seen on the side of the parent stem.

Fig. 28.

Disk budding is peculiar in the steps of the process, and is illustrated in the following figures. Figure 28 represents the upper view of an Astræa polyp, resembling in every respect an Actinia; in figure 29, the same polyp disk is enlarged in one direction, and it contains *two* mouths instead of one, a new one having opened; the tentacles have multiplied with the increase of size. In figure 30, the single disk has begun to subdivide, and the circles of tentacles are

Fig. 29.

Fig. 30.

Fig. 31.

partially completed; in figure 31, we have the two polyps distinct. Thus a parent shares itself off to its young, and each goes on again with the same process of subdivision. They have at first a common visceral cavity; but by gradual growth they separate, excepting the usual intercommunication by pores or lacunes. This has been called an instance of fissiparous generation by Ehrenberg, who first described it, as it has much analogy with the mode of splitting in halves which is found among some infusoria. Yet it does not appear that there is ever a bisection of stomachs; the new mouth is exterior, apparently, to the stomach of the old polyp, and has its own stomach, though one visceral cavity contains the two. Milne Edwards has shown that the lateral budding of an Alcyonium commences in one of the visceral lamellæ, which we have described as the seat of reproduction. It seems altogether probable that this is a general fact, and that in these disk buds the point of gemmation is situated in a lamella just under the disk; consequently, the distinction between disk and lateral buds is rather in the position of the budding centre than in the nature of the process of gemmation.

48. Both lateral and terminal budding may go on continuously, in the same manner as buds proceed from the creeping shoot of a plant. A shoot or process continues elongating uninterruptedly, and at intervals gives out a young polyp; and in the same manner the margin of a growing folium may be constantly widening and giving out young polyps as it widens. This process is called by Ehrenberg, gemmation by *stolons*. Thus, while in some zoophytes the buds are produced only after intervals of time, the young approaching its adult size before budding, in other cases the process of budding and growth proceed together. In the one case the growth of the young absorbs the nutriment for the time being, and in the other, the nutriment goes at the same time both to promote growth and gemmation.

49. *Modes of Growth.*—1. The polyps of a compound group may be united at base only, and each may grow out as a separate branch, as in figure 32. 2. They may be attached also by their sides to one another. In the latter case, they may be united to one another to their very summits, or nearly so, as in Astræas (figure 14) and most massive coral-zoophytes, or they may coalesce only by their lower portions, and then the polyps will project when expanded. If projecting, the corallum will be covered with projecting calicles provided the upper part of the polyps secrete coral, as in most Madrepores: but if the secretions are only basal, there will be no calicles, and only shallow cells; this is the case in the Goniopores which have very projecting polyps but no calicles. Thus we explain many of the peculiarities of corals.

Fig. 32.

When each polyp forms a separate branch, as in figure 32, the zoophyte may be said to be *segregate* in growth; but when they are laterally coalesced as in the massive Astræas and the Madrepores, they may be described as *aggregate*. In the former case, the coralla may also be styled *caliculato-ramose*, as each calicle becomes a separate branch.

50. 2. Polyps differ also essentially in the *process of growth*. 1. Some polyps on reaching the adult size cease farther growth. 2. Others continue endlessly their growth above, and after a while commence the process of death below, so that life and death go on at equal pace. This we style an *acrogenous* mode of increase.* 3. Other species instead of growing upward, scarcely exceed their adult size in height, but grow laterally by

* From ακρον, *top*, and γενναω, *I increase*.

indefinite increase; and as this *prolate* growth is connected with budding, it often produces large foliate zoophytes.

51. The process of consentaneous growth and death is one of the most important in the history of zoophytes, for upon it depend the size they attain and their great geological interest. An example of it is illustrated in figure 32, representing a Carophyllia, the whole of which is lifeless coral excepting the polyp tipping each branch. The bud after development continues elongating its branch, and when but a line long, it dies at base, and so the polyp continues dying as it grows above. It is evident that such a process has no limits; and a little polyp may give origin by growth and budding to a large branched zoophyte.

An Astræa dome is an example of a different kind. Though twelve feet in diameter, it is alive only for half or three fourths of an inch from the surface: the living portion if separated, would form a thin hollow hemisphere or shell of polyps. The polyps growing outward desert the old coral below; or more correctly, the circulation ceases below as the increase goes on above, and consequently, the tissues dry up in the old corallum.

A branching Madrepora on the same principle is dead along the centre of a branch: and after attaining a certain height (differing for different species) it begins to die at base. A Goniopore may form a column several feet in height, and still be alive for only an inch or two at top. The addition of an inch at apex is death to an inch below. The length of the living portion is properly a fixed characteristic of a species in this and other genera.

52. In some Cyathophyllidæ this process of death goes on interruptedly, as explained by Ehrenberg. The tissues of the polyp disappear at intervals from the sides of the corallum, or become dead, leaving a row of unoccupied cellules; then the animal goes on to increase from its contracted size, without refilling the cellules; the corallum consequently becomes covered with encircling ridges, or appears as if formed of a series of inverted cones. In some cases, as in those species referred to the genus Strombodes, the living portion becomes retracted at intervals to the very centre, all the rest dying, and afterwards the animal grows again and spreads to its original diameter; and thus it forms actually one low inverted cone upon another. This peculiarity (probably an occasional result of the exhaustion which often follows reproduction) cannot properly be considered a generic distinction. In the Cyathophylla there are all varieties, from the very roughly wrinkled species to those which are smooth. There are also corals identical in structure with the Strombodes, which present nothing of it; and the same specimen is cone-in-cone on one part and solid or nearly so on others. The facts stated in the preceding volume, page 201, respecting the Hydroidea are in close analogy with the foregoing.

53. This retraction also takes place intermittedly at the base of the polyps in some species, giving rise to a transverse arrangement of septa, more or less regular, as shown in some Cyathophyllidæ, the Favosites and Pocilloporæ.

54. 3. Another peculiarity in the mode of growth is deserving of a few words. I refer to the ready *coalescence of branches.* Some foliaceous Madrepores are made up of coalesced branchlets, none of which are free excepting those at apex; and in others the whole is a network of united branchlets. Simple contact leads to this growing together. It is a union of the animals, but is followed by calcareous secretions which make the union solid. In the same manner, in the Strombodes above mentioned, the separate cones, (or polyps more properly,) become united as they enlarge to their adult size. A fragment of live coral will grow to another of the same kind if placed in contact with it; or if fixed upon a piece of coral rock will finally become attached to the rock and grow on as before.

Connection of Budding and Growth.

55. Some of the points in the structure and forms of corals have been explained in the preceding pages; a farther consideration of the same principles and others closely connected, will explain to us why the tree of stone spreads wide its branches, and how the leafy clusters, domes, and columns are formed.

We may remark separately upon the instances of lateral or *inferior* budding, and terminal or *superior*.

56. A. *Inferior Budding.*—1. If a *non-acrogenous* polyp buds laterally at base, by a single creeping stolon, it will form a linear zoophyte; but if the basal buds are given out in different directions instead of a single line, the zoophyte will spread out in a broad plate, or else a net-work, according as the polyps coalesce laterally or not. The Xenidæ illustrate all these varieties; and they pass into one another by gradual shades. Should the polyps grow together by their sides to their very summit, the thickness of the zoophyte will be equal to the height of the polyps; otherwise, there will be less thickness and the polyps will stand prominent when expanded. Both of these conditions are illustrated among the Zoanthidæ, and the gradations are so imperceptible that we see no propriety in retaining in this family this distinction as generic, though so adopted by former writers.*

The following figure of a Gemmipora illustrates the formation of plates by lateral budding, without acrogenous growth. The fact that the budding is lateral is shown by the internal di-

* The genus Palythoa should include therefore the Mammilifera of Lesueur; see Report on Zoophytes, p. 423.

rection of the cells in the front broken margin. The growth at the outer margin is of the stoloniferous kind, or takes place by

Fig. 33.

Gemmipora.

gradual extension and gemmation. Such forms are termed *explanate* or foliaceous.

57. A very different form results when budding takes place alternately from different sides of polyps growing a little obliquely. Thus in the annexed figures of Oculinæ, the apical polyp gives out a bud, which for a while is the summit polyp, and this bud another in the same manner, and that another, and so on, and in such an alternating, or properly *spiral* order, (figure 35*a*,) that a cylindrical branch is the consequence. This mode of branching may be called *cumulato-ramose*.*

Figs. 34. 35*a*.

35

Oculinæ.

This mode of development may also be considered as closely allied to that of the stolon, since growth and budding is continuous. Indeed there is no important distinction of the stolon, excepting the one alluded to in § 48.

58. 2. In the above instances the polyps have been supposed not to have acrogenous growth, or to possess it only in a very limited degree. When they are *acrogenous*, the results are various according to the mode of budding. If each polyp as it grows goes on to bud, and all bud thus equally and indefinitely, only globular or hemispherical forms can result. This is exemplified among the Porites: yet owing to slight irregularities or more rapid development in one part than another, the forms are usually irregularly glomerate rather than symmetrically globular. When the polyps are not connate by their sides, (that is are *segregate* in growth,) the same will still be the result, as shown in the Columnariæ, Tubiporæ, and Caryophylliæ.†

* The Oculinæ are somewhat acrogenous, and thus the semidiameter of the branches below becomes much greater than the height of a polyp.

† The Cladocoræ of Ehrenberg.

59. But if instead of budding indefinitely, the older polyps after a while lose the power, the zoophyte may commence as a small hemisphere, but will soon lengthen upward without increasing in width; the outer and older effete polyps ceasing to bud, begin the sides of a growing column. Budding will thus be confined to a summit cluster, of some specific size, (according to the species,) and the older polyps will leave the cluster at the same rate as others are produced. The branching Porites, Sideroporæ, and Pocilloporæ grow in this way through a *budding cluster* which constitutes the apex of each branch. Such branches have an obtuse extremity, excepting in the Seriatoporæ and some Gorgoniæ where the budding cluster is small.

60. Again, if the budding by which a branch is formed is confined to a single central polyp, which is acrogenous, then the branch will terminate in this *parent-polyp*, and the new buds will appear in succession around it, as it elongates. This terminal polyp is actually the parent of all the lateral polyps of the branchlet. This mode of growth characterizes the Madrepores and Dendrophylliæ, and any common species of Madrepore will illustrate it. Figures 15 and 16 are examples. The error of placing the Oculinæ with the Dendrophylliæ in one genus, as proposed by Ehrenberg, is thus obvious.

61. When the buds form seriately only on two sides of a branch we may have a two-edged form, as in the Pterogorgia anceps. And if they spread laterally, as well as face in two directions, they give rise to vertical plates, as in some Milleporæ.

62. If the buds are unsymmetrical, or form more rapidly on one side of a cylindrical branch than another, the branches grow more or less horizontally; and thus the vase Madrepores are produced.

63. *Modes of branching as connected with lateral budding.*—We have already alluded to the *caliculato-ramose* forms of zoophytes. There are other modes of branching which should be distinguished.

64. *Patrio-ramose.*—In the Madrepores, one of the non-budding lateral polyps, after the branch is sufficiently lengthened beyond it, begins to bud, and a new branchlet thus commences from this as its *parent-polyp.* The same is the case in the Dendrophyllias, and it is the universal mode in these genera. We may designate such zoophytes by the term *patrio-ramose.*

65. *Cumulato-ramose.*—In the Gorgonias, in much the same manner, a budding cluster (of one or more polyps) begins on the side of a branch, at some specific interval below the apex, and this, by growing and budding, produces a branch. The pinnules of the *Gorgonia setosa* form at regular intervals in this manner, and each commences four to six inches from the summit. At much greater intervals, one of the pinnules below begins to bud

near its base and give rise to branchlets, thus commencing to become itself a branch.

66. *Furcato-ramose.*—In most species which grow from a *budding cluster*, the multiplication of buds in this cluster generally widens it; and the consequence is that the cluster tends to exceed its normal limits in breadth. But soon the central polyps lose the budding power, and the branch commences to fork or subdivide into two branches. This mode of branching (*furcato-ramose*) characterizes the Porites, Sideroporæ, Pocilloporæ and other species.

67. If the polyps of a parent cluster rapidly elongate as in the Gorgoniæ the cluster does not widen, and such species cannot branch by furcation.

68. The position of branches as well as their size is determined by the principles adduced. In Madrepores the angle which the polyps make with the axis of the stem is the angle with which the new branch begins, and this angle varies little therefore in the same species. The length or size of the polyps, and the breadth of a budding cluster, limits the diameters of branches.

69. In the horizontally growing Madrepores, the new branchlets form on the outer or lower side of the branches, and afterwards become successively nearly or quite vertical. This mode of budding retains the zoophyte in a horizontal position.

The warty prominences on a Pocillopora arise from the fact that certain small clusters of polyps of two or three in each, and regularly distributed, continue to bud for a while among those which from age are just leaving the terminal clusters.

70. B. *Superior or Terminal Budding.* In lateral budding, the prolate growth of polyps takes place by the extension of their inferior portions; while in *terminal* budding it proceeds from the *extension of the summits.* The following figure of an Echinopora shows well this peculiarity, and it is still better understood on comparing it with the Gemmipora, figure 33.

Fig. 36.

Echinopora.

The margin grows by extension of the *upper* parts of the polyps, instead of the lower, and it is connected with terminal budding. The cells therefore are not united below to one another as in the Gemmipora. The new bud opens in the extending margin a short distance from the edge, and there the polyp is developed; while in the Gemmipora the polyp cell opens at the very edge itself, and is continuous through the lower extremity of its visceral cavity with that of preceding polyps.

71. The Echinopora referred to is an example of *prolate* growth without *acrogenous.* In the Astræas, both modes are combined. The margin of an *Astræa argus* grows essentially like the Echinopora. But buds also multiply over the growing surface, as illustrated in the annexed figure. The growth, enlarging the surface, tends to enlarge the polyps and widen (in this species) the intervals between the disks. But this widening has its limits, determined by the normal size of the polyps, and when these limits begin to be exceeded, a new polyp buds out in the interval. An example of this is shown near the middle of the annexed figure. This process is constantly going on, and by means of it the symmetry of form which belongs to these hemispherical corals, is retained.

Fig. 37.

Astræa argus.

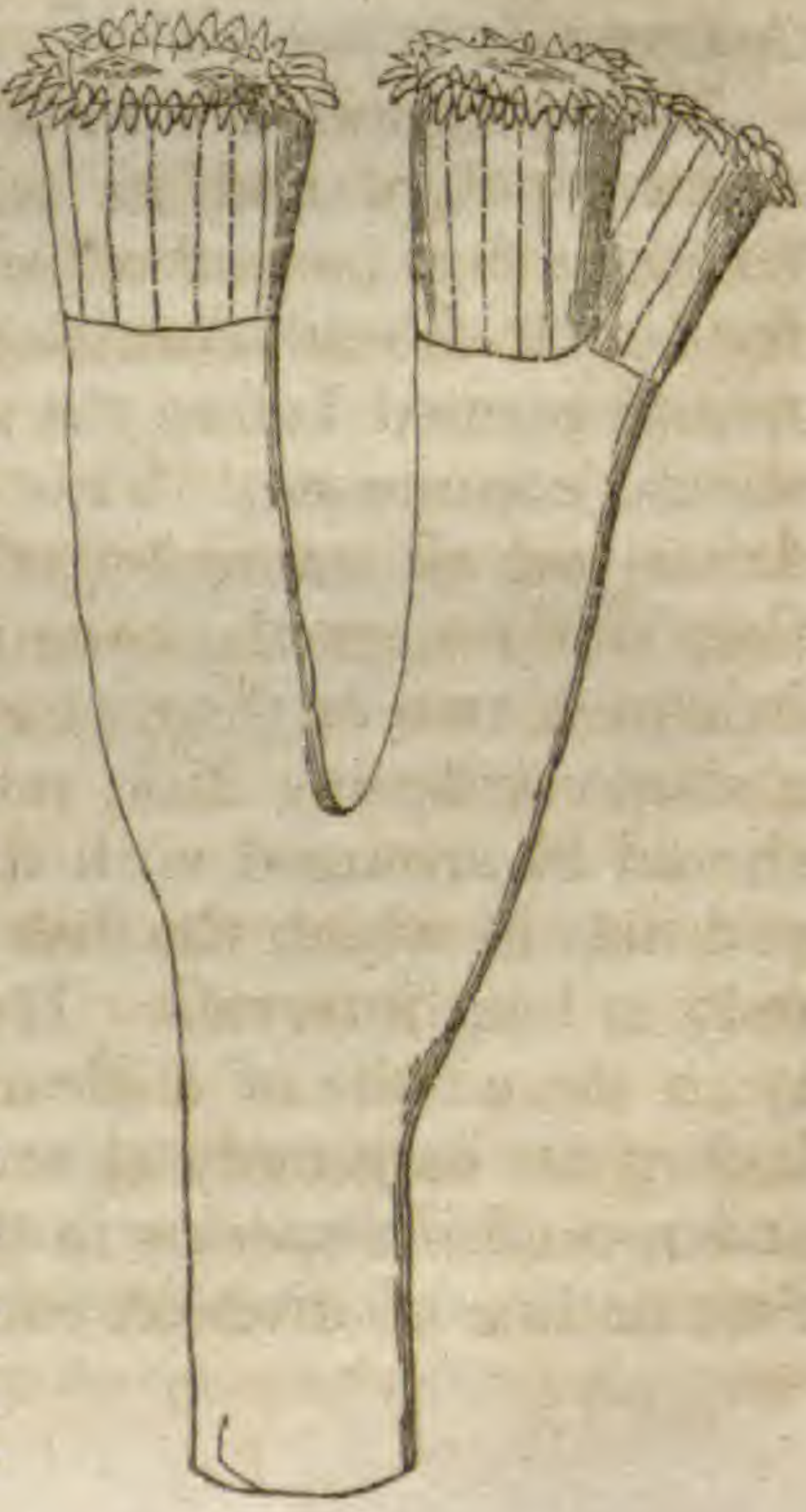
72. This prolate growth of the summits, instead of being confined to the parts exterior to the disks, belongs in many species to the disks themselves; and the consequence is that there is a tendency in these disks (and not in the intervals between them) to exceed their normal size. The result, namely, the opening of a new polyp, has already been described in § 47; and it takes place with the greatest regularity over the hemispherical Astræas.

73. In figures 28 to 31 we have illustrated the formation of a new polyp, and its subsequent separation from the parent. Suppose that instead of separating as soon as formed, the disk in figure 29 should continue widening, till another and another mouth opened before the subdivision (illustrated in the figures,) should commence. This is no hypothetical case, for the Meandrinas are all examples of it and in this simple particular alone, they differ from the common Astræas. There are some Astræas in which two or three mouths, or even four, occasionally open in a single widening disk, and it is difficult to say whether they should be arranged with the Meandrinas or not. There are Meandrinas in which the disk is prolonged indefinitely or subdivides only at long intervals. However great, therefore, the dissimilarity in the coralla of a Meandrina and an Astræa, their actual relations are extremely close. In some instances there are simple and meandrine species in the same genus (Mussa), for the reason that no line of division can be laid down.

74. As an Echinopora is related to the *Astræa argus*, so the foliaceous Merulinæ are related to the Meandrinæ and those Astræas that increase by *disk* buds. They are foliaceous Meandrinæ excepting a few species which are branching. The Monticulariæ differ from the Meandrinæ only in this; that the ridges of the latter are reduced in the former to isolated prominences, by a cross coalescence of the disk lines. The disk, instead of being prolonged, in a single line, is widened in two or three, and thus, this effect is produced. We have then a gradual passage from the Monticularia with a compound reticulate disk to the Astræa with a simple circular disk, and the differences depend upon the prolating disk subdividing or not, or its prolating in more lines than one. There are some branching Merulinas so closely approaching the Monticulariæ, that it is difficult to decide upon the genus to which they should be referred.

75. If the disk should widen in every direction, instead of in particular lines, still another variety would result not yet mentioned. The *Fungidæ* are instances of this. The simple species (Fungiæ) are polyps without margins to the disks; and the compound species (e. g. Polyphylliæ, Herpetolithi, Pavoniæ, Astræa siderea of Lamarck, &c.) have no intervals between the stars or disks. Like the lamellæ at the bottom of a trench in a Meandrina, the lamellæ of the stars pass *uninterruptedly* from one centre (oririme) to another, and this is their characteristic. Yet there are species with concave cells, because the intervals between two polyp-mouths may be prominent, and not because the disks are not confluent.

Fig. 38.



If the facts here stated appear to throw some difficulty in the way of distinguishing the genera and species of zoophytes by their coralla, we may say that no fault can be attributed to the author, for if any where, it pertains to the zoophytes themselves. In this matter we take them as our teachers. A proper study of recent zoophytes, we feel assured, will set aside to a great extent the apparent difficulties. In another place the various characteristics will be further dwelt upon.

76. *Modes of Branching.*—The annexed figure (of a Caulastræa) illustrates a common mode of branching among the ramose species. It is a result of the mode of disk budding already described (§ 47.) On one branch two polyp-mouths already ex-

ist in the enlarged disk; and at the extremity of the other, furcation has commenced. The subdivision is a consequence of the growth and budding; and as it takes place at nearly uniform *intervals*, and depends on the fact that the polyps *have normal limits of size*, the resulting zoophytes are generally very regularly hemispherical in form; moreover the branches in all individuals of the same species are very nearly *alike in size and in the intervals which separate them*. These characters therefore afford important specific distinctions.

77. Other species branch by a succession of buds, nearly as in the Oculinæ. This is the case with the Merulinæ, and may be seen in the branch-like processes over foliaceous species, as well as in the ramose species.

78. From the facts which have been presented, it appears that the distinction of *superior* and *inferior* gemmation and growth is of high importance in the classification of Actinoid Zoophytes. We observe farther that the species which bud just exterior to the disks, and those that subdivide the disks, should be arranged together. Very marked characters separate the Echinoporæ, a type of superior gemmation, from the Gemmiporæ, a type of inferior gemmation; while a very close relation unites the Echinoporæ, Astræa argus and allied species, to the other Astræidæ. We find from the Meandrinæ that this subdivision of disks is a character of no importance; for although these zoophytes are so closely related to the dichastic Astræas, *no* subdivision takes place (§ 73) or only at very long intervals. The *actual distinction therefore consists in the disks widening by growth in some species, and in others the parts just exterior to the disks*,—a peculiarity of little physiological importance in these animals; for there are Astræas (A. stellulata) in which both modes of budding may be occasionally observed. There appears therefore to be sufficient reason for departing from the system of Ehrenberg, in which reproduction by subdivision of disks is considered a character of prime importance, and in accordance with which this distinguished author separates the Astræa argus and similar species from the genus Astræa, and arranges them with species of inferior gemmation.* In the classification we adopt, superior gemmation separates the Astræacea from the Caryophyllacea.†

79. The following tables present a review of the mode of growth, budding and branching, which have been described. And it will be perceived that the subject receives increased interest from the illustrations it affords of corresponding facts in the vegetable kingdom.

---

* Ehrenberg places the Astræa argus, a foliated Gemmipora and some other species in the same genus, to which he has applied Lamarck's name, Explanaria.

† Other distinguishing characters will be hereafter given.

- **Polyps,**
  - **Growth not acrogenous,**
    - **Gemmation inferior,**
      - Budding and growth in a single direction laterally from the base, - 1. Linear.—*Zoanthæ.*
      - Budding laterally from the base in different directions,
        - Coalescent only at intervals, 2. Reticulate.—*Auloporæ.*
        - Every way coalescent, - 3. Explanate or foliaceous, with prominent polyps if the coalescence does not extend to the summits of the polyps.
      - Polyps oblique and budding in erect or ascending lines.
        - Buds in simple or complex series, 4. Erect stems with polyps facing in certain directions.—Many *Sertularidæ.*
        - Buds alternate in direction, and thus forming a spiral series, 5. Erect stems, polyps facing variously.—*Oculinæ.*
        - Budding from a cluster and not limited in direction, 6. Erect stems, as in many *Gorgoniæ.* (These and the Oculinæ are at times somewhat acrogenous.)
    - **Gemmation superior;** polyps every way coalescent, - - - 7. Explanate, with the polyps but little or not at all prominent.—*Echinoporæ.*
  - **Growth acrogenous,**
    - **Buds not limited in direction,**
      - Unlimited by age,
        - Segregate, - - 8. Globular or hemispherical, and consisting of tubular or calicular branches.—*Tubiporæ, Mussæ, Caryophylliæ.*
        - Aggregate, 9. Globular or hemispherical, massive.—*Astræas,* &c.
      - Limited to the younger polyps, - - - 10. Columnar, or subcylindrical stems, with a budding cluster at apex.—Many *Porites, Pocilloporæ,* &c.
      - Limited to a single acrogenous polyp, which buds laterally and indefinitely, 11. Cylindrical stems with a parent-polyp at apex.—*Madreporæ, Dendrophylliæ.* These become *horizontal* or oblique, when the polyps are developed unequally on two opposite sides, as in horizontally growing Madrepores, which, when the branches spread from a centre, are *vase-shape.*
    - **Buds facing in two directions, and spreading laterally as well as upward,** 12. Vertical plates, some *Milleporæ.*

The branching of Zoophytes takes place :—1. By means of terminal shoots, from summit buds, periodical or not.
2. By means of lateral shoots, proceeding from a cluster of lateral polyps, assuming the gemmating function, (cumulato-ramose.)
3. By means of lateral shoots from a single lateral polyp becoming a parent-polyp, (patrio-ramose.)
4. By the furcation of a budding cluster owing to its enlargement, (furcato-ramose.)
5. By furcation, in certain segregate species, of a terminal polyp, arising from disk-budding, (Mussæ, Caulastrææ.)

Branching species are farther modified by coalescence, and become thus reticulate, laminate, or even massive, according to the extent of the coalescence.

We cite the following concluding remarks from the Report on Zoophytes, to which work reference may be made for fuller details on the various points which have been under consideration.

80. We thus perceive the principal steps by which corals take on their specific forms, and see reason for the fact that these forms are constant in the same species. The many varied shapes of zoophytes,—the tree, the shrub, the clustered leaves, globes and hemispheres, clubs, twigs, and coral network,—require for their explanation only the few principles here adduced. The germ-polyp, growing upward and budding as it grows, gives rise to the various branching and nodular zoophytes, while by growth laterally, the *explanate* or oblique foliated species originate. In the upward mode of growth, when all the polyps bud equally, globes and hemispheres are produced; but if the gemmating power is retained only by the recent polyps, the zoophyte lengthens into stems and cylinders. When, in this last process, budding takes place symmetrically, the zoophyte is erect; if unsymmetrical, it is oblique or horizontal; and the zoophyte, when erect, is cylindrical or a flattened plate, according as buds form alike on all sides of a centre, or open in two opposite directions. In some acrogenous species, there is a terminal polyp,—*parent-polyp*,—from which the buds proceed; in others, a terminal *cluster of polyps*. The *former*, ramify by lateral shoots, common polyps changing to parent-polyps, and thus becoming the germs of branches, which take their direction from the position of the budding-polyp; the *latter*, branch generally by furcation at summit, the size of the terminal cluster determining the diameter of the branch, and indirectly occasioning the furcation.

In other species still, each polyp gives out its single polyp in succession, and the continued accumulation produces the rising stem, which ramifies either by the processes just mentioned, or from buds at apex, forming periodically and becoming the germs of branches.

There is much to surprise and interest us in tracing out the simple causes of results so remarkable. The small polyp, incapable even of extending its arms without a drop of water to inject them, is enabled, by means of a simple secretion in its texture, in connexion with the process of budding, to rise from the rock and spread wide its branches, or erect, with solid masonry, the coral domes, in defiance of the waves that break over them. The microscopic germ of a Gorgonia developes a polyp barely visible to the naked eye, which has the power of producing a secretion from its base. The polyp buds, and finally the growing shrub is covered with branches and branchlets, many a mere thread in thickness, which stand and wave unhurt in the agitated waters. The same secretions fix it to its support, and so strongly, that even the rock comes away before the zoophyte will break from its attachment. Tens of thousands of polyps cover the branches, like so many flowers, spreading their tinted petals in the genial sunshine, and quiet seas, but withdrawing when the clouds betoken a storm.

"Excelsior," is the grave motto of the zoophyte. Ever upward, they continue growing and elongating, although death is at work below, with as rapid progress. A beautiful provision protects the branching coral-tree—often the work of ages—from being destroyed by the dissolving waters, when exposed, on the death and removal of the polyps. Certain minute incrusting corals—the Bryozoa and Sertularidæ, together with Nullipores—make the surface their resting place, as soon as it is laid bare, and go on spreading and covering the dead trunk, and so prevent the wearing action of the sea. The Madrepore may thus continue to enlarge beyond its adult size ; the Caryophyllia may multiply almost endlessly its cylindrical branchings, although the living animal but tips the extremities of each : for protection is given at once, when needed, and the polyps die, only to leave the surface to other forms of life, more varied and no less strange.

Finally, the coral becomes subservient to a still higher purpose than the support of polyps and nullipores. The debris, produced by the waves over a reef, settles into the many crevices among the dead trunks, and fills up the intervals, often large, between the scattered coral-patches ; and, by this combined action of living growth and detritus accumulations, a solid rocky basement is formed, and kept in constant increase. In this way the coral reef gradually nears the surface, and finally becomes the foundation of one of the fairest of

> "The sea-girt isles,
> That, like to rich and various gems, inlay
> The unadorned bosom of the deep ;"

the coral polyps now yield place to the flowers and groves of the land, which fulfill their end in promoting the comfort and happiness of man.

Note.—The figures illustrating this article represent the following species of corals.

Fig. 13. Polyp of the *Mussa cactus* (D), natural size. Allied to the *Caryophyllia carduus* of Lamarck, (genus *Lobophyllia* of Blainville.)

Fig. 14. The *Astræa purpurea* (D), alive and expanded ; natural size.

Fig. 15. Part of a branch of the *Madrepora cribripora* (D), alive and expanded ; natural size.

Fig. 16. Part of a branch of the *Dendrophyllia nigrescens* (D), alive and expanded ; natural size.

Fig. 17. A lobe of the *Xenia florida*, probably the *Actinantha florida* of Lesson ; natural size.

Fig. 18. A polyp of the *Tubipora fimbriata* (D), enlarged between three and four diameters.

Fig. 32. *Caryophyllia arbuscula*. (Lesueur.)

Fig. 34. Part of a branch of *Oculina varicosa*. (Lesueur.)

Fig. 35. Part of a branch of *Oculina pallens*. (Ehrenberg.)

Fig. 38. A branch of the *Caulastræa furcata*. (D.)

ART. II.—*On the Induction of Atmospheric Electricity on the Wires of the Electrical Telegraph;* by Prof. JOSEPH HENRY.*

THE action of the electricity of the atmosphere on the wires of the electrical telegraph, is at the present time a subject of much importance, both on account of its practical bearing, and the number of purely scientific questions which it involves. I have accordingly given due attention to the letter referred to me, and have succeeded in collecting a number of facts in reference to the action in question. Some of these are from the observations of different persons along the principal lines, and others from my own investigations during a thunder-storm on the 19th of June, when I was so fortunate as to be present in the office of the telegraph in Philadelphia, while a series of very interesting electrical phenomena was exhibited. In connexion with the facts derived from these sources, I must ask the indulgence of the society in frequently referring, in the course of this communication, to the results of my previous investigations in dynamic electricity, accounts of which are to be found in the Proceedings and Transactions of this Institution.

From all the information on the subject of the action of the electricity of the atmosphere on the wires of the telegraph, it is evident that effects are produced in several different ways.

1. The wires of the telegraph are liable to be struck by a direct discharge of lightning from the clouds, and several cases of this kind have been noticed during the present season. About the 20th of May, the lightning struck the elevated part of the wire, which is supported on a high mast at the place where the telegraph crosses the Hackensack river. The fluid passed along the wire each way, from the point which received the discharge, for several miles, striking off at irregular intervals down the supporting poles. At each place where the discharge to a pole took place, a number of sharp explosions were heard in succession, resembling the rapid reports of several rifles. During another storm, the wire was struck in two places in Pennsylvania, on the route between Philadelphia and New York; at one of these places twelve poles were struck, and at the other eight. In the latter case the remarkable fact was observed, that every other pole escaped the discharge; and the same phenomenon was observed, though in a less marked degree, near the Hackensack river. In some instances the lightning has been seen coursing along the wire in a stream of light; and in another case it is described as exploding from the wire at certain points, though

* Communicated by the author from the Proceedings of the American Philosophical Society, vol. iv, p. 260.

there were no bodies in the vicinity to attract it from the conductor.

In discussing these, and other facts to be mentioned hereafter, we shall, for convenience, adopt the principles and language of the theory which refers the phenomena of electricity to the action of a fluid, of which the particles repel each other, and are attracted by the particles of other matter. Although it cannot be affirmed that this theory is an actual representation of the cause of the phenomena as they are produced in nature, yet it may be asserted that it is, in the present state of science, an accurate mode of expressing the laws of electrical action, so far as they have been made out; and that though there are a number of phenomena which have not as yet been referred to this theory, there are none which are proved to be directly at variance with it.

That the wires of the telegraph should be frequently struck by a direct discharge of lightning, is not surprising, when we consider the great length of the conductor, and, consequently, the many points along the surface of the earth through which it must pass, peculiarly liable to receive the discharge from the heavens. Also, from the great length of the conductor, the more readily must the repulsive action of the free electricity of the cloud drive the natural electricity of the conductor to the farther end of the line, thus rendering more intense the negative condition of the nearer part of the wire, and, consequently, increasing the attraction of the metal for the free electricity of the cloud. It is not however, probable, that the attraction, whatever may be its intensity, of so small a quantity of matter as that of the wire of the telegraph, can of itself produce an electrical discharge from the heavens: although, if the discharge were started by some other cause, such as the attraction of a large mass of conducting matter in the vicinity, the attraction of the wire might be sufficient to change the direction of the descending bolt, and draw it in part or whole, to itself. It should also be recollected, that on account of the perfect conduction, a discharge on any part of the wire must affect every other part of the connected line, although it may be hundreds of miles in length.

That the wire should give off a discharge to a number of poles in succession, is a fact I should have expected, from my previous researches on the lateral discharge of a conductor transmitting a current of free electricity. In a paper on this subject, presented to the British Association in 1837, I showed that when electricity strikes a conductor explosively, it tends to give off sparks to all bodies in the vicinity, however intimately the conductor may be connected with the earth. In an experiment in which sparks from a small machine were thrown on the upper part of a lightning rod, erected in accordance with the formula given by the French Institute, corresponding sparks could be drawn from every part of the rod, even from that near the ground. In a communication since made to this society, I have succeeded in referring this phenomenon to the fact, that during the transmission of a quantity of electricity along a rod, the surface of the conductor is charged in succession, as it were, by a wave of the fluid, which, when it arrives opposite a given point, tends to give off a spark to a neighboring body, for the same reason that the charged conductor of the machine gives off a spark under the same circumstances.

It might at first be supposed that the redundant electricity of the conductor would exhaust itself in giving off the first spark, and that a second discharge could not take place; but it should be observed, that the wave of free electricity, in its passage, is constantly attracted to the wire by the portion of the uncharged conductor which immediately precedes its position at any time; and hence but a part of the whole redundant electricity is given off at one place; the velocity of transmission of the wave as it passes the neighboring body, and its attraction for the wire, preventing a full discharge at any one place. The intensity of the successive explosions is explained by referring to the fact, that the discharge from the clouds does not generally consist of a single wave of electricity, but of a number of discharges along the same path in rapid succession, or of a continuous discharge which has an appreciable duration; and hence the wire of the telegraph is capable of transmitting an immense quantity of the fluid thus distributed over a great length of the conductor.

The remarkable facts of the explosions of the electricity into the air, and of the poles being struck in interrupted succession, find a plausible explanation in another electrical principle which I have established, namely, in all cases of the disturbance of the equilibrium of the electrical plenum, which we must suppose to exist throughout all terrestrial space, the state of rest is attained by a series of diminishing oscillations. Thus, in the discharge of a Leyden jar, I have shown that the phenomena exhibited cannot be explained by merely supposing the transfer of a quantity of fluid from the inner to the outer side of the jar; but in addition to this we are obliged to admit the existence of several waves, backwards and forwards, until the equilibrium is attained. In the case of the discharge from the cloud, a wave of the natural electricity of the metal is repelled each way from the point on which the discharge falls, to either end of the wire, is then reflected, and in its reverse passage meets in succession the several waves which make up the discharge from the cloud. These waves will therefore interfere at certain points along the wire, producing, for a moment, waves of double magnitude, and will thus enhance the tendency of the fluid at these points to fly from the conductor. I do not say that the effects observed were actually produced in this way; I merely wish to convey the idea that known principles of electrical action might, under certain circumstances, lead us to anticipate such results.

2. The state of the wire may be disturbed by the conduction of a current of electricity from one portion of space to another, without the presence of a thunder-cloud; and this will happen in case of a long line, when the electrical condition of the atmosphere which surrounds the wire at one place is different from that at another. Now it is well known that a mere difference in elevation is attended with a change in the electrical state of the atmosphere. A conductor, elevated by means of a kite, gives sparks of positive electricity in a perfectly clear day; hence, if the line of the telegraph passes over an elevated mountain ridge, there will be continually, during clear weather, a current from the more elevated to the lower points of the conductor.

A current may also be produced in a long level line, by the precipitation of vapor in the form of fog at one end, while the air remains clear at the other; or by the existence of a storm of rain or snow at any point along the line, while the other parts of the wire are not subjected to the same influence.

Currents of sufficient power to set in motion the marking machine of the telegraph have been observed, which must have been produced by some of these causes. In one case the machine spontaneously began to operate without the aid of the battery, while a snow storm was falling at one end of the line, and clear weather existed at the other. On another occasion, a continued stream of electricity was observed to pass between two points at a break in the wire, presenting the appearance of a gas-light almost extinguished. A constant effect of this kind indicates a constant accession of electricity at one part of the wire, and a constant discharge at the other.

3. The natural electricity of the wire of the telegraph is liable to be disturbed by the ordinary electrical induction of a distant cloud. Suppose a thunder-cloud, driven by the wind in such a direction as to cross one end of the line of the telegraph at the elevation, say of a mile; during the whole time of the approach of the cloud to the point of its path directly above the wire, the repulsion of the redundant electricity with which it is charged would constantly drive more and more of the natural electricity of the wire to the farther end of the line, and would thus give rise to a current. When the cloud arrived at the point nearest to the wire, the current would cease for a moment; and as the repulsion gradually diminished by the receding of the cloud, the natural electricity of the wire would gradually return to its normal state, giving rise to a current in an opposite direction. If the cloud were driven by the wind parallel to the line of the telegraph, a current would be produced towards each end of the

wire, and these would constantly vary in intensity with the different positions of the cloud. Although currents produced in this way may be too feeble to set in motion the marking apparatus, yet they may have sufficient power to influence the action of the current of the battery so as to interfere with the perfect operation of the machine.

4. Powerful electrical currents are produced in the wires of the telegraph by every flash of l ghtning which takes place within many miles of the line, by the action of dynamic induction; which differs from the action last described, in being the result of the influence of electricity *in motion* on the natural electricity of the conductor. The effect of this induction, which is the most fruitful source of disturbance, will be best illustrated by an account of some experiments of my own, presented to the society in 1843. A copper wire was suspended by silk strings around the ceiling of an upper room, so as to form a parallelogram of about sixty feet by thirty on the sides; and in the cellar of the same building, immediately below, another parallelogram of the same dimensions was placed. When a spark from an electrical machine was transmitted through the upper parallelogram, an induced current was developed in the lower one, sufficiently powerful to magnetize needles, although two floors intervened, and the conductors were separated to the distance of thirty feet. In this experiment no electricity passed through the floors from one conductor to the other; the effect was entirely due to the repulsive action of the electricity in motion in the upper wire on the natural electricity of the lower. In another experiment, two wires, about 400 feet long, were stretched parallel to each other between two buildings; a spark of electricity sent through one produced a current in the other, though the two were separated to the distance of 300 feet; and from all the experiments, it was concluded that the distance might be indefinitely increased, provided the wires were lengthened in a corresponding ratio.

That the same effect is produced by the repulsive action of the electrical discharge in the heavens, is shown by the following modification of the foregoing arrangement. One of the wires was removed, and the other so lengthened at one end, as to pass into my study, and thence through a cellar window into an adjacent well. With every flash of lightning which took place in the heavens, within at least a circle of twenty miles around Princeton, needles were magnetized in the study by the induced current developed in the wire. The same effect was produced by soldering a wire to the metallic roof of the house, and passing it down into the well; at every flash of lightning a series of currents in alternate directions was produced in the wire.

I was also led, from these results, to infer that induced currents must traverse the line of a railroad, and this I found to be the case. Sparks were seen at the breaks in the continuity of the rail, with every flash of a distant thunder-cloud.

Similar effects, but in a greater degree, must be produced on the wire of the telegraph, by every discharge in the heavens; and the phenomena which I witnessed on the 19th of June in the telegraph office in Philadelphia, were, I am sure, of this kind. In the midst of the hurry of the transmission of the congressional intelligence from Washington to Philadelphia, and thence to New York, the apparatus began to work irregularly. The operator at each end of the line announced at the same time a storm at Washington, and another at Jersey City. The portion of the circuit of the telegraph which entered the building, and was connected with one pole of the galvanic battery, happened to pass within the distance of less than an inch of the wire which served to form the connexion of the other pole with the earth. Across this space, at an interval of every few minutes, a series of sparks in rapid succession was observed to pass; and when one of the storms arrived so near Philadelphia that the lightning could be seen, each series of sparks was found to be simultaneous with a flash in the heavens. Now we cannot suppose, for a moment, that the wire was actually struck at the time each flash took place; and indeed it was observed that the sparks were produced when the cloud and flash were at the distance of several miles to the east of the line of the wire. The inevitable conclusion is, that all the exhibition of electrical phenomena witnessed during the afternoon, was purely the effect of induction, or the mere disturbance of the natural electricity of the wire at a distance, without any transfer of the fluid from the cloud to the apparatus.

The discharge between the two portions of the wire continued for more than an hour, when the effect became so powerful, that the superintendent, alarmed for the safety of the building, connected the long wire with the city gas pipes, and thus transmitted the current silently to the ground. I was surprised at the quantity and intensity of the current; it is well known, that to affect a common galvanometer with ordinary electricity, requires the discharge of a large battery; but such was the quantity of the induced current exhibited on this occasion, that the needle of an ordinary vertical galvanometer, with a short wire, and apparently of little sensibility, was moved several degrees.

The pungency of the spark was also, as might have been expected, very great. When a small break was made in the circuit, and the parts joined by the fore-finger and thumb, the discharge transmitted through the hand affected the whole arm up to the shoulder. I was informed by the superintendent, that on another occasion a spark passed over the surface of the spool of wire, surrounding the legs of the horse-shoe magnet at right angles to the spires; and such was its intensity and quantity, that all the wires across which it passed were melted at points in the same straight line as if they had been cut in two by a sharp knife.

The effects of the powerful discharges from the clouds may be prevented in a great degree, by erecting at intervals along the line, and aside of the supporting poles, a metallic wire, connected with the earth at the lower end, and terminating above at the distance of about half an inch from the wire of the telegraph. By this arrangement the insulation of the conductor will not be interfered with, while the greater portion of the charge will be drawn off. I think this precaution of great importance at places where the line crosses a river, and is supported on high poles. Also in the vicinity of the office of the telegraph, where a discharge, falling on the wire near the station, might send a current into the house of sufficient quantity to produce serious accidents. The fate of Prof. Richman, of St. Petersburg, should be recollected, who was killed by a flash from a small wire, which entered his house from an elevated pole, while he was experimenting on atmospheric electricity.

The danger, however, which has been apprehended from the electricity leaving the wire and discharging itself into a person on the road, is, I think, very small; electricity of sufficient intensity to strike a person at the distance of eight or ten feet from the wire, would, in preference, be conducted down the nearest pole. It will, however, in all cases, be most prudent to keep at a proper distance from the wire during the existence of a thunder storm in the neighborhood.

It may be mentioned as an interesting fact, derived from two independent sources of information, that large numbers of small birds have been seen suspended by the claws from the wire of the telegraph. They had, in all probability, been instantaneously killed, either by a direct discharge, or an induced current from a distant cloud, while they were resting on the wire.

Though accidents to the operators, from the direct discharge, may be prevented by the method before mentioned, yet the effect on the machine cannot be entirely obviated; the residual current which escapes the discharge along the perpendicular wires, must neutralize, for a moment, the current of the battery, and produce irregularity of action in the apparatus.

The direct discharge from the cloud on the wire is, comparatively, not a frequent occurrence, while the dynamic inductive influence must be a source of constant disturbance during the season of thunder storms; and no other method presents itself to my mind at this time for obviating the effect, but that of increasing the size of the battery, and diminishing the sensibility of the magnet, so that, at least, the smaller induced currents may not be felt by the machine. It must be recollected, that the inductive influence takes place at a distance through all bodies, conductors and non-conductors; and hence no coating that can be put upon the wire will prevent the formation of induced currents.

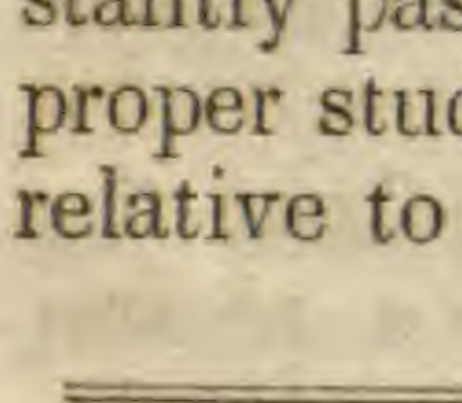
I think it not improbable, since the earth has been made to act the part of the return conductor, that some means will be discovered for insulating the single wire beneath the surface of the earth; the difficulty in effecting this is by no means as great as that of insulating two wires, and preventing the current striking across from one to the other. A wire, buried in the earth, would be protected, in most cases, from the effect of a direct discharge; but the inductive influence would still be exerted, though perhaps in a less degree.

The wires of the telegraph are too small and too few in number to affect, as some have supposed, the electrical condition of the atmosphere, by equalizing the quantity of the fluid in different places, and thus producing a less changeable state of the weather. The feeble currents of electricity which must be constantly passing along the wires of a long line, may, however, with proper study, be the means of discovering many interesting facts relative to the electrical state of the air over different regions.

Art. III.—*A New Mineral from the Azores;* by J. E. Teschemacher.

In examining a portion of a volcanic boulder from St. Michael's, Azores, for specimens of Pyrrhite, I discovered several small crystals, apparently octahedrons, of a translucent slightly yellowish white color, which alone before the blowpipe were totally infusible; on farther examination they proved to be nearly pure columbate of lime. The following is a description of them.

Form—a square prism terminated by four-sided pyramids.



M on c = 133·40 }
c " c = 123·15 } by the reflecting goniometer.
M " M′ = 90 }

Nearly all the crystals are in the form of obtuse octahedrons, the vertical axis being shorter than the lateral; one or two were found with prisms about the height of the pyramids—these were measured.*

The color is usually translucent to opake white, with a very faint greenish yellow tinge; one or two were however as clear as fine quartz; these were probably pure columbate of lime.

* Specimens of this mineral, received through the kindness of Mr. Teschemacher, correspond entirely to the description above given.—*J. D. D.*

Fracture vitreous—no trace of cleavage. The largest crystal is only 1½ lines at the base of the pyramid.

Before the blowpipe alone, the small pure crystals become opake white; those larger and more colored acquire in the outer flame a distinct red color, *partially* disseminated in the interior of the crystal. This color disappears in the reducing flame, the whole becoming of a very light sulphur yellow; the red color is reproduced by exposure to the outer flame, after cooling, and again disappears in the reducing flame; this alternation takes place as often as desired. The edges are not even rounded.

With borax on the platina wire, the crystals in the hottest reducing flame dissolve with extreme slowness and difficulty; the globule is quite transparent, sometimes exhibiting a very faint greenish tint. When the globule is saturated with the mineral, it becomes opake white by flaming. On the addition of peroxyd of iron to the globule, it gives the usual green color of a ferruginous oxyd. These characters do not permit a doubt of its being a columbic acid mineral.

Phosphoric salt dissolves the crystals slowly, a faint green tint becoming apparent; this indicates a trace of uranium.

The powdered mineral is decomposed on fusing with bisulphate of potash, and the addition of hydrochloric acid precipitates columbic acid. On removing the acid liquor by the filter, and immersing in it a crystal of bisulphate of potash, flocculent crystals of sulphate of lime appear.

The mineral, therefore, like Pyrochlore, is a columbate of lime, but as there can be no doubt that this latter is a regular octahedron, there must be some cause for the difference in their forms. This may either arise from a change produced by a chemical combination of some of the other ingredients of Pyrochlore, or from this new mineral being columbic acid in a different state of saturation by lime, from that in Pyrochlore. Either of these cases is of much interest to the chemist and mineralogist, and I regret that the quantity found is so small as for the present to preclude regular chemical analyses of this beautiful though microscopic mineral. It seems most probable, as far as we can judge from the examinations, that it is a case of dimorphism.

The characters of Pyrrhite before the blowpipe were examined at the same time, and confirm my previous opinion of its titanic composition. On the addition to its solution in the borax globule of a portion of peroxyd of iron, it gives the usual reddish brown glass indicative of titanium.

I am indebted to my friend Dr. A. A. Hayes, for a careful examination and confirmation of the blowpipe characters, as well as for the chemical reactions.

There is so great a similarity in the occurrence of this crystallized columbate of lime in the volcanic boulders of the Azores, and that of Pyrochlore in the vein in granite at Chesterfield, that a comparison of the two seems worthy of notice; premising, however, that I have examined too small a quantity of the St. Michael's rock, to arrive at any conclusions of consequence.

Chesterfield, Massachusetts.

A large vein of granite in mica slate, lying nearly in the direction of the slate, obliquely crossed by a vein of the following contents.

Albite—chief ingredient, the quartz appearing mostly aggregated in the central part of the vein.

Tourmaline—red, green, blue and black, in considerable quantity, often in small crystals.

Mica—quantity very moderate.

Pyrochlore—(columbate of lime)—quantity very small.

Damourite }
Columbite } extremely rare.
Uranium }

Titanium—a trace sometimes in the Pyrochlore.

Professor Hitchcock does not give the bearings of these eruptive veins, and I have not visited the locality.

St. Michael's, Azores.

Contents of volcanic boulders.

Albite—chief constituent.

Tourmaline—black, in considerable quantity. Crystals small.

Mica—a trace.

Columbate of lime, the mineral described in this paper, quantity very small, but containing a trace of Uranium.

Titanium—Pyrrhite, quantity very small.

There is another volcanic rock from this locality, in which the Albite is replaced by Ryakolite, and the octahedral Pyrrhite by a titanium mineral of a different form.

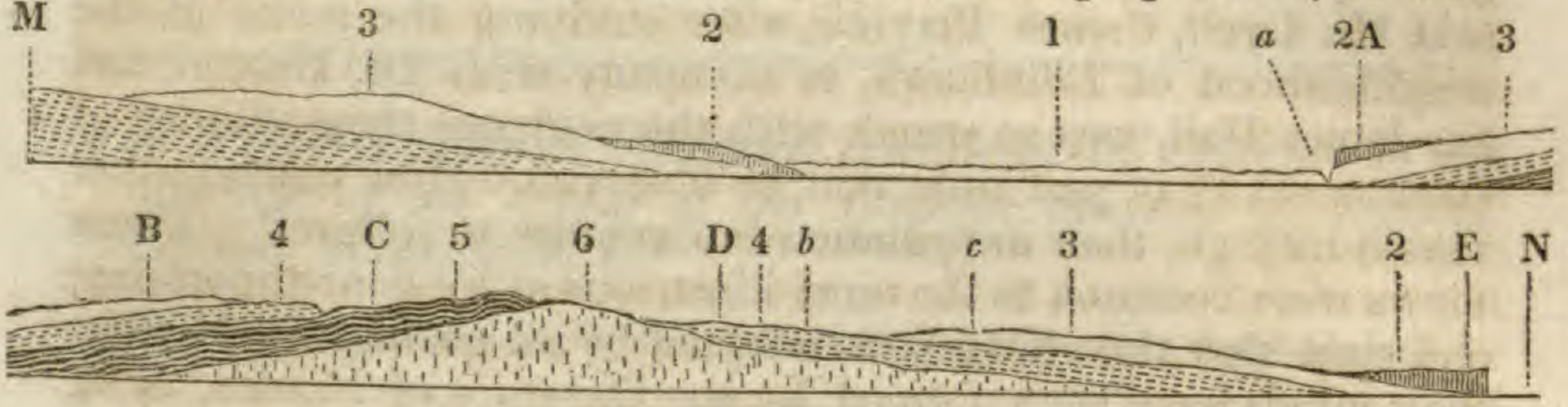
Art. IV.—*On the Delta and Alluvial Deposits of the Mississippi, and other points in the Geology of North America, observed in the years* 1845, 1846; by C. Lyell.*

The delta of the Mississippi may be defined as that part of the great alluvial plain which lies below, or to the south of the branching off of the highest arm of the river, called the Atchafalaya. This delta is about 13,600 square miles in area, and elevated from a few inches to ten feet above the level of the sea. The greater part of it protrudes into the Gulf of Mexico beyond the general coast line. The level plain to the north, as far as Cape Girardeau in Missouri above the junction of the Ohio, is of the same character, including, according to Mr. Forshey, an area of about 16,000 square miles, and is, therefore, larger than the delta. It is very variable in width from east to west, being near its northern extremity, or at the mouth of the Ohio, 50 miles wide; at Memphis 30; at the mouth of the White River 80, and contracting again farther south, at Grand Gulf, to 33 miles. The delta and alluvial plain rise by so gradual a slope from the sea as to attain, at the junction of the Ohio, (a distance of 800 miles by the river,) an elevation of only two hundred

* Abstract of a discourse before the British Association, Sept. 14, 1846, from the Athenæum, for September 26.

feet above the Gulf of Mexico. Mr. Lyell first described the low mud banks covered with reeds at the mouths of the Mississippi, and the pilot-station called the Balize; then passed to the quantity of drift wood choking up the bayous, or channels, intersecting the banks; and, lastly, enlarged on the long narrow promontory formed by the great river and its banks between New Orleans and the Balize. The advance of this singular tongue of land has been generally supposed to have been very rapid, but Mr. Lyell and Dr. Carpenter, who accompanied him, arrived at an opposite conclusion. After comparing the present state of this region with the map published by Charlevoix, 120 years ago, they doubt whether the land has, on the whole, gained more than a mile in the course of a century. A large excavation, eighteen feet deep, made for the gas works at New Orleans, and still in progress, March, 1846, shows that much of the soil there consists of fine clay or mud, containing innumerable stools of trees, buried at various levels in an erect position, with their roots attached, implying the former existence there of fresh-water swamps covered with trees, over which the sediment of the Mississippi was spread during inundations, so as slowly to raise the level of the ground. As the site of the excavation is now about nine feet above the sea, the lowest of these upright trees imply that the region where they grew has sunk down about nine feet below the sea level. The exposure, also, in the vertical banks of the Mississippi at low water for hundreds of miles above the head of the delta, of the stumps of trees buried with their roots in their natural position, three tiers being occasionally seen one above the other, shows that the river in its wanderings has opened a channel through ancient morasses, where trees once grew, and where alluvial matter gradually accumulated. The old deserted beds, also, of the river, with banks raised fifteen feet above the adjoining low grounds, bear testimony to the frequent shifting of the place of the main stream; and the like inference may be drawn from the occurrence, here and there, of crescent-shaped lakes, each many miles in length and half a mile or more in breadth, which have once constituted great curves or bends of the river, but are now often far distant from it. The Mississippi, by the constant undermining of its banks, checks the rise of large commercial towns on its borders, and causes a singular contrast between the wealth and splendor of eight hundred or more fine steamers, some of which may truly be called floating palaces, and the flat monotonous wilderness of uncleared land which extends for hundreds of miles on both sides of the great navigable stream. Mr. Lyell visited, in March, 1846, the region shaken for three months in 1811, 12, by the earthquake of New Madrid. One portion of it, situated in the States of Missouri and Arkansas, is now called "the sunk country." It extends about seventy miles north and south, and thirty east and west, and is for the most part submerged. Many dead trees are still standing erect in the swamps, a far greater number lie prostrate. Even on the dry ground in the vicinity, all the forest trees which are of prior date to 1811, are leafless: they are supposed to have been killed by the loosening of their roots by the repeated shocks of 1811, 12. Numerous rents are also observable in the ground where it opened in 1811; and many "sink holes," or cavities, from ten to thirty yards wide and twenty feet or more in depth, now interrupt the general level of the plain, which were formed by the spouting out of large quantities of sand and mud during the earthquake. In attempting to compute the minimum of time required for the accumulation of the alluvial matter in the delta and valley of the Mississippi, Mr. Lyell referred to a series of experiments, made by Dr. Riddell, at New Orleans, showing that the mean annual proportion of sediment in the river was, to the water $\frac{1}{1245}$ in weight, or about $\frac{1}{3000}$ in volume. From the observations of the same gentleman, and those of Dr. Carpenter, and of Mr. Forshey, (an eminent engineer of Louisiana,) the average width, depth, and velocity of the Mississippi, and thence the mean annual discharge of water, are deduced. In assuming 528 feet (or the tenth of a mile) as the probable thickness of the deposit of mud and sand in the delta, Mr. Lyell founds his conjecture on the depth of the Gulf of Mexico, between the southern point of Florida and the Balize, which equals on an average 100 fathoms. The area of the delta being about 13,600 square statute miles, and the quantity of solid matter annually brought down by the river 3,702,758,400 cubic feet, it must have taken 67,000 years for the formation of the whole; and if the alluvial matter of the plain above be 264 feet deep, or half that of the delta, it has required 33,500 more years for its accumulation,—even if its area be estimated as only equal to that of the delta, whereas it is, in fact, larger. If some deduction be made from the time here stated, in consequence of the effect of drift wood, which must have aided in filling up more rapidly the space above alluded to, a far more important allowance must be made, on the other hand, for the loss of matter, owing to the finer particles of mud not settling at the mouth of the river, but being swept out far to sea, and even conveyed into the Atlantic by the Gulf Stream. Yet the whole period during which the Mississippi has transported its earthy burthen to the ocean, though perhaps far exceeding 100,000 years, must be insignificant, in a geological point of view, since the bluffs or cliffs bounding the great valley, (and therefore older in date,) and which are from 50 to 250 feet in perpendicular height, consist in great part of loam, containing land, fluviatile, and lacustrine shells of species still inhabiting the same country. These fossil shells, occurring in a deposit resembling the *loess* of the

Rhine, are associated with the bones of the mastodon, elephant, tapir, mylodon, and other megatherioid animals; also a species of horse, ox, and other mammalia, most of them of extinct species. The loam rests at Vicksburg and other places on eocene or lower tertiary strata, which in their turn, repose on cretaceous rocks. A section from Vicksburg to Darien, through the States of Mississippi, Alabama and Georgia, exhibits this superposition, as well



Section (M to N) about 750 miles in length from west to east, from Louisiana (on the west) through Jackson, Mississippi, to Tuscaloosa, in Alabama, and thence, by Montgomery, to the Atlantic, near Darien, in Georgia.*

as that of the cretaceous strata on carboniferous rocks at Tuscaloosa. Mr. Lyell ascertained that the huge fossil cetacean, named Zeuglodon, by Owen, is confined to the eocene deposits. In the cretaceous strata, the remains of the mosasaurus, and other reptiles, occur without any cetacea.

The coal-fields of Alabama were next alluded to; from which fossil plants have been procured, by Prof. Brumby and Mr. Lyell, of the genera Sphenopteris, Neuropteris, Calamites, Lepidodendron, Sigillaria, Stigmaria, and others, most of them identical in *species*, as determined by Mr. C. Bunbury, with fossils of Northumberland. This fact is the more worthy of notice, because the coal of Tuscaloosa—situated in lat. 33° 10′ N.—is farther south than any region in which this ancient fossil Flora had previously been studied, whether in Europe or North America; and it affords, therefore, a new proof of the wide extension of a uniform Flora in the carboniferous epoch. Mr. Lyell—adverting to the opinion recently adopted by several able botanists, that the climate of the coal period was remarkable for its moisture, equability, and freedom from cold, rather than the intensity of its tropical heat—stated that this conclusion, as well as the oscillations of temperature implied by the glacial period, are confirmatory of the theory first advanced by him, in 1830, to explain the ancient geological changes of climate, by

* 1. The alluvium of the Mississippi.—2. Post-pliocene loam and sand, with recent shells and bones of extinct mammalia; the shells in this deposit, on the borders of the valley of the Mississippi, are of land and fresh-water species, those near Darien, of marine species.—3. Eocene formation.—4. Cretaceous strata.—5. Carboniferous rocks.—6. Hypogene or granite, gneiss, mica schist, &c.

M to *a*. Louisiana.—A. Vicksburg, Mississippi.—B. Jackson.—C. Tuscaloosa, Alabama.—D. Montgomery.—E. Darien, Georgia.—N. Atlantic.

a. Mississippi river.—*b*. Chatahoochie river.—*c*. Flint river.

geographical revolutions in the position of land and sea. The lapse of ages, implied by the distinctness of the fossils of the eocene, cretaceous, carboniferous, and other strata, is such, that, were we to endeavor to give an idea of it, we must estimate its duration, not by years, as in the case of the delta, but by such units as would be constituted by the interval between the beginning of the delta and our own times. "It is now fifty years," said Mr. Lyell, "since Playfair, after studying the rocks in the neighborhood of Edinburgh, in company with Dr. Hutton and Sir James Hall, was so struck with the evidence they afforded of the immensity of past time, that he observed, 'How much farther reason may go, than imagination can venture to follow!' These views were common to the most illustrious of his contemporaries; and since that time have been adopted by all geologists, whether their minds have been formed by the literature of France, or of Germany, or of Italy, or Scandinavia, or England;—all have arrived at the same conclusion respecting the great antiquity of the globe, and that, too, in opposition to their earlier prepossessions and to the popular belief of their age. It must be confessed that, while this unanimity is satisfactory as a remarkable test of truth, it is somewhat melancholy to reflect, that, at the end of half a century, when so many millions have passed through our schools and colleges since Playfair wrote that eloquent passage, there is still so great a discordance between the opinions of scientific men and the great mass of the community. Had there been annual gatherings, such as this, where those who are entitled to speak with authority, address themselves to a numerous assembly, drawn from the higher classes of society, who, by their cultivation and influence, must direct the education and form the opinions of the many of humbler station, it is impossible that so undesirable and unsound a state of things should have now prevailed as that where there is one creed for the philosopher and another for the multitude. Had there been meetings like this, even for a quarter of a century, we should already have gained for geology the same victory that has been so triumphantly won by the astronomer. The earth's antiquity, together with the history of successive races of organic beings, would have been ere this as cheerfully and universally acknowleged as the earth's motion, or the number, magnitude, and relative distances of the heavenly bodies. I am sure it would be superfluous if I were to declare, in an assembly like this, my deep conviction, which you —all of you—share, that the further we extend our researches into the wonders of creation in time and space, the more do we exalt, refine, and elevate our conceptions of the Divine Artificer of the Universe."—Mr. Lyell concluded this discourse by announcing his corroboration of the discovery, recently made by Dr. King, at Greensburg, thirty miles from Pittsburg, in Pennsylvania, of the occurrence of fossil foot-prints of a large reptilian, in the middle of the ancient coal-measures. They project, in relief, from the lower surfaces of slabs of sandstone; and are also found impressed on the subjacent layers of fine unctuous clay. This is the first well-established example of a vertebrated animal, more highly organized than fishes, being met with in a stratum of such high antiquity.

Art. V.—*Hybridity in Animals, considered in reference to the question of the Unity of the Human Species;* by Samuel George Morton, M. D.*

(Read before the Academy of Nat. Sci. of Philadelphia, Nov. 4 and 11, 1846.)

Part I.

Introductory Remarks.

The facts connected with hybridity in the inferior classes of animals, have an important bearing on one of the most interesting questions in Ethnography; and it is in reference to this question, that we now propose to arrange and review them.†

It was taught by Buffon, John Hunter, and other naturalists of the past century, and is yet assumed by some learned men of the present day, that the hybrid offspring of two distinct species of animals, are incapable of reproducing their kind; thus making hybridity the test of specific character. It follows, according to this supposed law of nature, that if mankind embraced several species, the intermixture of these would go no further than to produce a sterile hybrid variety. But since all the races are capable of producing, with each other, a progeny more or less fertile, it is inferred that they must all belong to one and the same species. This is the question at issue.

It may, at first view, appear superfluous to go over the whole ground of inquiry; but apart from its Ethnographic relations, it is my wish to call attention to a branch of science that has hitherto been singularly neglected, and perhaps more so than any other. Having sought in vain for some collective exposition of its details, I was at length induced to examine them for myself; and in now giving them publicity, I respectfully solicit, from

---

* In receiving this paper, we commit ourselves (as in other cases) to none of the opinions of the author. We may add, that we have no fear of discussion on any point in science. Facts are the markings of a Divine hand around and within us, and when studied in all their bearings, they lead in the end to the establishment of Truth.—*Eds.*

† Dr. James Cowles Prichard, the first Ethnographer of this or any age, has, with great care and candor, collected many of the following examples of hybridity, although to my view, they conflict strongly with his main position.—See *Researches into the Physical History of Mankind,* vol. i.

practical observers, any authenticated examples of an analogous kind, that may not be embraced in this memoir.

We shall merely further premise that naturalists have differed as to the import of the word *species*, but we know of no better definition than that which is expressed by "separate origin and distinctness of race, evinced by the constant transmission of some characteristic peculiarity of organization." The term *race* has been indefinitely and conveniently used in those instances in which it is difficult to decide whether an individual of any tribe of plants or animals, is a distinct species, or only a variety of some other species. Races are properly successions of individuals propagated from any given stock; and we agree with the learned Dr. Prichard, from whom we cite these definitions, that when races can be proved to possess certain primordial distinctions, which have been transmitted unbroken, they should be regarded as true species.*

Let us now proceed to examine the question before us, commencing with the larger mammiferous animals, and proceeding from these to birds, fishes, insects and plants.

Equine Hybrids.—The common mule, the progeny of the ass and mare, has been familiar to man since the days of Homer; and it is equally well known that with this animal, the hybrid born, as a general rule, begins and terminates. But the result appears to depend much on temperature; for in the south of Spain, mules have often been observed to produce young; and M. de la Malle observes that this phenomenon is frequent in hot climates, in which their period of gestation is twelve months, being the same as that of the mare. The same author quotes

---

* Researches into the Physical History of Mankind, 3d ed., p. 105, 109.—For some highly interesting views of this question, and their practical application, see Prof. Haldeman's Enumeration of Fresh Water Mollusca, in Boston Jour. of Nat. Hist., 1844. Further researches into Ethnographic affinities, may render it probable that what are now termed the *five races* of men, would be more appropriately called *groups*; that each of these groups is again divisible into a greater or smaller number of primary races, each of which has expanded from an aboriginal nucleus or centre. Thus I conceive that there were several centres for the American group of races, of which the highest in the scale are the Toltecan nations, the lowest the Fuegians. Nor does this view conflict with the general principle, that all these nations and tribes have had, as I have elsewhere expressed it, a common origin; inasmuch as by this term is only meant an indigenous relation to the country they inhabit, and that collective identity of physical traits, mental and moral endowments, language, &c., which characterize all the American races. The same remarks are applicable to all the other human races; but in the present infant state of Ethnographic science, the designation of these primitive centres, is a task of equal delicacy and difficulty. I may here observe, that whenever I have ventured an opinion on this question, it has been in favor of the doctrine of *primeval diversities* among men,—an original adaptation of the several races to those varied circumstances of climate and locality, which, while congenial to the one are destructive to the other; and subsequent investigations have confirmed me in these views. See *Crania Americana*, p. 3; *Crania Ægyptiaca*, p. 37; and *Distinctive Characteristics of the Aboriginal Race of America*, p. 36.

from Columella, the remark of Mago, a Carthagenian agriculturalist, that in his country the fecundity of the mule was a frequent event, although it was regarded as a prodigy in Greece and Italy. He adds, that these mixed mules do not cross again with each other, but only with the primitive species that has given them birth.*

The ancients gave the name *ginnus* to the offspring of the mule with the mare, which appears to have been a common animal among the Romans, who called it also the *little mule*, (parvum mulum.†)

Prevost and Dumas, repeating the experiments of Lieuenhœck, assure us that the sterility of these mules in northern climates, depends on an absence of spermatic animalcules; but the latter must be present in hot countries, to explain the phenomena of reproduction.

The *Hinny*, on the other hand, is the offspring of the horse and a female ass—*Bardo ex equo et asinâ*—an animal of a very refractory disposition, and little esteemed, either in ancient or modern times; nor have I been able to obtain any facts in relation to its reproductiveness.

Again, when a male, derived from the cross "between the she ass and the male *onager*, (Equus onager,) is allowed to couple with the mare, the offspring is more docile than either parent, and unites the beauty of form and gentle disposition of the father with the strength and swiftness of his grandsire;"‡ whence the ancients preferred the onager to the ass for the production of mules, and Mr. Gliddon informs me this opinion is prevalent in Egypt, at the present day.

The Baron Cuvier informs us that he had seen the cross between the ass and zebra, and between the female zebra and horse.§

The ass is not the proximate species of the genus Equus, when compared with the horse; but that place is held, as Cuvier remarks, by the *dziggetai* of Asia, (*Eq. hemionus.*) And two distinguished naturalists, Mr. Bell and Mr. Gray, are even disposed to remove the ass to a separate genus. Without passing judgment on this question, I will merely observe, that in order to obtain a prolific breed of hybrid horses, the true horse should be coupled with the *hemionus*, under the same adaptation of climate and domesticity that have been bestowed on some other mixed animals; nor until this experiment has been fairly tried, can we speak with absolute certainty of the extent of productiveness of equine mules.

* M. de la Malle, Ann. des Sciences Nat., xxvii, p. 235.

† M. de la Malle, ibid., p. 143.

‡ Columella, quoted *ut supra*, p. 135.

§ Regne animal, i, p. 182.

The phenomenon of productiveness has little or no limit among the true horses; whence it has been inferred that they all belong to one species; and that their various forms and colors are solely owing to the diversified circumstances in which they have been placed. But the researches of Hamilton Smith, have not only given rise to much doubt on this subject, but have adduced a surprising array of facts in favor of the opposite opinion.

We must refer to his learned and elaborate essay for the mass of evidence therein embodied; merely observing, on the present occasion, that he separates the horses into five primitive stocks, which appear to constitute "distinct, though osculating species, or at least races separated at so remote a period, that they claim to have been divided from the earliest times of our present Zoology."*

He adds, that some of these forms yet exist in the wild state on the table-lands of Central Asia, and that all of them were so constituted as to be fusible into a common, specific, but very variable stock, for the purposes of man; and he finally concludes, that if man had been necessitated to cultivate the zebras of South Africa, instead of the horses of Asia, he would have succeeded in amalgamating the three or four known species into one domestic animal, little inferior to the horse itself.†

It therefore becomes a reasonable supposition that some varieties of the horse now known to us, may be hybrid mixtures of proximate species; more especially, since the facts collected by Hamilton Smith, De Azara, and De la Malle, show conclusively that all the domestic horses were reclaimed from an original wild state.

Bovine Hybrids.—In the argument in question, the ox tribe has always been referred to as one of the strongest evidences of the operation of local causes in producing varieties of breed. But the parent type or stock is wholly unknown to naturalists; and although it corresponds in its osteological structure with a fossil species (Bos urus) found throughout Europe, it is extremely doubtful whether all the modifications now familiar to man are derived from this animal. "An opinion has lately been started," observes a learned zoologist, "that the haunched varieties of cattle, are derived from a different species; against which no conclusive ob-

---

* Natural History of the Equidæ, p. 154.

† Ibid, p. 75, 183. Fossil remains of the horse, and especially the teeth, have been of late years abundantly found in Europe and Asia, and in North and South America; (and especially near Natchez, by Dr. Dickerson;) showing that this animal was once indigenous to all these widely extended regions; and yet there are now no horses in the Western Hemisphere, excepting those that have descended from the European stock. The indigenous species must have become extinct from some remote and extended cataclysm. It is curious, also, to note that these fossil horses were different in species from the present variety, although they were closely allied to it. There were in ancient times several, perhaps many, species of the genus Equus.

jection can well be made, when it is considered that the Gayal (Bos gavæus) produces a mixed race with the domestic animal; and that the yak of Tartary, (Bos grunniens,) and even the American bison, are equally reported to mix with that species, notwithstanding their anatomical differences, and that the times of gestation are not similar."*

The hybrid offspring of the buffalo and the common breed of cattle, is now familiar in the western parts of the United States, particularly in Missouri and Kentucky; but I have not been informed whether they have ever bred away among themselves, or with either of the parent stocks. I have instituted inquiries on this subject, the results of which I hope to add as a sequel to this memoir. In fact, it is now conceded that all the species of the genus Bos are similarly circumstanced †; whence we have no difficulty in supposing that among the ox tribe, as among various other classes of animals, hybridity has more or less modified their forms during the long lapse of thousands of years.

Bovine and Cervine Hybrid?—The Baron Larrey incidentally mentions in his memoirs, the following circumstance that occurred during his residence at the Bay de Croc, in Newfoundland: "The *Carabon* (Cervus Wapiti) sometimes comes near the houses. In the night, one of them broke into our sheep-fold, where we had a cow, that became pregnant by him. She no doubt produced a mongrel; but I lost the opportunity of ascertaining the fact, because she was taken back to Brest."‡

I see no reason to question any part of this statement, which ceases to astonish us when we regard the many analogous phenomena that are now fully authenticated, and among others the following very remarkable one.

Bovine and Ovine Hybrid.—In the article on hybridity, in Brande's Dictionary of Literature and Science,§ it is mentioned, without doubt or reservation, that a mule has been obtained between the bull and sheep; a statement that claims our entire credence, from the circumstance that the physiological part of the work in which it is contained, is from the pen of Prof. Owen, of the Royal College of Surgeons.

Cervine Hybrids.—The only example of this class that I have met with in authors, is that between the Indian buck of the Axine species, (Cervus axis,) with the Porcine species, thus giving rise to the well known intermediate stock, called the *Spotted Hog-deer.*‖

---

* Griffith's Cuvier, iv, p. 419.—Prichard's Researches, i, p. 190.
† Loudon's Magazine of Nat. Hist., ix, p. 511.
‡ Memoirs of Military Surgery, &c., Dr. Hall's trans., vol. i, p. 11.
§ Article *Hybrid*.
‖ Hamilton Smith, Æquidæ, p. 341.

Caprine Hybrids.—The goat called the *wild ægagrus*, which is found in all the Alpine regions of Europe and Asia, appears in every instance to be a prolific hybrid between the domestic goat and the local wild one of the country it inhabits, although the latter animal may be the *ibex*, the *caucasica*, or any other species.*

A mixed breed has also been obtained between the chamois (Antilope rupicapra) and the common goat.†

Ovine Hybrids.—It was until lately supposed by most zoologists, that the domestic sheep, and the Asiatic and American *Argali*, were mere varieties of one species; but they are now known to be distinct, and are severally designated by the names of *Ovis musmon*, *O. ammon* and *O. pygargus*. The common sheep, called in the systems, *O. aries*, is generally classed as a variety of the first named species; but recent investigations render it more than probable that several wild species have commingled to form the numerous cultivated races.‡

This view is to a certain degree sustained by a hybrid product recently obtained in Paris, between a wild *moufflon* (species not mentioned) and the common sheep; but as this result dates with the present year, the productive faculty of the intermediate animal had not been tested.§

Ovine and Caprine Hybrids.—The ancients, more especially the Romans, regarded all the varieties of domestic sheep as a mixed offspring of the sheep and goat, (*Capra hircus.*) The possibility of this union was proved by Prof. Pallas, by personal observation during his travels in Russia; and although a doubt has been here and there expressed with respect to it, the fact is now conceded by all naturalists from abundant evidence. Some new and very interesting information has lately been afforded us from another quarter. "For a very long time," observes M. Chevreul, "an extensive commerce has been carried on in Chili, in the skins of sheep with rather coarse wool, derived from a cross between the male of the common goat and the ewe, which was obtained as follows: a single goat was placed with six ewes, and male hybrids were obtained with a hairy fleece, which was little esteemed for the particular purpose for which it was designed. But by coupling these male hybrids with ewes, the latter were fruitful, and their offspring bore a fine, soft fleece, which is highly valued in the manufacture of *shabraques*, called also *pellians*, in Chili. After several generations, the hair becomes coarse and hard, when it becomes necessary to recur to a male hybrid of a former generation, in order to obtain the requisite cross for the production of the perfect fleece.||

---

* Hamilton Smith, Æquidæ, p. 341.
† Idem.
‡ Idem., p. 70.—Blyth, Proceedings of the Zoolog. Soc. of London, 1840.
§ Chevreul, Journal des Savants, Juin, 1846, p. 357.
|| Journal des Savants, Juin, 1846, p. 357.

I have only to add, on the same authority, that Prof. Flourens, of Paris, has recently obtained a cross between the wild ram* (Ovis musmon ?) and the female of the common goat.

Cervine and Ovine Hybrid.—Hellenius, quoted by Rudolphi, mentions the very interesting case of a Sardinian doe that refused the goat, but was crossed by a ram. The young had the figure of the father, but in color more resembled the mother. These hybrids were again crossed by a Finland ram, and after a few generations assumed the characters of the Finland breed of sheep.†

Cameline Hybrids.—The two species of camel, *C. bactrianus* and *C. dromedarius*, produce with each other an intermediate offspring, which is said to be fertile without limit. Buffon could not deny this proverbial fact; and in order to obviate a difficulty that conflicted with a favorite opinion, he assumed that these animals must be mere varieties of a single species. Modern science, however, has established, beyond question, the specific differences of the camel and the dromedary.‡

Canine Hybrids.—If we could admit that all the dogs, with their varied external forms and peculiar instincts, have been derived from a single pair of these animals, we could have no difficulty, I conceive, in adopting so much of Lamarck's theory as relates to the progressive transmutation of species, resulting from what he calls the force of external circumstances; and it is curious to observe, that he especially adduces the canine race in support of his hypothesis. "In nature we seek in vain for mastiffs, harriers, spaniels, greyhounds, and other races between which the differences are so great that they *would be readily admitted as specific* among wild animals; yet all these have sprung originally from a single race, at first approaching very near to a wolf; if, indeed, the wolf be not the true type which at some period or other was domesticated by man."§

He further maintains that the peculiar instincts and functions of animals, the dogs for example, have not resulted from a previous and pre-adapted organization; but that these instincts, on the contrary, have developed by constant use those very organs of which they are the seat. The greyhound for example, has derived his long and slender legs, and his proverbial speed, from the mere habit of running with celerity in pursuing some animals and in escaping from others. The mastiff again has become large, strong and muscular, from habitually seizing and holding animals larger and stronger than himself. In fine, Lamarck applies the same principle to all organized beings, which according

* Moufflon. The particular species is not designated.
† Rudolphi, Beyträge zur Anthropologie, &c., p. 165.
‡ Cuvier, Regne animal, i, p. 187.
§ See Lyell's Principles of Geology, B. III, chap. 1, &c.

to his doctrine have been developed by the mere force of circumstances, a tendency to progressive advancement from the simplest to the most perfect forms. And here we may inquire, if education and domesticity can so vary not only the instincts but the very proportions of anatomical structure in dogs, do we not realize in the theory of Lamarck, a law of nature which would with equal readiness explain the unlimited transmutation of species into each other?

But is it proved that all the domestic dogs are really derived from a single species? Here again we appeal to one of the latest and best authorities on this question—Charles Hamilton Smith, whose laborious researches have led him to the following conclusions:—that the parents of our domestic dogs are derived from several distinct species, which were constituted with faculties to intermix, and thus to produce the interminable varieties familiar to man; that five of these types belong to the old world alone, viz. the *wolf*, the *buansu*, the *anthus*, the *dingo* and the *jackal;* that a *dhole* or a *thus* may have been the progenitor of the grayhound; and that the origin of the primitive mastiff may yet be traced to a lost or undiscovered species belonging to the hyena tribe.*

The wolf, the dog, the jackal and the fox, all intermix with each other. So does the common jackal with the jackal of Senegal. Do they therefore belong to one species? It is well known that the cross between the dog and the European wolf in the experiments of Buffon, did not extend beyond the fourth generation; but the distinguished writer whom we have just quoted, has observed, that the animals were in a state of neglect and restraint, and gradually tended to sterility from their small number, and from the want of recrossings from one or other of the parental stocks. It is worthy of remark, that the *dingo* of Australia when placed in similar circumstances with the common dog, also becomes sterile in the fourth generation; whence, according to this test, the *dingo* is not a true dog, but some other species of the genus Canis.

The greatest number of mammæ in the common dog is ten, the smallest number, six; in the wild species they are always in pairs, and they never vary in a species. "To what other cause, then, can we ascribe the anomaly in domestic dogs, so justly as to an intermixture of species?"†

The dogs that have become wild in Paraguay, always hunt in packs, thus resuming the wolf-like instinct of their progenitors. Will it be said that this is a newly developed instinct? or is it not rather an old one that new wants have reproduced.

---

* Natural History of the Dog, in Naturalist's Library, vol i, p. 104, *et passim.* The *Canis venatica* of Burchell, connects the dog with the hyena almost without an interval.

† Ibid, ii, p. 79.

It is therefore certain that dissimilar species of the dog tribe are capable of producing a fertile hybrid offspring; and if it was the interest of man again to cultivate and extend these mixed species, there is every probability that the race would become unlimited.

"Experiments show," observes Mr. Lyell, "that after repeated failures, the union of two recognized species may at last, under very favorable circumstances, give birth to a fertile progeny; and such circumstances," he adds, "the naturalist may conceive to have occurred again and again in the course of a great lapse of ages."*

Every one who is in the least degree acquainted with the natural history of dogs, knows that certain remarkable changes of color, and sometimes of form, take place in particular localities. These changes are usually attributed solely to climate, food, training, and other exterior agents. I do not deny the modifying action of such agents in these and other cases; but it is a reasonable subject of inquiry, whether there may not be something in these localities that favors an effort of nature to reproduce a primitive type? The localities to which we allude,† do not operate equally on all varieties of the dog tribe; which we might suppose would be the case if all the canine breeds were derived from a single stock or species. It is important in connection with this subject, to observe that all the pure Indian dogs of North America are of one variety, with erect ears, a wolfish aspect, and having a howl in place of a bark. Most naturalists agree in considering it a reclaimed wolf. The late Mr. Thomas Say, regarded it as the *canis latrans* or *howling wolf*, in a state of domestication. It is remarkable, when unmixed, for the uniformity of its characters, which are the same in every locality over thousands of miles in extent.‡ No varieties have arisen from it, excepting by crossing the breed with other dogs, when a hybrid is produced that is prolific without end. It is much to be regretted that so little is known of the history of the indigenous dogs of America,—a subject that affords a fine field for scientific inquiry.

While engaged in writing this memoir, I am assured by my friend Dr. M'Coy, an intelligent physician and naturalist, that in the interior of Pennsylvania, the common wolf, *C. lupus*, has been taken when young, and successfully trained to deer hunting. The difficulty, however, with these animals was, that they devoured the game, unless the sportsman was on the spot to pre-

* Principles of Geology, Book III, chap. 2.

† See Dr. Prichard's Natural History of Man, for an admirable exposition of these and all other facts on which the *analogical argument* is founded.

‡ Carver's Travels in North America, p. 417. See also the plates of the magnificent Atlas of the Prince de Wied's Travels in this country.

vent them. To obviate this fault, these wolves were crossed by the common dog; giving rise to a mixed breed, that combined the keener instinct of the wolf with the greater docility of the dog. Should these hybrids reproduce among themselves, or with either of the parental sources, how completely will the history of these animals illustrate the origin of the dog tribe, its primitive domestication, the crosses between different species, and the varieties that must have followed from such intermixture? I hope yet to be able to lay before the reader all the facts of this singular history.

Surine Hybrids.—Another domestic animal which presents remarkable varieties of form as well as of marking, is the hog; and these have also been attributed to a single species modified by immemorial domestication. Some new light, however, has recently been thrown on this branch of zoology by Mr. Eyton of London, who has compared the skeletons of the Chinese, the African,* and the English pig, and finds that while they agree in the number of cervical vertebræ, (as indeed all quadrupeds do,) there is a remarkable difference in each of the other classes of these bones. We have not space for details, except to observe that the dorsal vertebræ vary from thirteen to fifteen, the lumbar from four to six, and the caudal from thirteen to twenty. Now, as far as time and circumstances had allowed the experiment to proceed, these several animals bred freely with each other, and in the instance of the Chinese pig, the offspring is unquestionably fruitful.

Mr. Eyton very justly remarks, that the above three pigs must be considered as distinct species, or osteological characters can no longer be received as criteria of species; and Hamilton Smith has arrived at the conclusion, that there were three if not four original species, endued with powers of unlimited reproduction.

Feline Hybrids.—These animals, at least the domestic varieties, had long been regarded as of one species; but modern researches have established that the blue or Chartreuse cat, originally belonged to a distinct feline group; the Bengal cat of Pennant pertains to a second; while the tortoise-shell cat is believed to have sprung from a third group originally indigenous to South America.† I believe all these animals produce with each other a fertile offspring. It may be denied, however, that they belong to different species; but that the domestic cat was once of at least two species, seems now decided by the observation of Dr. Ruppell, who finds the embalmed cat of the Egyptians to cor-

* The *Sus æthiopicus* has even been removed to a separate genus by Cuvier—*Phascochæres.* See *P. Æliani* in Ruppell, Atlas zu der Reise in Nord-Afrika, p. 61.
† Hamilton Smith, Equidæ, p. 339.

respond to the *Felis maniculata** of Nubia, and not to the *Felis domestica.* Where then is the race of cats once so abundant in ancient Egypt? They have probably come down to us so blended with other species that their identity is lost.

De Azara states, in the forests of Paraguay the *Felis yaguarundi* and the *F. eyra*, both unite with the domestic cat; and he adds, that should these wild species become in time extirpated, and the mixed breed alone remain, the latter would be very naturally referred with all its varieties, to a single original species.†

Mixed breeds have also been obtained between the black leopard and the African species, and between the lion and the tigress. The latter cross which is much the more remarkable, produced three cubs, which were doing well at the time the facts were published.‡ We regret that no further particulars have come under our notice.

Feline and Musteline Hybrid.—A most remarkable instance of hybridity between the cat and an animal of a totally distinct genus, is described in the following account, which is published in several of the best scientific periodicals, and appears to be well authenticated. "A domestic cat disappeared from a house in Penza. After being absent some time, she returned; and within the regular time, produced four young ones, two of which strongly resembled the marten. Their claws were not retractile, as in the cat; and the snout was elongated, like that of the pine marten, (Mustela martes.) The two others of the same litter more nearly resembled the cat; as they had retractile claws and round heads. All of them had the black feet, tail and ears of the marten; and they killed birds and small animals more for the pleasure of destroying them than for food. The proprietor endeavored to multiply this race, and to prevent their intermixing with the domestic cats, in which he proved highly successful. In the space of a few years he reared more than a hundred of these animals. A specimen presented to the Imperial Society of Natural History of Moscow, was of the third or fourth generation, and it retained all the characters of the first."§

Professor Pallas has described and figured the *Perxsa cat*, which has long been suspected for a hybrid, although very prolific. It may yet prove to be the animal we have just described.

Lepine Hybrid.—Amoretti, quoted by Rudolphi, has published the history of a cross between the European or English rabbit, *Lepus cuniculus*, and the hare, *L. timidus.*‖

---

* Atlas zu der Reise im Nordlichen Afrika, p. 4, tab. I. Prof. Bell has also decided that the *Felis catus*, found wild in the forests of Europe is different from both the domestic species.

† Quadrupeds of Paraguay, i, p. 174.

‡ Vide Griffith's Cuvier, ii, p. 448. 1827.

§ Loudon's Mag. of Natural History, ix, p. 616. Griffith's Cuvier, ii, p. 480.

‖ Rudolphi, Beyträge zur Anthropologie, etc., p. 165.

Phocine Hybrid.—Finally, among mammiferous animals, it remains to notice the singular fact discovered by the traveler Steller, and mentioned by Rudolphi, that the sea-lion, *Phoca jubata*, of Behring's island, produces young with the sea-bear, *P. ursina.* "I have no doubt of this fact," adds Prof. Rudolphi, "since Pallas speaks of Rudolphi with the greatest respect, and Telesius proved the accuracy of his observations."*

(*To be continued.*)

ART. VI.—*Solution of a Mathematical Problem;* by O. ROOT.

A STRAIGHT line whose length is (r) being so moved as always to terminate in the sides of a right angle, required the locus of its consecutive intersection.

The sides of the right angle being taken as the axes of coordinates, the equation of the line whose length is given will be

$$y=ax+b \qquad (1).$$

In this equation if we make $x=0$, we get $y=b$; when we make $y=0$, we get $x=-\frac{b}{a}$. These values of xy squared, give

$$b^2+\frac{b^2}{a^2}=r^2 \qquad (2).$$ This solved for (a) gives

$$a=\frac{b}{(r^2-b^2)^{\frac{1}{2}}} \qquad (3).$$

The value of (a) in equation (3), substituted in equation (1) gives

$$y=\frac{bx}{(r^2-b^2)^{\frac{1}{2}}}+b \qquad (4).$$

If we differentiate equation (4) allowing (b) only to vary, we shall get

$$\frac{dy}{db}=\frac{r^2x}{(r^2-b^2)^{\frac{3}{2}}}+1=0 \therefore b=r\left(1-\left(\frac{x}{r}\right)^{\frac{2}{3}}\right)^{\frac{1}{2}};$$

this value of (b) substituted in equation (4) gives

$$y=r\left(1-\left(\frac{x}{r}\right)^{\frac{2}{3}}\right)^{\frac{3}{2}},$$ or by reduction,

$$y^{\frac{2}{3}}+x^{\frac{2}{3}}=r^{\frac{2}{3}} \qquad (5),$$

which is the equation of the required locus, and is the hypocycloid, the radius of whose base circle is (r) the length of the given line, and the radius of its generating circle $\frac{1}{4}r$.

We can show that (5) is the equation of the hypocycloid as follows:

In the general equation for cycloidal curves we have

$$\left.\begin{aligned} y&=(r\pm r')\cos.\theta+(r\pm r')\cos.\left(\frac{r\pm r'}{r'}\right)\theta \\ x&=(r\pm r')\sin.\theta+(r\pm r')\sin.\left(\frac{r\pm r'}{r'}\right)\theta \end{aligned}\right\} \qquad (6).$$

* Ibid. Loco citat.—Prichard's Researches, i, p. 142.

If in equation (6) we take the lower sign and make $r'=\frac{r}{4}$, we shall get

$$\left.\begin{aligned} y&=\tfrac{3}{4}r\cos.\theta+\tfrac{3}{4}r\cos.3\theta=r\cos.^3\theta \\ x&=\tfrac{3}{4}r\sin.\theta+\tfrac{3}{4}r\sin.3\theta=r\sin.^3\theta \end{aligned}\right\} \quad (7);$$

hence from (7) $y^{\frac{2}{3}}=r^{\frac{2}{3}}\cos.^2\theta$

$$x^{\frac{2}{3}}=r^{\frac{2}{3}}\sin.^2\theta\ ;$$

consequently by adding, we get $y^{\frac{2}{3}}+x^{\frac{2}{3}}=r^{\frac{2}{3}}$, which is the same as equation (5). Also in Leroy's Descriptive Geometry this is proved to be the equation of the hypocycloid.

If we differentiate equation (7) we shall get

$$\left.\begin{aligned} dy&=-3r\cos.^2\theta\sin.\theta d\theta \\ dx&=+3r\sin.^2\theta\cos.\theta d\theta \end{aligned}\right\} \quad (8);$$

hence $\int(dy^2+dx^2)^{\frac{1}{2}}=3r\int\sin.\theta\cos.\theta d\theta=\frac{3}{2}r\sin.^2\theta=$ length of the curve: taking the integral from $\theta=0$ to $\theta=90°$, it becomes $=\frac{3}{2}r$. From equations (7) and (8) we get

$\int ydx=3r^2\int\sin.^2\theta\cos.^4\theta d\theta$: taking the integral from $\theta=0$ to $\theta=90°$, this becomes $\frac{3\pi r^2}{32}$ for the area of the curve between the axes xy.

Cor. 1. Equation (5) shows that our problem includes question 8, No. 11, Leybourn's Math. Repository, which reads as follows: If from one of the angles of a rectangle a perpendicular be drawn to its diagonal, and from their intersection lines be drawn perpendicular to the sides containing the opposite angle, then putting (P, p) for the last perpendiculars, and (D) for the diagonal, $P^{\frac{2}{3}}+p^{\frac{2}{3}}=D^{\frac{2}{3}}$.

Cor. 2. Equation (5) is identical with the result obtained for a question I proposed in the Mathematical Miscellany for 1836, in which it was required to find the locus of the points so situated within a right angle, that the straight line whose length is (r) and terminates in the sides of the right angle, shall be a minimum for each of the points.

Cor. 3. Equation (5) furnishes a solution to No. 12 of the Cambridge Problems for 1803, which requires the length of the longest ladder that can be slided up a perpendicular wall from a horizontal plane, under an obstacle given in position—xy will be given as co-ordinate of the obstacle, and (r) will be the length of the ladder; hence we have $r=(y^{\frac{2}{3}}+x^{\frac{2}{3}})^{\frac{3}{2}}$ the length required.

In Wright's solutions of the Cambridge Problems, this question is erroneously solved; his result will give $r=(y+x)^{2\frac{1}{2}}$.

ART. VII.—*On the North American Species of Isoëtes and Marsilea;* by Prof. A. BRAUN.—Communicated by Dr. G. ENGELMANN.

Dr. A. BRAUN, since last spring Professor of Botany at the University of Freiburg, Germany, has from time to time communicated to me the results of his investigations on the cryptogamous plants of this country. His notes on *Charæ* and *Equiseta* have been published in a former number of this Journal, (January, 1844.) I am now enabled to offer some remarks of his on the above named genera of rhizocarpous plants. Those on *Marsilea* have been furnished in manuscript; the paper on *Isoëtes* was published in the "Flora, oder Bot. Zeitung," No. 12, 1846.—G. E.

The species of *Isoëtes* hitherto discovered in the United States, have been considered identical with the European *I. lacustris*, Linn., especially one found in Pennsylvania. But this, as well as two others obtained from North America, on careful examination prove to be distinct species. The true *I. lacustris*, if any where in North America, must be looked for in the Northern regions.

Within a few years three new species of *Isoëtes* have been discovered by Durieu in Algeria, and were described by Borg under the names of *I. hystrix*, *I. Durieui* and *I. longissima*. My friends Engelmann and Shuttleworth have enabled me to describe three more species, so that the number at present known is nine, or with the two fossil ones, eleven. It is to be expected that this number will be considerably increased by future researches, as the species of *Isoëtes* are easily overlooked by collectors on account of their apparent sterility.

All the species examined by me may be distinguished by the different size and surface of the spores. Other characters are to be found in the shape of the rhizoma, and in the shape and section of the leaves. These last can be well examined only in living plants; the shape of the rhizoma may also be seen in dried, but not in much pressed specimens. Collectors should pay attention to these circumstances.

All the species are very much alike in general habit. Some are found only under water (*I. lacustris, I. flaccida, I. longissima*); others grow in shallow water, or on wet places which sometimes become quite dry (*I. setacea, I. Engelmanni, I. riparia*); others again grow on perfectly dry hills (*I. Durieui, I. hystrix*). *I. setacea* of the South of Europe is also often found in dry places; near Frejus it forms large patches of a beautiful green color at the foot of walls; and I have cultivated it in flower pots, which were kept moderately moist. I will here take occasion to remind travelers and collectors, who may meet with species of this genus, that all of them are very tenacious of life, much like bulbous plants, and may in the same manner be obtained for botanical gardens. The specimens of *I. setacea* cultivated by me, had been preserved in an herbarium near two years, when I had the pleasure to see them vegetate, soon after throwing them in water.

I give the characters of both European species, with the American, in order that they may be compared together.

1. *Isoëtes lacustris*, Linn. Submersed; rhizoma placenta-shaped, depressed, orbicular or irregular; leaves tubular, semicylindrical, above cylindrical, rigid, fragile, dark green; spores large, covered with coarse farinaceous tubercles, irregularly roughened, scarcely reticulated.

2. *I. Engelmanni*, mihi. Emersed; rhizoma large, similar to the preceding; leaves longer, more slender, soft, light yellowish-green; sheaths elongated (longer than broad); sporangia longer, spores somewhat smaller, coarse, farinaceous, reticulated.

3. *I. riparia*, Engelm. MSS. Emersed, rhizoma small (orbicular?); leaves slender, soft, yellowish green, sheaths short (broader than long); sporangia smaller, spores as large as in the foregoing one, very neatly and minutely farinaceous and reticulated.

4. *I. setacea*, Rosc. Emersed; rhizoma subglobose, regularly trilobed; leaves subulate, somewhat triquetrous, soft, yellowish-green; spores as large as in the foregoing ones, minutely farinaceous, not reticulated nor tuberculate.

5. *I. flaccida*, Shuttlew. Submersed; rhizoma small; leaves very long, slender, flaccid, yellowish-green; spores very small, minutely pulverulent, not reticulated.

The first, *I. lacustris*, has been found only in middle and northern Europe. It is distinguished from all others by its thicker, stiffer, dark green (when dry, blackish green) leaves, and large spores, which are covered with an irregular granulation. The rhizoma sometimes measures one inch in diameter. The leaves are mostly straight, and 6 to 8 inches long; a variety with shorter leaves (2 to 3 inches long) which are recurved at the tip rarely occurs, probably in shallow water, as the leaves never rise above the surface.

I. Engelmanni has been distributed by Dr. E. to many correspondents as *I. lacustris* var. *microspora*. It was afterwards distinguished by him as a species, and named *I. microspora;* but as this name is not sufficiently characteristic, the spores being not much smaller than those of *I. lacustris*, and other species having much minuter ones, I have taken the liberty to give it the name of its discoverer. While *I. lacustris* inhabits, at least in the centre of Europe, only the bottom of cold mountain lakes, mostly with the rare *Nuphar Spennerianum* and *Sparganium affine*, this species grows on the margin of shallow ponds in the hilly country southwest of St. Louis,* in the warm climate of Missouri, with *Cephalanthus*, *Lycopus angustifolius*, several *Cuscutæ*, *Sagittariæ*, *Polygona*, *Leersiæ*, etc. In winter and spring it is covered by water, but late in summer and in the fall the ground on which it grows is mostly dry, or nearly so. It forms thick tufts with many leaves, 9 to 12 inches long, of a bright yellowish green color. The rhizoma is also flat, depressed, and often one inch in diameter. The sheath or dilated base of the leaf, which bears the sporangia, is longer, and the sporangia themselves somewhat larger, than in any of the other species.

I. riparia has been described from specimens collected by Dr. Wm. Zantzinger on the banks of the Delaware below Philadelphia. It grows there with *Sagittaria pusilla*, *Eriocaulon flavidulum*, *Crypta minima*, *Limosella subulata*, etc., abounding among loose gravel and mud between high and low water mark, therefore frequently exposed to the air, and in dry soil. The specimens examined by me are small; the rhizoma hardly 4 or 5 lines in diameter; the leaves 4 to 6 inches long, narrower and more slender than in *I. lacustris*, only 10 or 12 in number, while *I. Engelmanni* has often 30 to 40 or more. Their base is shorter than in either of the preceding, and the sporangia only half as large as in the last. I have not been able to obtain for examination specimens of the *Isoëtes* found in Pennsylvania, on "ponds and shaded wet places," mentioned by Darlington in his Flora Cestrica, nor any from New York, etc., and it is not known whether they are identical with *I. riparia* or not.

I. setacea is common in the south of Europe (especially the south of France and Sardinia) and also in northern Africa, and is sufficiently well known. The tufts are always smaller than those of *I. lacustris* and *I. Engelmanni*, but larger than in *I. riparia;* the leaves are still more narrow and slender than in the last species, and 8 to 12 inches long.

I. flaccida was discovered by Mr. Rugel in Lake Tamonia, Florida, and first distinguished and named by R. J. Shuttleworth, Esq. It has a small roundish rhizoma, and leaves 18 to 24 inches long, as slender as in *I. setacea*, but of thinner texture, and somewhat transparent. The sporangia are smaller, and the spores by far the smallest of all the species. I am not now prepared to decide, what relation this species bears to *I. longissima*, Bory, from Lake Houbeira, in Algeria, or to an *Isoëtes* from California, which Prof. Kunze considers as identical with *I. longissima*, but which more probably stands near the Florida species, or is identical with it.

* The places where it has been collected by me as late as 1842, are now changed by cultivation, or the vegetation destroyed by hogs and ducks. I have not been able to find it since, but doubt not that it still inhabits more secluded ponds in this remarkable region, where the strata of the carboniferous or mountain limestone offer in their numberless "*sink-holes*" (originating undoubtedly from the caving in of the roof of caverns, and peculiar, in this neighborhood at least, to this formation) many localities of a similar description.—G. E.

Marsileæ of North America.

The North American *Marsileæ* form a peculiar group, well distinguished from the species of the old world by the large purple stomata of the capsule, which is always solitary at the base of the petiole, and by the two large conspicuous approximate teeth of the raphe.

Marsilea uncinata, A. Braun. (Fig. 1.) Fruit basilar and single; stipe erect, nearly twice the length of the capsule; capsule horizontal, short oval or suborbicular, considerably compressed, truncate behind with a long raphe which terminates in two approximate teeth, the upper one being the longest and uncinately recurved; stomata of the capsule large, purple; paleæ appressed; 13 to 14 sori on each side in the capsule; leaflets narrow at base, fan-shaped, entire, nearly naked.

Marsilea mucronata, A. Braun, MSS. (Fig. 2.) Fruit basilar and single; stipe ascending, hardly as long as the capsule; capsule nearly horizontal or slightly ascending, somewhat obliquely oval, slightly compressed, rounded above, carinate below, truncate behind, with a shorter raphe, which terminates in two approximate teeth, the upper one being the longest and straight or slightly curved at the point; stomata of the capsule large and purple; paleæ appressed, indistinct; 8 to 9 sori on each side of the capsule; leaflets spathulate, entire, slightly hairy.

Marsilea vestita, Hook. and Grev. (Fig. 3.) Fruit basilar and single; stipe erect, hardly as long as the capsule; capsule ascending, oval, somewhat compressed, with a short raphe which terminates in two approximate teeth, the lower one being short and blunt, the upper one acute, a little larger, hardly curved; paleæ long, dense and somewhat patulous; 7 to 8 sori on each side in the capsule; leaflets entire, covered with paleaceous hairs. (Stomata of the capsule not seen in the young specimen examined by me, but undoubtedly similar to those of the other two species, only more hidden by the paleæ.)

Fig. 2. Fig. 1. Fig. 3. (Half the natural size.) Fig. 4.

This last species was the first of the genus discovered in North America. It was collected by Douglas on the Columbia river, in Oregon, and was described and figured by Hooker and Greville. (*Icones Filicum, tab.* 159.) The plant is small, petioles 3 to 4 inches long, and, like the fruit and to some extent also the leaves, densely coated with long hairlike paleæ. The description of Hooker and Greville, mentions only one tooth on the fruit, but their figure shows both.

Marsilea mucronata is nearly related to the Oregon species, but is sufficiently distinguished by the nakedness of the whole plant, and especially by the shape of the capsule. The rhizoma is elongated, and has not the fascicled branches of the following; the petioles are 2 to 3 inches long; and the spathulate or slightly fanshaped leaflets are 3 to 4 lines long. It was collected by Mr. Charles Geyer, in Nicollet's Northwestern expedition, July 24th, 1839, in small exsiccated swamps near Devil's Lake, in the Sioux territory, between the Mississippi and Missouri rivers. It is mentioned by Prof. Torrey in the Catalogue of Nicollet's collections (appendix, p. 165) as *M. vestita.* In several European herbaria it is preserved under the name "*M. quadrifolia*, Herb. Ward;" from where derived is to me unknown.

M. uncinata was discovered by Dr. Engelmann, in July, 1835, on the margin of small swamps in the deep bottom woods on the Arkansas river, not far below Little Rock, with *Azolla caroliniana*, etc., and was first described in "Flora, or Botanische Zeitung," 1839, i, p. 300. It is a much larger plant than either of the others, nearly naked, with long petioles, (5 to 9 inches,) and fanshaped leaflets 6 to 10 lines long; the rhizoma produces many fascicled branchlets which are paleaceous at tip. The shape of the capsule and the large number of *sori* in it, readily distinguish it from the others.—A. Br.

Note.—I find a fourth species in the collections made by Mr. Lindheimer in Texas. (Fig. 4.) He met with it in January, 1845, in swampy soil on the lower Guadaloupe river, near its mouth in the Matagorda Bay. It is widely distinct from the three others, in having long and branching stipes (10 to 14 lines long) bearing 3 to 5 capsules, three or four times as long as these, and at the base connected with the petiole; capsule obliquely obovate, with a short raphe, lower tooth blunt, upper one very indistinct; stomata not observed on the paleaceous capsule; rhizoma nearly naked, only the ends of the branches paleaceous; petioles 4 to 9 inches long, hairy; leaflets triangular or fanshaped, entire, more or less covered by fine paleaceous hairs, 7 to 12 lines long. It is not improbable that this is the *Marsilea polycarpa*, Hook. and Grev., found throughout South America, and lately discovered by Dr. Schiede in Mexico; but having seen no description of it, I am unable to give more than this suggestion, based merely on the name. If on further comparison the Texan species should prove to be distinct, the name of *M. macropoda* would appear to be most appropriate. Sterile specimens of a *Marsilea* occurring in Drummond's Texan collections, belong probably to the same species as Lindheimer's plant.—G. E.

Art. VIII.—*Review of the New York Geological Reports.*

(Continued from Vol. i, Second Series, p. 70.)

The members of the New York System which have so far claimed our attention, comprise the whole of the lower and middle divisions. It remains now to pass in review the leading facts bearing on those formations embraced in the upper, last or Erie division. They are exposed chiefly in the middle, southern, and western parts of the state, and, therefore, have been made known to us chiefly by the explorations of the geologists of the third and fourth districts.

In place of the conspicuous calcareous beds of the previous division, we find henceforth schistose, argillaceous deposits, and grits, with only an occasional inter-lamination of subordinate calcareous layers. This change of lithological character is accompanied, as we might expect, by a corresponding variation of organic forms, inasmuch as the nature of the marine sediment necessarily imparts a peculiar type to the inhabitants of adjacent seas. The base of this third division of American Protozoic rocks is formed by the so-called

Marcellus Shale. (Lower part of F. 8 of Pennsylvania and Virginia Post-medidial Older Black Slate of Rogers.)—From the Corniferous and Seneca limestones, the last members of the middle division, to this black slate, the passage is abrupt and striking; it affords, therefore, over a very extended district, an excellent guide to the geologist contrasting formations of distant regions.

The lower portion is, like the Utica slate, black and bituminous; in many places so much so that it flames in the fire; hence, as before remarked, it has frequently been mistaken for coal shale, and all along its outcrop, excavations and borings have been undertaken in the hopes of discovering valuable beds of bituminous coal. But, since it is a member of a system of rocks in which no perfect seams of that combustible have ever been found, and belongs to an epoch far antecedent to the true coal formation, these explorations have been equally abortive with those attempted in the region of the Utica slate. The lower division of the Marcellus shale is moreover distinguished by being occasionally calcareous, and is always marked, according to Hall, by one or more courses of concretions or septaria often of a large size. A band of limestone marks their termination as well as the blackest and most bituminous beds. This is overlaid by fissile shales passing gradually from black to olive, which constitute the upper division of the group.

It is inferred, both from the extremely fine sediment of which the Marcellus shale is composed and the preservation of some of the most delicate structures of its fossils, that it was accumulated during a period of great tranquillity.

By reason of its soft and destructible nature, this black slate is seldom exposed to view, except in ravines and water-courses: nevertheless it has a wide range; commencing near the Hudson river it runs nearly due west to Lake Erie and the west line of the state. This rock and the Genesee slate have doubtless formed the impervious beds which hold up the waters, not only of that lake, but also of Lakes Huron and Michigan, since they show themselves in many places bordering their shores. All that flat wet region of country interspersed with small lakes and ponds, lying in the vicinity of the Kankakee and the head waters of the Wabash, is also probably underlaid either by these schistose argillaceous beds themselves or the clay derived from their disintegration.

In the western part of New York the Marcellus shale is not over fifty feet thick: it thickens, however, to the eastward; we are informed by Vanuxem that in his district it has been bored through a hundred feet in search of coal.

The best localities cited for examining this deposit, are, the ravine of Conesus outlet, west of the village of Avon; the bed and bank of Allen creek near LeRoy; Cherry Valley above the falls of Oneida creek; between Onondaga and Marcellus and the outlet of Owasco lake at Auburn.

Sulphuret of iron occurs every where in connection with this formation; and sulphate of barytes is not uncommon in the septaria. It contains no where valuable minerals. Owing to the presence of sulphuret of iron, the springs issuing from the black slate are often sulphuretted.

By its decomposition a stiff, cold, clayey soil results; but fortunately in the state of New York it is mostly so covered with drift that it rarely gives character to the surface soil to any considerable extent.

Fossils are not abundant in the Marcellus shales. Goneatites measuring sometimes one foot across, occur in the two upper limestone layers between the lower and upper shales.

The forms figured in Vanuxem's Report are given on the opposite page.

The most characteristic fossils of this formation in the western part of the state are embraced in the following wood cut taken from Hall's Report.

The black slate of the Western states has usually been considered the equivalent of the Marcellus shale; but so few fossils have hitherto been observed in that formation in Ohio, Indiana, Illinois, or Kentucky, and these are so obscure, that no satisfactory palæontological evidence has been adduced in support of this decision. Indeed some facts rather favor the idea of its being the

Vanuxem's Report.

Fig. 1. *Goneatites expansus.* 2. *G. marcellensis.* 3. *Orthis limitaris.* 4. *Cypricardites marcellensis.*

Hall's Report.

Fig. 1. *Orthoceras subulatum.* 2. *Strophomena setigera.* 3. *S. mucronata.* 4. *S. pustulosa.* 5. *Avicula muricata.* 6. *A. lævis.* 7. *A. equilatera.* 8. *Orthis nucleus.* 9. *Orbicula minuta.* 10. *Tentaculites fissurella.* 11. *Atrypa limitaris.*

representative of the Genesee slate. Our remarks on this subject will be more appropriately introduced after treating of the succeeding formation, denominated the

Hamilton Group. (Part of F. 8 of Penn. and Virg.)—We are informed by Hall, that the line of separation between this and the upper olive shales of the Marcellus group is no where well marked, the change in lithological character being gradual, and even some of the fossils are continued from one into the other, so that the beds last described might be considered the inferior members, and those now under consideration, the upper beds of one and the same group; indeed in Pennsylvania and Virginia all are included in Formation 8. The New York geologists have separated them only because some of the fossils are peculiar to the Marcellus shales, and some to the Hamilton beds.

The various members embraced in the latter division, are:— Pyritiferous rock and third graywacke of Eaton; Ludlowville, Moscow, and Skaneateles shales; dark slaty fossiliferous shales; compact calcareous blue shale; olive shales, shales near Apulia and Sherburne; Cazenovia group, Encrinital limestone. Under these names have they been noticed in the Annual Reports.

Dull, olive, bluish-gray, calcareous shale constitutes the principle mass. The mud from which it has been derived must have been equally fine with that of the previous group, indicating a continuation of the tranquil condition of the oceanic currents. Towards the east the upper part is more arenaceous, even a regular sandstone.

The range, extent, and bearings are south and nearly parallel with the preceding strata; indeed on the marl the same light blue tint designates all, from the base of the Marcellus shale to the Portage group, and embraces a belt of country from five to ten miles wide running nearly east and west through the middle of the state.

The Hamilton group is of great thickness. Vanuxem informs us that in no part is it less than three hundred feet, and it swells in some places to seven hundred feet; and Hall estimates it on the eastern limit of his district at not less than one thousand feet.

The town of Hamilton, in Madison county, gives name to the group, and it is one of the best localities for examining its most important members. The bank of Cayuga and Seneca lakes, the ravines on the Genesee river near Avon, York, and Leicester, the shores of Lake Erie at Eighteen-mile creek; the hills on both sides of Cherry Valley, Middlefield, Milford, Otsego, Brookfield, Cazenovia, Lafayette, Pompey, Owasco, are enumerated by Vanuxem and Hall as points where its various members can be advantageously studied.

Septaria of very curious and fantastic shapes are of frequent occurrence; so wonderfully regular are some of them that they are usually taken for petrified turtles. The nucleus is either a fossil body or a nodule of iron pyrites around which the segregation has taken place.

Speaking of the general character of the fossils of the Hamilton group, Hall has the following paragraph:—

"Organic remains abound throughout the group, but they vary somewhat in different parts. In the lower division, the most abundant are those of *Orthis*, *Atrypa* and *Strophomena* with some spiral univalves; while above this portion, great numbers of *Avicula*, *Cypricardia*, *Nucula*, and other similar forms abound, with fewer of genera *Orthis*, *Delthyris*, &c. In the next division *Delthyris*, *Strophomena*, and *Atrypa* abound, to the almost entire exclusion of the forms before mentioned. In the same situations with these we find numerous species of corals: *Cyathophylli*, *Favosites*, and other forms, are abundant; while fragments of crinoidal columns are every where scattered through the mass, or spread evenly over the surface, and form thin layers by themselves."

"The contrast in the prevailing fossils of this group with those of the last is as great as in the lithological products of the two formations. We sometimes indeed meet with a species that occurs in the limestone below, but except in a few instances these recognitions are rare. Some of the more abundant corals are identical, but the great number of new forms renders them of less importance, and in all instances they are too few in number to produce any doubt or difficulty in identification of strata."

"Shells both of the Brachiopoda and Dimyaria have immensely increased, and in many single localities from twenty to fifty species may be obtained."

In Vanuxem's district, where the lithological character of the Hamilton group is more arenaceous, the following are the prevailing forms, as given by that author.

Vanuxem's Report. (36.)

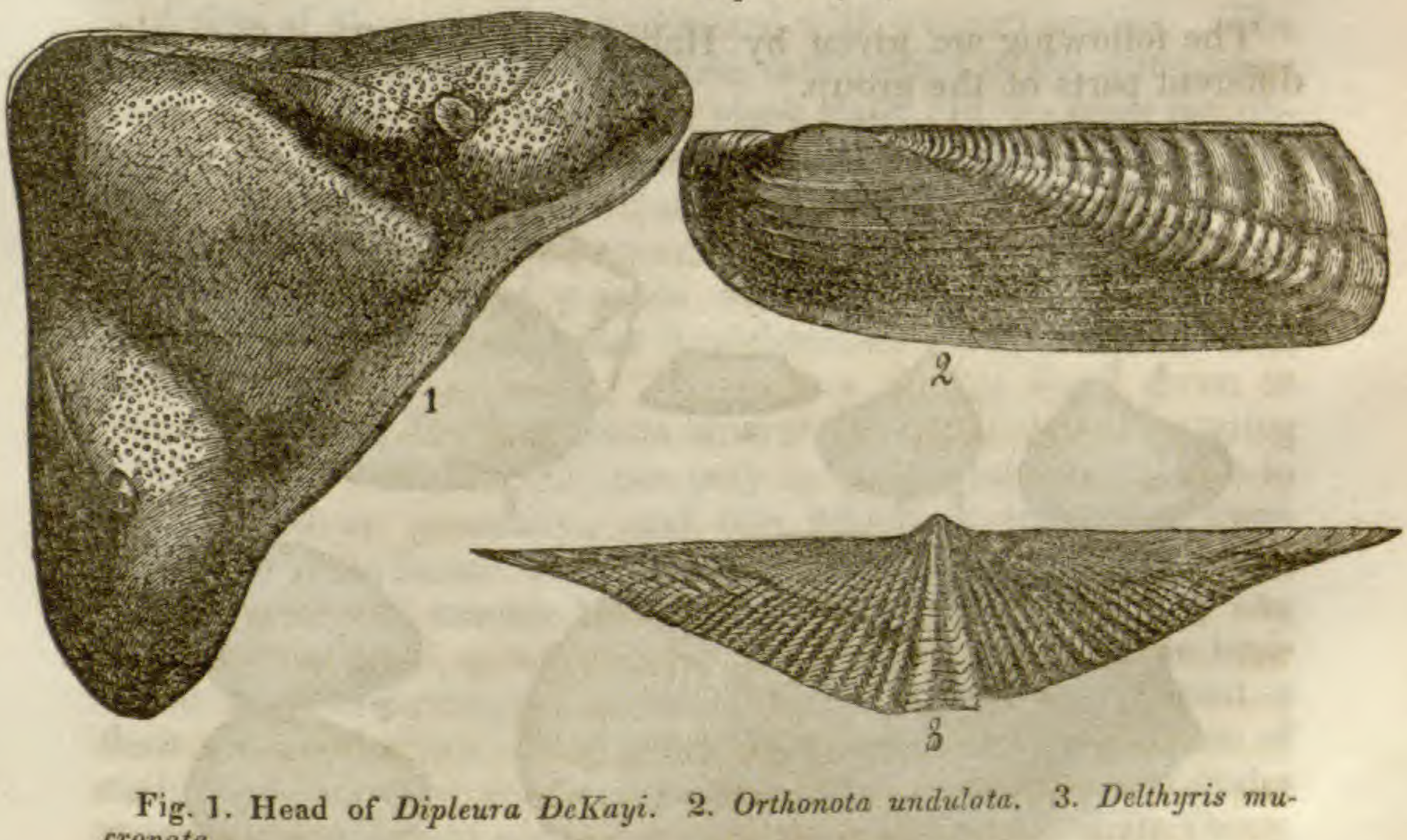


Fig. 1. Head of *Dipleura DeKayi*. 2. *Orthonota undulota*. 3. *Delthyris mucronata*.

Fig. 1 resembles somewhat the head of the Clinton and Niagara *Trimerus*, but differs, according to Vanuxem, not only in the form of the snout, but also in the parts around the eyes being more full and protuberant in the *Dipleura*. It is also allied to the *Homalonotus* of the Ludlow formation of England, but differs in the tail, which, in the *Dipleura*, is divided into three lobes as in the *Trimerus*.

Those on the following plate have been selected by Vanuxem both as common and exclusive species of the group.

Vanuxem's Report. (37.)

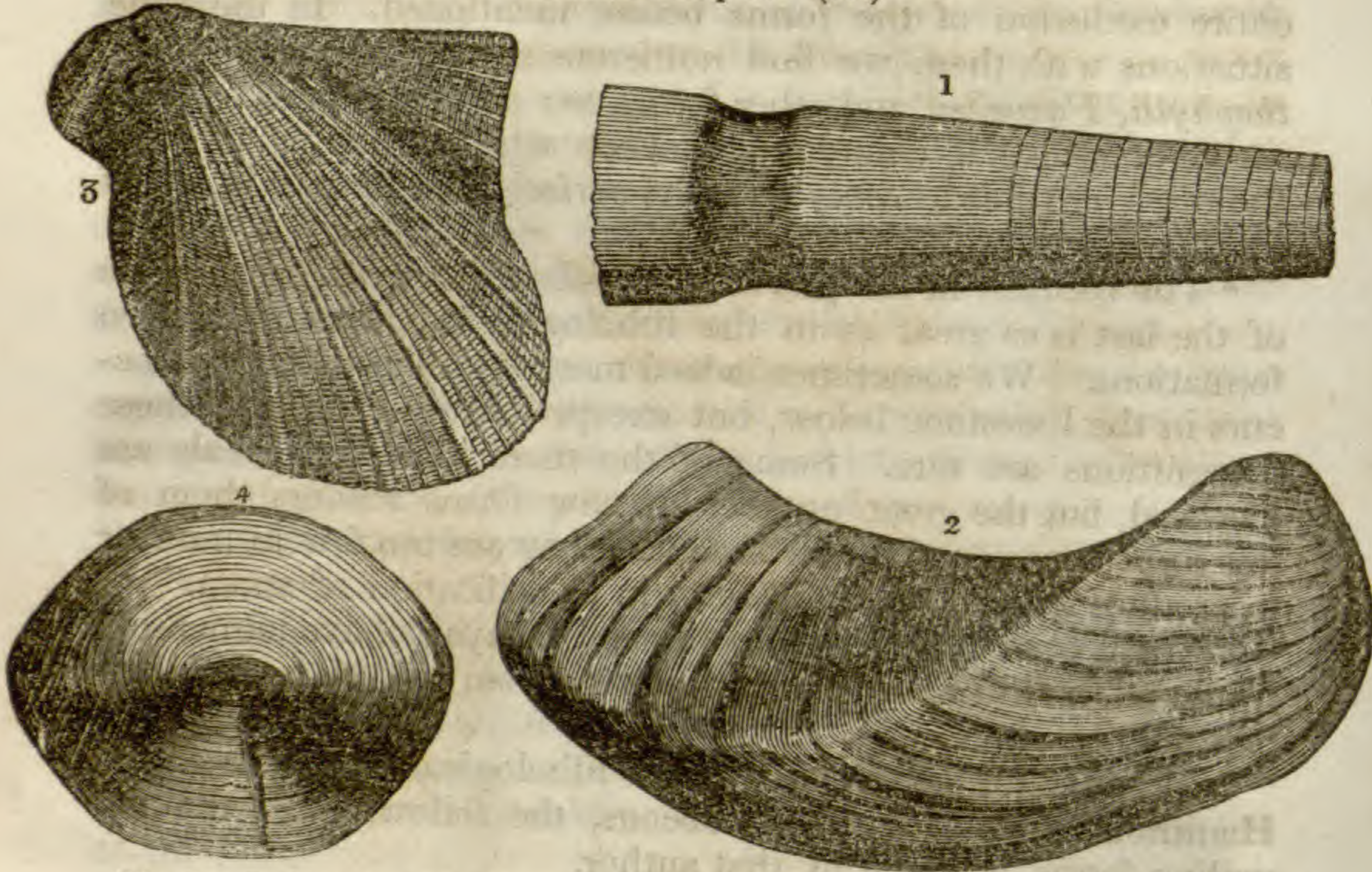
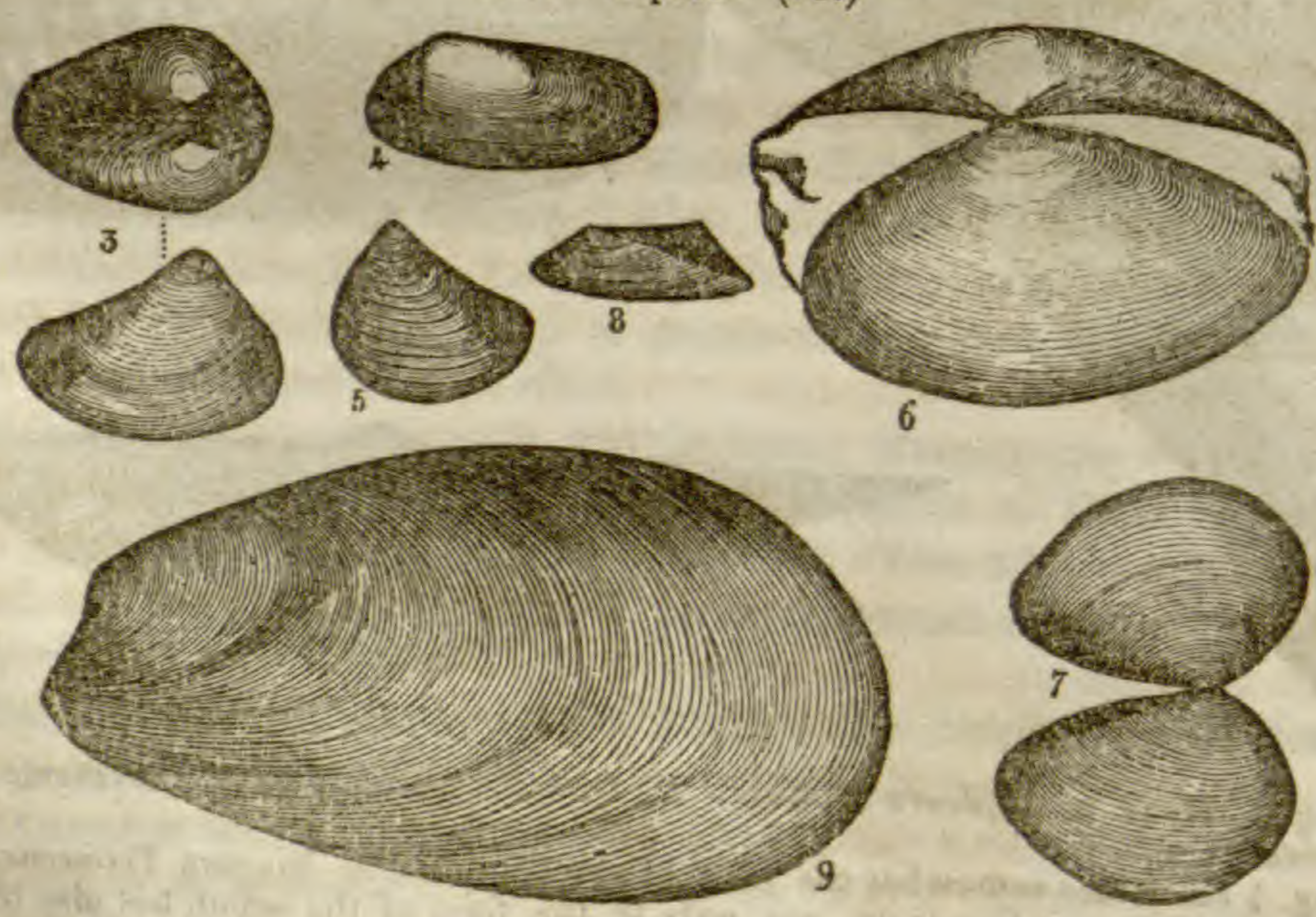


Fig. 1. *Orthocera constrictum.* 2. *Cypricardites recurva.* 3. *Avicula flabella.* 4. *Orbicula grandis.*

The following are given by Hall as the prevailing forms in different parts of the group.

Hall's Report. (78.)



Bellerophon patulus. *Microdon bellastriata.* 3. *Cucullea opima.* 4. *Nucula oblonga.* 5. *N. lineata.* 6. *Tellina? ovata.* 7. *Nucula bellatula.* 8. *Cypricardia truncata.* 9. *Modiola concentrica.*

The whole of the above seem to be American species excepting fig. 5, which is believed to be identical with a species figured by Phillips. Fig. 9, *Modiola concentrica* is thought to resemble in some respects *Modiola* (?) *semi-sulcata* which occurs in the lower Ludlow rocks of the Silurian system. (See Silurian Researches, pl. 8, fig. 6.)

Hall's Report. (79.)

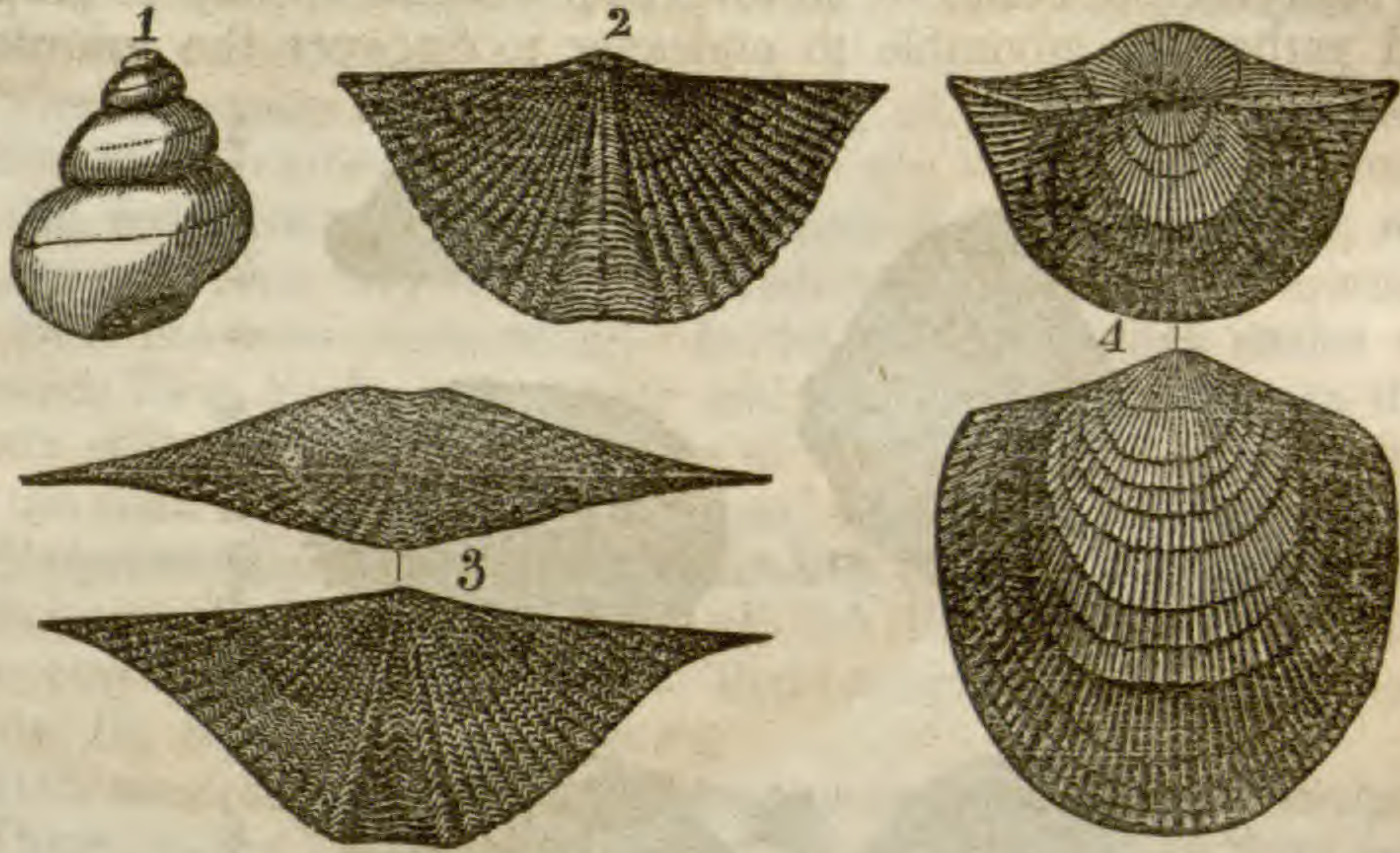


Fig. 1. *Turbo lineatus.* 2 and 3. *Delthyris mucronata.* 4. *Atrypa prisca.*

A few of these fossils are identical with western species. The *Atrypa prisca*, as already remarked, is abundant in the water limestone and shale beds below the black slate, but we have not observed it either *in* or *above* that formation. At the Button-mould Knob south of Louisville, a fossil very like fig. 2, *D. mucronata*, is found, except that those specimens which have come under our observation are not so pointed at the termination of the hinge line, but it would appear that this character is not constant in the same species in the east. The figures of this fossil given in Vanuxem's and Hall's Reports are very instructive as illustrating a most important principle, not only in palæontology, but also in natural history generally; and one which is too often overlooked by describers. It is the very diversified form which the same species will assume by modifying circumstances. Any one who looks at fig. 3, p. 61, and fig. 2, above, would feel little hesitation in pronouncing them distinct species, so very different is their general outline. Had there been but a few specimens of each collected, they would, doubtless, have been described under at least two different specific names; and the intermediate forms, perhaps by several more. It is only by the careful examination of a vast number of individuals and thus tracing the various gradations from one extreme to the other, that they have been ultimately discovered to be one and the same species. A want of a sufficient number of individuals for comparison, and a too hasty and superficial examination of specimens, together with an inordinate ambition to append *nobis* to a nondescript, has created not only a confusion and a multiplicity of synonyms in many branches of science, but it has often extended the number of species far beyond what maturer deliberation would sanction. In studying the fauna of an unexplored region it may be proper and perhaps is advisable to endeavor to discover the minutest

Hall's Report.

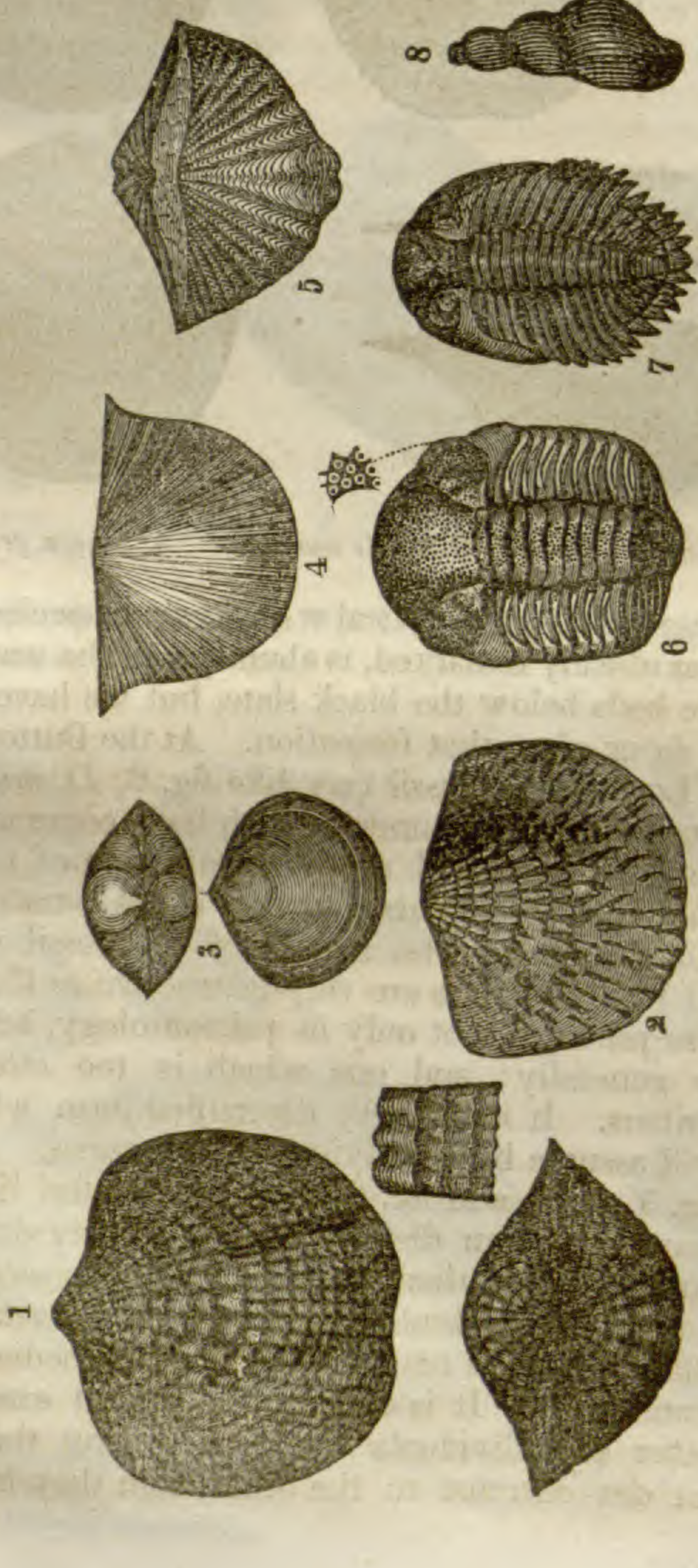


Fig. 1, 2. *Atrypa spinosa.* 3. *A. concinna.* 4. *Strophomena inequistriata.* 5. *Delthyris zigzag.* 6. *Calymene bufo.* 7. *Cryphæus calliteles.* 8. *Loxonema nexilis.*

points of difference, and, if you please for your own convenience and for the sake of classification, to give *provisional* names to those apparently distinct; but we feel convinced that just in proportion as the collection is extensive and the comparison of forms critically traced, the tendency of maturer reflection will be to curtail the number of species. We have been forcibly struck with this fact in our investigations into the specific character of those western palæozoic forms which occur, in certain localities, in such vast profusion.

The diversity of outline which the *D. mucronata* assumes, seems to be caused by a variation in the lithological character of the sedimentary deposits, as appears from the following remarks:—"This very ornamental shell and its numerous varieties in form are very interesting. In the soft calcareous shales of western New York, it is shorter and more rotund; while in the sandy shales and shaly sandstones of the middle and eastern part of the state it is greatly extended and its extremities very acute."

Calymene bufo, fig. 6 of the preceding cut, is an abundant and well known fossil of the shale strata on the Falls of the Ohio. It occurs also in the limestone of Red Cedar and the Wapsenonox in the Du Buque district of Iowa.

Hall remarks on fig. 4, *Strophomena inequistriata* of Conrad: "There seems to me good reason for considering this form and *S. mucronata* of Conrad as identical, and that both are identical with *Orthis interstrialis*. (Phil. Palæozoic Fossils, plate 25, fig. 103.)"

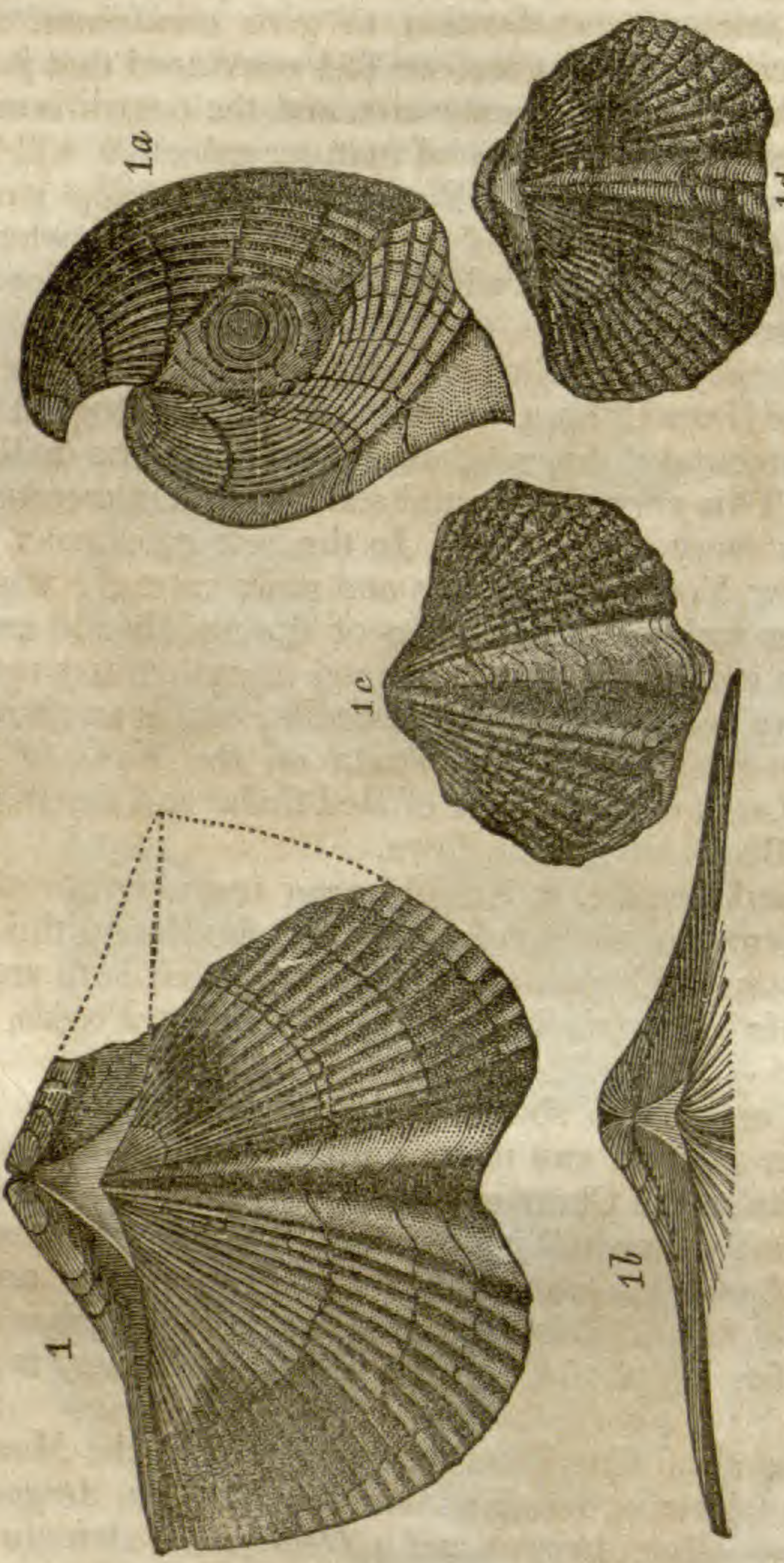
"In the calcareous shales of the Hamilton group, its form is often better defined and more rotund, though the striæ are less sharp; while in the Chemung rocks, it is usually compressed, and very frequently the shell is partially or entirely removed."

Fig. 8, *Loxonema nexilis* is believed to be the same as fig. 183, pl. 38, Phil. Palæozoic Fossils, and *Terebra nexilis* of Sowerby, fig. 17, pl. 54, volume v, Second Series, is given as a synonym.

A thin band of Encrinital limestone below the Moscow shale affords the following fossils: *Avicula orbiculata*, *Atrypa rostrata*, besides three other *Atrypas* and a *Delthyris*. *Avicula decussata* is also associated with the same rock throughout the fourth district.

The species of *Delthyris* considered by Hall as most characteristic, and represented in his Report, are embraced in the two wood-cuts on the following pages.

At Charleston, Clark county, Indiana, an extension of the shell beds of the Falls of the Ohio contains a *Delthyris* having a remarkably broad cardinal area, bearing a strong resemblance to *D. macronota*, fig. 3, of the annexed wood-cut. The aperture of the western fossil is not quite so narrow, the concentric laminæ



Hall's Report, p. 207.

Fig. 1, *a*, *b*, *c*, *d*. *Delthyris granulifera.*

not quite so numerous, and the beak of the fissured valve does not overhang the cardinal area. These differences are, probably, variations depending on age, geographical distribution and lithological peculiarity, rather than essential specific distinctions.

Both at the Falls of the Ohio and the southern part of the Du Buque district of Iowa, these western rocks contain another Delthyris allied to the above, but, for the most part, having a narrower cardinal area; but a recent inspection of a number of individuals, induces us to believe that this *Delthyris* passes by almost imperceptible gradations into a species, with a wide cardinal area which cannot be distinguished from *D. macronota.* If we are not mistaken, this is the fossil described by Conrad under the name *D. duplicata.* It is an abundant fossil also in the Louis-

Hall's Report, p. 207.

Fig 2. *Delthyris congesta.* 2a. Front view of same. 3. *Delthyris macronota.*

ville water-limestone. We should not be surprised if more extended observation might prove *D. medialis*, fig. 8 of the following wood-cut, to be only a modified form of the same. The number of ribs, and laminæ of growth, and width of cardinal area, are characters which certainly are liable to variation in the same species. Acuteness of the mesial fold, too, depends considerably upon age and condition.

An elegant form of fucoid allied to that characterizing the Caudi-galli grit, appears in this group. It is known as the curtain-shaped fucoid. Here also is the first evidence of terrestrial vegetation. Vanuxem gives the figure of a specimen found in his district, (p. 127,) and another on p. 161; they are not referred to any known plant.

Hall's Report, p. 208.

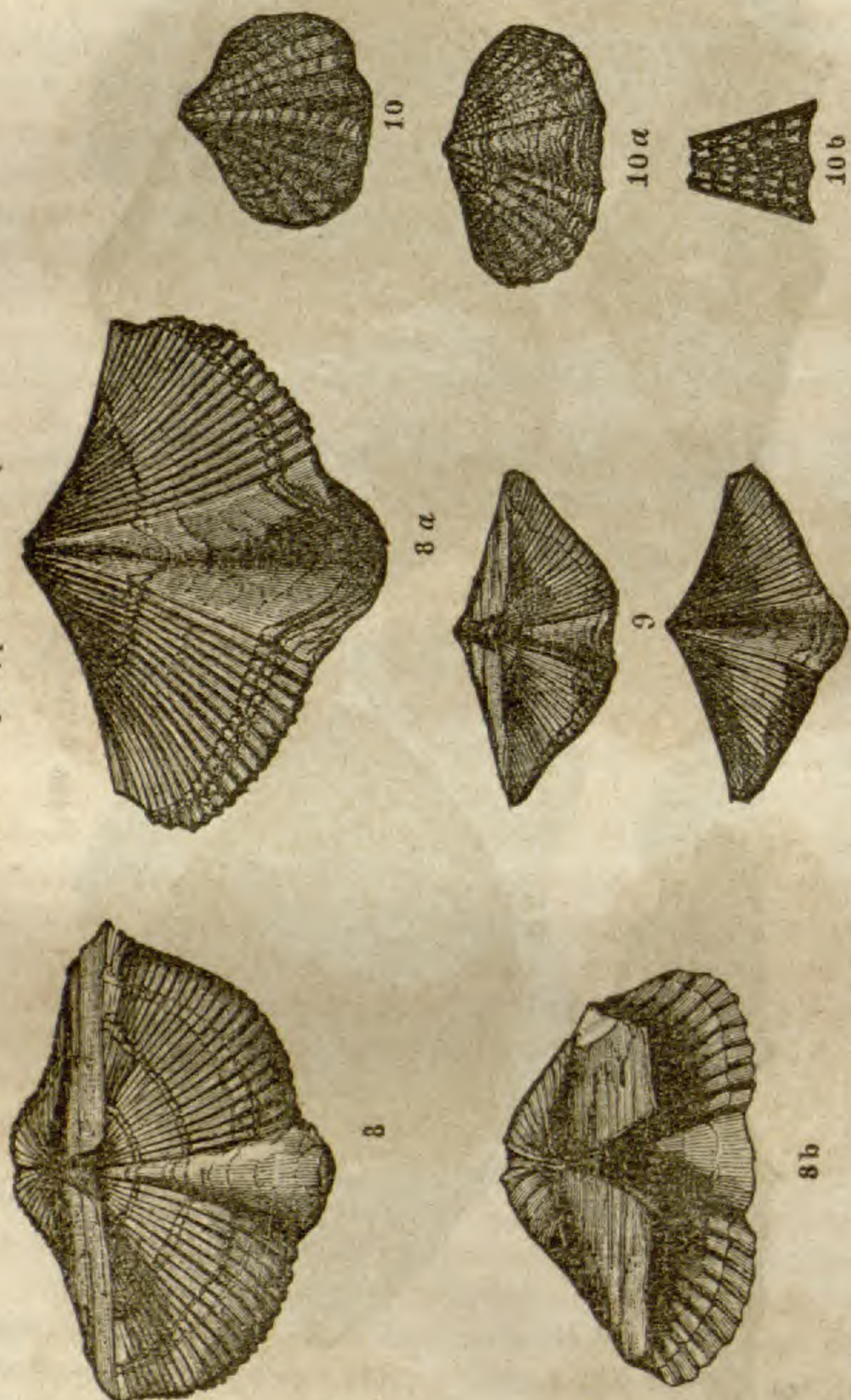


Fig. 8*a*, *b*. *Delthyris medialis*. 9. Young shell of the same species? 10*a*, *b*. *Delthyris fimbriata*.

Amongst the most numerous corals of the Hamilton group, the following have been selected as presenting some of the most common forms.

The shell and coralline beds of the Falls of the Ohio and its vicinity furnish examples of a coral like fig. 3, though for the most part, in glomerate masses. The fossil to which we have reference, has been usually regarded as the *Cyathophyllum helianthoides* of Goldfuss, which is also given as a synonym of the New York fossil. Like this Hamilton species the lamellæ of the western coral proceed from the centre, and no transverse laminæ

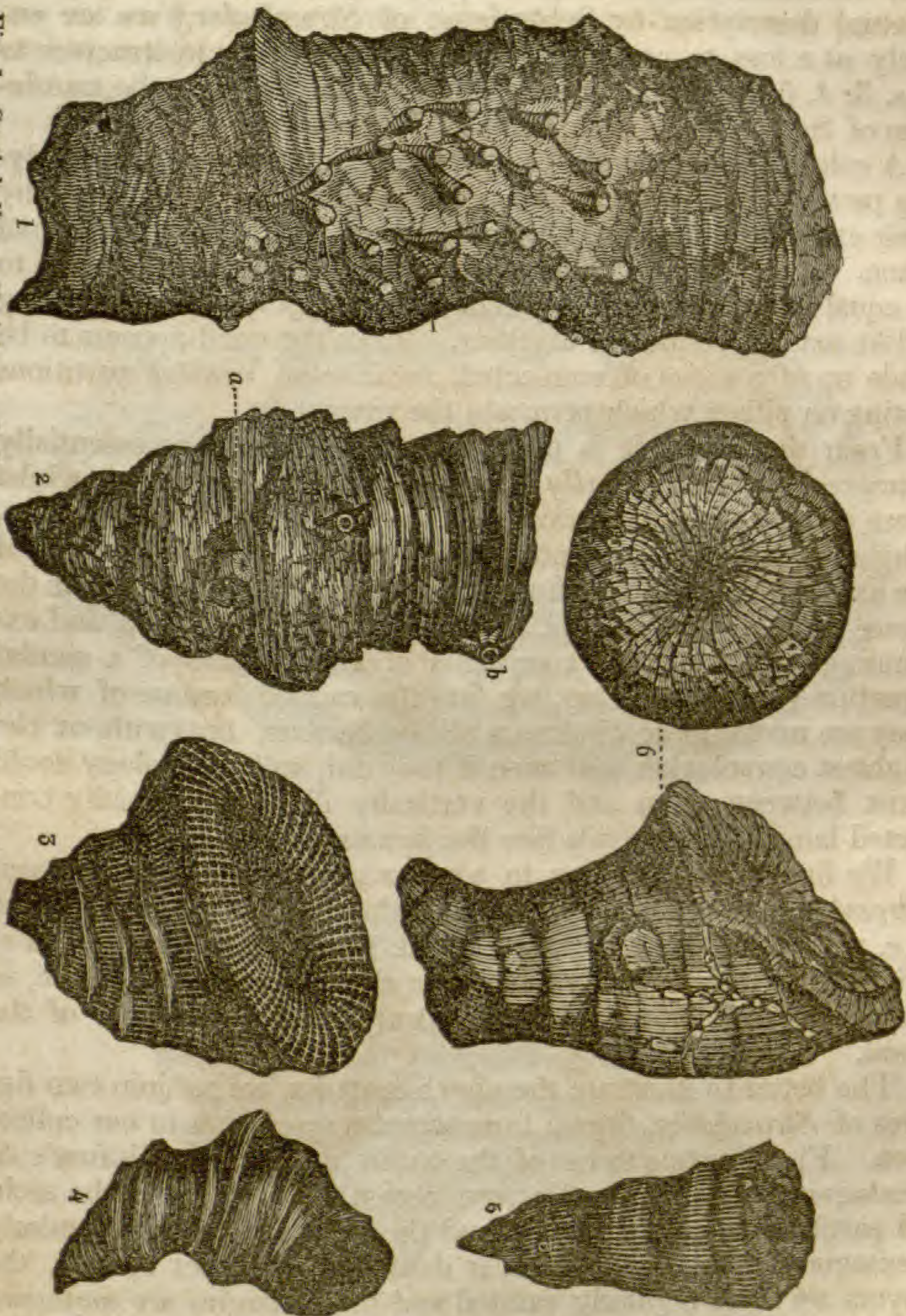


Fig. 1. *Cystiphyllum cylindricum.* 2. Do. 3. *Strombodes helianthoides.* 4. *S. distortus.* 5. *S. ? rectus.* 6. *S. simplex.*

Hall's Report, p. 209.

are observable towards the axis, when ground down. The lamellæ do not appear however to be denticulate, but neither the figure nor the description of Goldfuss denote this as a distinctive character of *C. helianthoides.* Following Lonsdale's definition of *Strombodes*,* Hall supposes this fossil to belong to that genus. If the presence of transverse plates, like the septa of Nautilus, traversing the axis of turbinated corals, is to be regarded as characteristic of a true *Cyathophyllum*, then the coral in question may be entitled to rank as a separate genus, but looking to the original description by Schweigger of *Strombodes*,† we are entirely at a loss to conceive how corals analogous in structure to figs. 3, 4, 5, 6, can be placed in that genus. Here is the translation of Schweigger's description of *Strombodes*.

A calcareous coral stem composed of lamellar, conical cells lying parallel and vertical beside one another, and connected by their expanded margins growing together in the same horizontal plane. A second and third grows up out of the previous one to an equal height with the adjacent ones, their broad margins being in like manner connected together. Thus the coral appears to be made up of a series of connected, *horizontal*, *vaulted* partitions resting on pillars which permeate the mass.

From the above it is evident that *Strombodes* is essentially composed of *horizontally disposed*, *vaulted* partitions, whilst these corals consist of *vertical lamellæ*. Now, we would inquire, why should the partial contortion of the vertical lamellæ around the axis of the coral constitute it a *Strombodes?* Turning to the figure of *S. pentagonus*, pl. 21, fig. 2, *a*, *b*, of Goldfuss, and examining the numerous specimens of fossil corals of a similar structure in our possession, we find the vaulted laminæ of which they are made up, to dip into a pillar-like axis, but without the slightest convolution, and even if they did, still no analogy could exist between them and the vertically disposed, partially contorted lamelliferous corals like the figures referred to.

We find it difficult even to admit a generic analogy between *Strombodes* of Schweigger, and Lonsdale's *S. plicatum*, fig. 4, *a*, *b*, *c*, pl. 16, *bis*, (C. plicatum of Gold. fig. 5, pl. 18,) composed of crimped, funnel-shaped laminæ; the more especially if these, as we are led to infer, are spirally contorted around the axis of the coral.

The better to illustrate the above remarks, we subjoin two figures of *Strombodes*, drawn from western specimens in our collection. Fig. 1 seems to be of the same species as Goldfuss's *S. pentagonus*, though the diameter across the margins of the arched partitions is much greater, and their outline more irregularly pentagonal. In fig. 2, which is doubtless a distinct species, the layers are more regularly vaulted and their margins are *confluent*, so that the surface presents small mammillary elevations with depressions in their centers. The upper surface of the arched laminæ is undulating or slightly furrowed. These run in

* Corals composed of "lamellæ contorted spirally."

† See also this Journal, i, ii ser., 185, and this volume, p. 14.

gently curving lines from the axis to the circumference. To the naked eye these appear like striæ or fine vertical lamellæ; no doubt this structure has given origin to the idea that *Strombodes* possessed "lamellæ contorted spirally around the axis." 1*a* shows the disposition of the arched layers dipping concentrically into the axis of growth, and producing, as Schweigger has described, a pillar-like axis permeating the mass.

Fig. 1*a*. Fig. 1.

Fig. 2.

Cystiphyllum cylindricum, fig. 1. p. 69, is considered identical with a species which occurs in England in the Wenlock formation. It is a remarkable coincidence, that, in both countries, it is encrusted with *Aulopora tubiformis*. The latter coral is found in the west also at Button-mould Knob, near Louisville.

From the preceding comparison of fossils in the east and west, we discover that the rocks immediately below the black slate in the vicinity of the Falls of the Ohio, contain not only Onondaga limestone and corniferous fossils, but likewise some Hamilton fossils. The latter fact rather favors the idea of our black slate being the equivalent of the Genesee slate. The position of our Goneatites rather confirms the same. It is true those found are not identified with New York species; but the first appearance of this family of chambered shells in the west is in an argillaceous limestone, *below* the black slate, whereas in the east they are first observed in the upper limestone layers, separating the lower and upper divisions of the Marcellus shale. So few organic remains have hitherto been discovered in the western black slate that they are but little guide in the solution of the question of equivalency. The *Tentaculites fissurella*, the most abundant of these, occurs both in the Marcellus shale and Genesee slate, and, therefore, does not help us out of the difficulty. A specimen of black slate in our possession, from Jefferson county, Indiana, contains an *Orbicula*, but not in a good state of preservation, so that it is difficult to ascertain its specific characters. The size and outline resemble the *O. lodensis* of the Genesee slate, rather than the *O. minuta* of the Marcellus shale.

On the other hand, we have, both in Tennessee and in Kentucky, (Button-mould Knob,) an encrinital limestone, which may represent the "encrinital limestone of the Hamilton group," since it contains similar entrochites and probably a few other Hamilton fossils. This group is, therefore, but feebly represented in the west, and until we can identify more fossils and establish the true equivalency of the black slate, it becomes difficult to decide what is the representative of the Hamilton group in the west.

In the northwest the limestone of Red Cedar and Wapsinonox is probably its equivalent.*

The fossiliferous shales of the preceding group terminate abruptly, and are succeeded by an impure, dark colored limestone, usually thick-bedded and accretionary especially in its lower part. This rock has derived its name from the village of Tully in Onondaga county, where it is best developed. Sometimes it has thin seams of shale interposed which separate the calcareous part into wedge-form irregular laminæ. This is the most southern belt of limestone in the state of New York. The Tully limestone is of no great thickness, never exceeding twenty feet, even in the eastern extension where it is thickest, and mostly under ten feet. In the western part of the state it is only represented by a calcareous band of three or four inches. It is, therefore, a

* See Report [*Senate*] of a Geological Exploration of part of Iowa, Wisconsin, and Illinois, pages 32 and 33.

very subordinate member of the New York system, and, for this reason, not represented on the chart by a separate color.

Besides the locality already mentioned, the western shores of Lakes Cayuga and Seneca and the outlet of Crooked Lake, the village of Belona, Ontario county, afford opportunity for investigating the characters of the Tully limestone.

No minerals of interest occur in it.

In the fourth district fossils are rare in the Tully limestone, but in Vanuxem's district they are more common. Some of the forms are here given:—

Vanuxem's Report, p. 163.

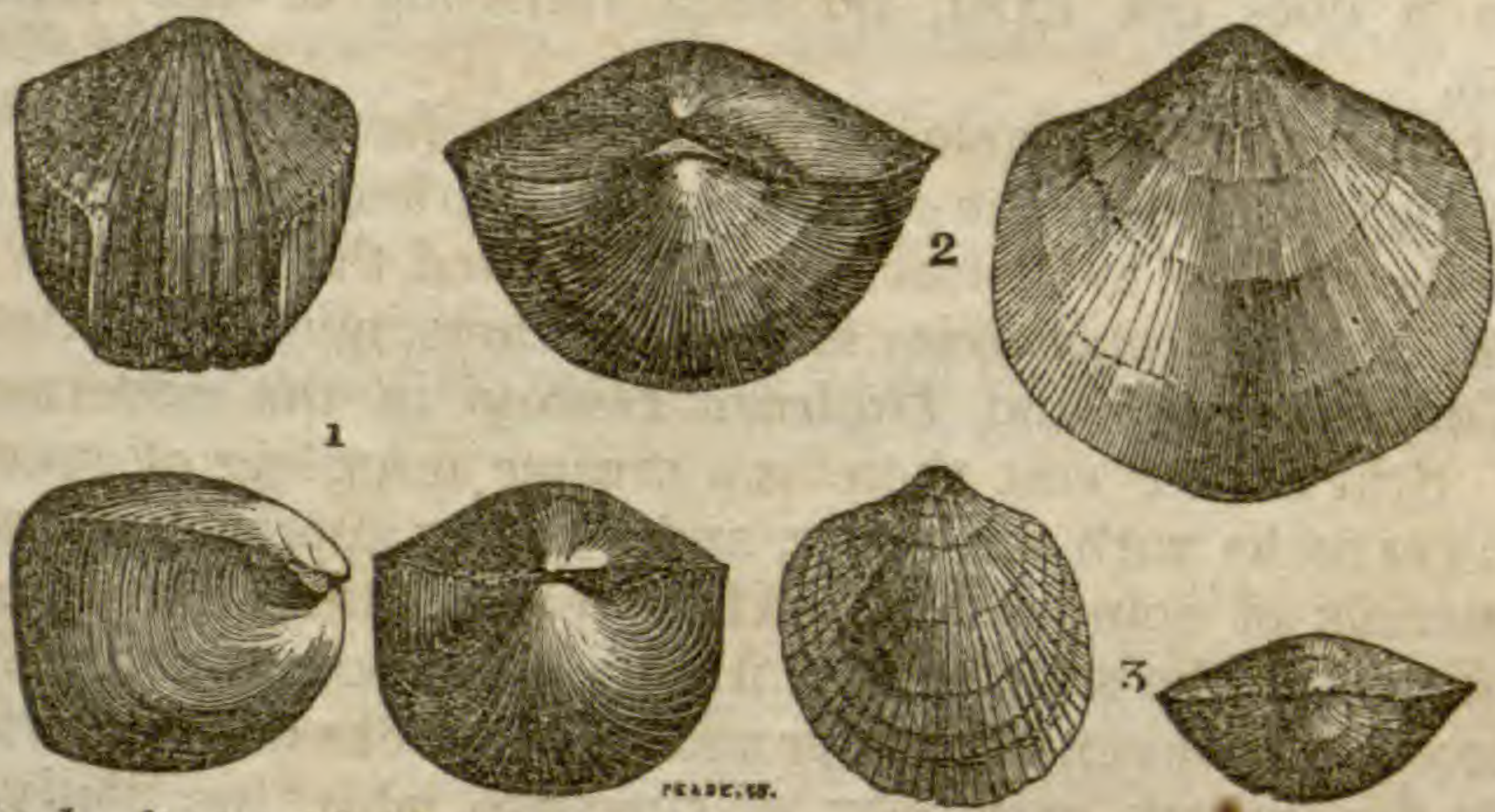


Fig. 1. *Atrypa cuboides*. 2. *Orthis resupinata*. 3. *Atrypa lentiformis*.

Hall's Report, p. 215.
Fig. 4.

Fig. 4. *Atrypa affinis*.

Of these, fig. 1, *A. cuboides*, and fig. 2, *A. resupinata*, are peculiar to this rock. Both are English species. The former found in what is considered the Devonian system, the latter in the mountain limestone. Fig. 3 is probably a small variety of *A. affinis*.

Speaking of the rocks which follow this formation, Hall makes the following general remarks:—

"In the fourth district, the Tully limestone terminates all those deposits in which calcareous matter forms an essential part. In all the higher rocks, this material, when existing, is the result of the destruction of organic bodies; and in the few instances where it appears the origin is unquestionable, for the fossils still retain so much of their original form as to be readily recognized. This rock forms a strong line of demarcation, not only in this respect, but also as regards fossils; very few forms which are known below continuing into the rocks above. The lithological character of the products above this rock are throughout more or less similar, while they differ from those below; and, with a single exception, lithological character is a sufficient guide for distinguishing the different strata."

"This contrast of character is more marked towards the western extremity of the district than it is farther east; and, finally, on its eastern extreme, there is a great similarity in the lithological features. This change is likewise attended with the occurrence of some of the fossils of the lower group in the rocks of the higher, the nature of the two being very similar, although the Tully limestone is in its greatest force; while at the west, where it does not exist, no such mingling of the fossils is known."

"At Ithaca, for example, where we are far above the Tully limestone, and where the rocks are well marked by an abundance of fossils peculiar to themselves, still we find the *Microdon bella-striata*, *Modiola concentrica* and some others, and I have detected the *Calymene bufo* and *Dipleura Dekayi* in the same association. Still farther east there is a greater mingling of species of the lower rocks with the upper, and a nearer approach constantly in materials of composition. These circumstances, in the eastern portion of the state, render it difficult to point out the line of demarcation between the lower and higher rocks of this division."

"At the eastern extremity of the state, also, the Tully limestone does not exist, and, therefore, that guide to the line of division between the lower and higher groups is wanting. The absence of this rock, and the similarity of lithological products, as well as the mingling of organic remains of the lower rocks, renders it impossible to make a distinction in groups with the same degree of satisfaction as further west." D. D. O.

(*To be continued.*)

Art. IX.—*Notice of New Fossil Footprints*; by James Deane.

Several new species of footprints of birds, and one of quadrupeds, have been discovered at Turner's Falls, during the past year, and like all others obtained at this remarkable locality, they are singularly distinct, and through their configuration, we are enabled to determine the class of animals by which they were made. The impress of the tarsus and phalanges, and of the dermoid and unguinal appendages is true to life, and their perfection supplies us with the means of connecting the extinct with living races of animals.

The new examples, three in number, are very beautiful; the foot is comparatively long and slender, toes slightly diverging, and the stride of great extent, which indicates that the birds were long legged, and also, in connection with the structure of the foot, that they were waders. This was unquestionably the character of the multitudes of birds whose tracks are found in the sandstone of the Connecticut valley. The step is comparatively long in all, and in many very much so. The foot of colossal individuals averages 14 inches in length, and the stride 48 inches in extent, which gives the proportion of 1 to 3½. But in some of the smaller varieties the proportion is vastly greater. Some individuals having a foot of 2 inches, and a stride of 22 inches, or 1 to 11; and the proportion is even sometimes greater than this. The foot of one of the new varieties is 4 inches in length, with a 16 inch stride, or 1 to 4; that of another is 2 inches long, with a 12 inch stride, or 1 to 6. The perfection of the Turner's Falls footprints, not only indicates the order of animals by which they were impressed, but demonstrates the fact, that these early inhabitants of our planet frequented regions which were periodically, or at least occasionally, submerged.

The cause of this submergence, is an enquiry of much interest and uncertainty. From certain facts, it would seem to be due to the action of *floods*, for it is difficult, nay, almost impossible, to see how the exact imprint could be retained, if the overflow were due to the agency of tides. An impression upon soft mud cannot, of course, retain its precise form; a certain degree of hardening, by drying, is necessary to this result, and during an interval of a few hours only this could never happen, unless solar heat were excessive beyond all probability. Many imprints bear evidence that they were made upon soft mud; they are more or less misshapen or obliterated, no trace of articulations, much less of integuments, being perceptible. But one of the most prominent indications that the elevation was due to occasional floods, is the fact, that the *superior* surfaces of the strata upon which distinct impressions occur, are incrusted with a thin glazing, differing in character and often in color from the principal mass. This crust is formed of finely comminuted materials, such as is deposited from turbid water, in a state of comparative rest. This phenomenon may always be observed after summer rains, where water is accumulated in pools and gradually dissipated by evaporation and absorption; or where streams have suddenly overflowed their banks, and have again quietly resumed a former level. A thin, shining, adhesive deposit results, but an interval of several days of summer heat is necessary to harden the surface sufficiently to retain the accurate form of an animal's foot. I have frequently seen upon the same surface of rock several rows of footprints, made by different birds; the impressions made by some individuals were deep and imperfect, having been made while the substance of the rock was yet soft; others were quite superficial, though perfect, being evidently imprinted when the hardening process was carried so far as to offer greater resistance to pressure. I have repeatedly witnessed this process of desiccation upon the alluvial mud of a river's bank, and have removed various footprints of birds, dogs, frogs, &c., which vie with those found in the hidden depths of the rock, and I am satisfied that under existing temperature, even in midsummer, it would be impossible that footprints should retain their perfect configuration, when impressed during the interval between the ebb and flow of tides.

This opinion is sustained by another singular fact. When a stream has a sluggish movement, or where placid water stands at stationary levels, we may observe that at the line of junction with the muddy banks, an abrasion takes place in consequence of the rippling movements of the water. If another depression of level occurs, the wearing process is again repeated, and thus several parallel lines are traced upon the shore, indicating the point at which the water was stationary. Now this phenomenon I have often seen beautifully illustrated upon the rocky strata: for example; I removed from the quarries at Turner's Falls, a large slab of sandstone, the upper limits of which, (a space of six inches in breadth,) was glazed with sedimentary deposit, and was covered with rain-drops and footprints of several varieties of birds. On its lower limits there was an abrasion of the surface, running in a straight line the entire length of the slab, and below this was a second parallel breadth, upon which the surface was still more deeply worn away. The curious fact was illustrated, by finding that the space *a*, above the first line, fig. 1, was completely pitted with hemispherical rain-drops, while not a trace of them occurred below it, that part being occupied by water. The small bird, also, walked directly into the water, but it left no trace below the space *a*. When the waters receded to the second level, the space *b* was exposed, and subsequently the large birds walked directly into the water.—Their imprints upon the space *a*, are quite superficial, but in the space *b*, they are remarkably deep, a condition which proves that the space *a* was hard, while that of *b* was soft, but below this, in the space *c*, not a vestige of any impression is seen, that division being submerged at the time of passage of the birds. Such facts are of frequent occurrence, but it is difficult to reconcile them with the idea that the elevation and depression of the waters is referable to the action of tides. It is proper to observe that the water levels were parallel to the upper edge of the slab, and could be traced a distance of fifteen or twenty feet.

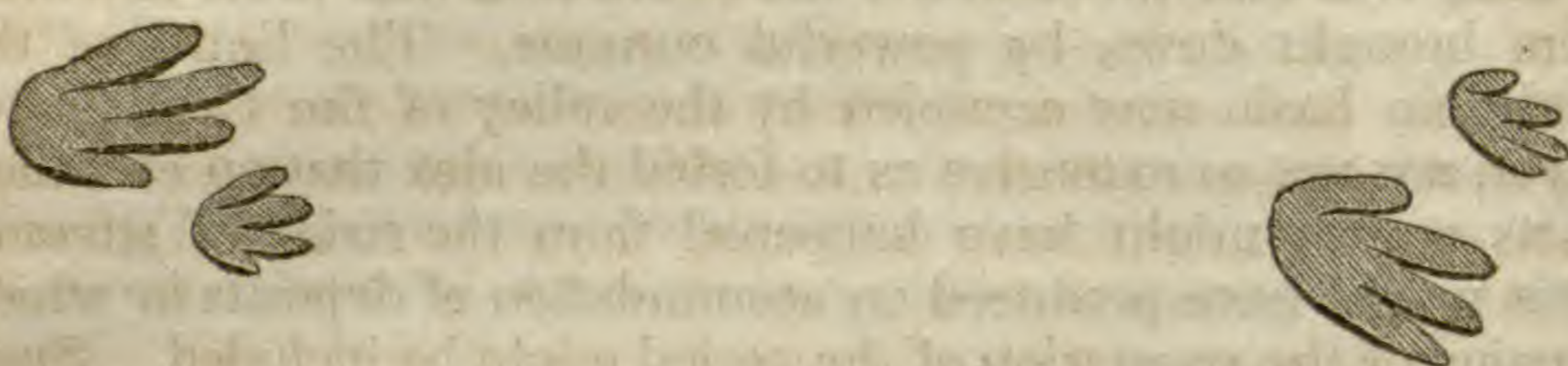
Fig. 1.

The physical composition of the rock is presumptive evidence that its elements were accumulated in some large basin, through the agency of powerful streams. It is in a great degree composed of the debris of former rocks, of pebbles, great and small, precisely similar to those rounded by diluvial action. Numerous remains of trees are found, both in the stratified and unstratified masses. In fact, it is difficult to avoid the conclusion that these materials were brought down by powerful currents. The limits of the sandstone basin now occupied by the valley of the Connecticut River, are not so extensive as to forbid the idea that an elevation of its waters might have happened from the rising of streams. This would have produced an accumulation of deposits in which remains of the vegetation of the period might be included. Such are some of the considerations which induce the belief that the elevation of the waters of the sandstone basin, and the deposition of sandstone were due to the agency of extensive floods; and we at least know that rains fell abundantly in that remote period of our earth's history.

The new quadruped footprints add a fourth species to the catalogue of this description of fossils derived from Turner's Falls, which locality supplies all that are known in the Connecticut valley. It is probable that they all belong to the Batrachian division of vertebrated animals. The new species was discovered by Mr. Marsh, and is now deposited in his magnificent collection of sandstone fossils. It differs specifically from those hitherto discovered, the footsteps being arranged in two parallel rows, widely separated, whereas, in one of the species, the first and second footsteps fall nearly together, while at the same time there is a remarkable difference in the size of these members. In a second order, the nature of the impressions is so obscure, that the organization of the animal cannot be referred with much probability to any known type. I have elsewhere figured and described these several impressions, excepting the new variety, and only allude to them now for the sake of comparison, and of grouping the whole. With one exception, these quadrupeds moved by walking, although it is probable they were adapted for swimming also. In one instance, however, progressive motion was obviously accomplished by leaping, which, if this conjecture be true, joins the animal to the tailless or ranal family of Batrachians. These animals were all diminutive in comparison with their cotemporaries, the colossal birds, with whom they occupied common ground.

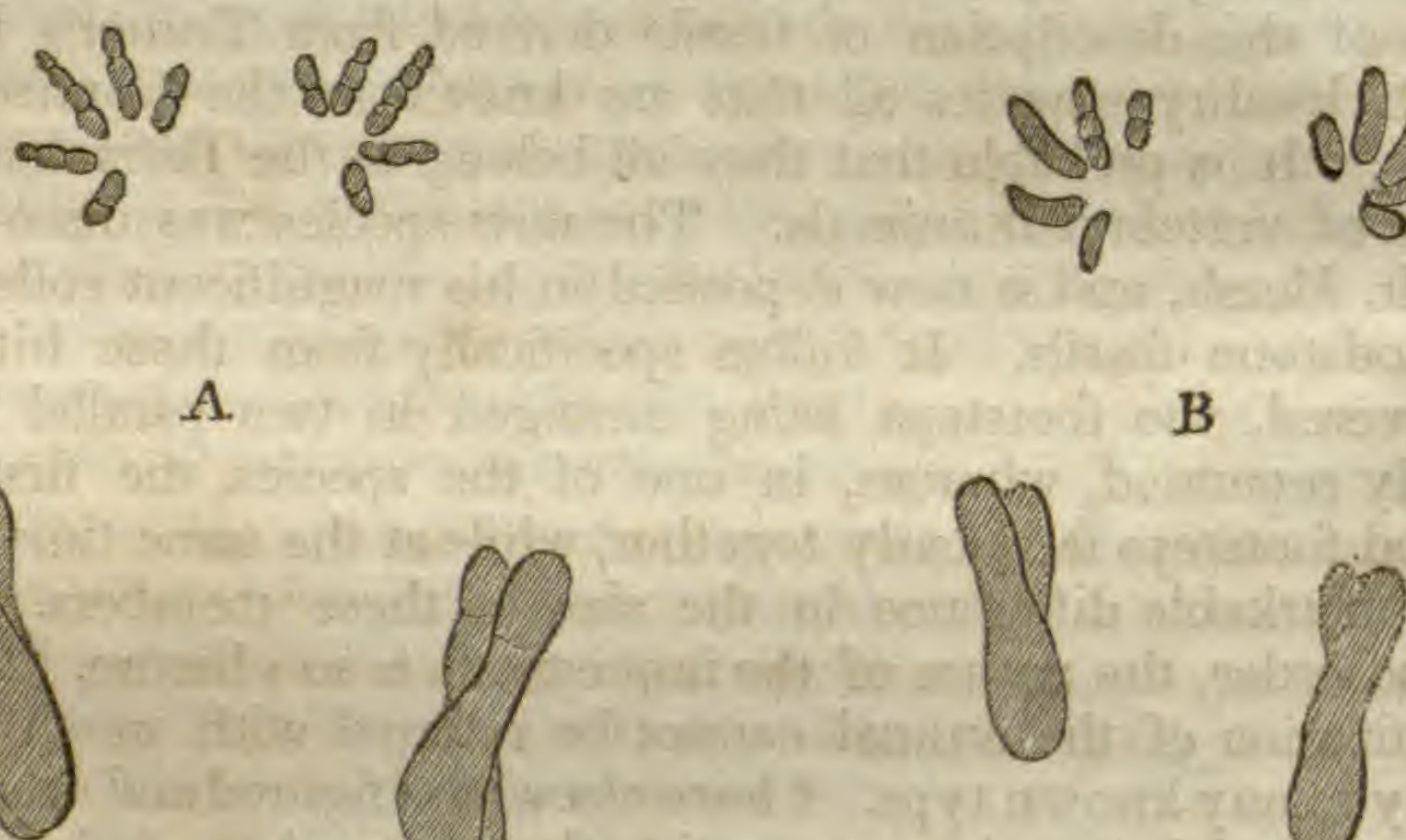
The configuration of the footprints represented by fig. 2, and the relative distance in size between the posterior and anterior feet, assigns the animal, by which they were impressed, to the Salamandrian, or tailed family of Batrachian reptiles. Two species are found in considerable numbers, one having pachydactylous toes, and a short stride, and the other, leptodactylous toes, and comparatively great length of step. Of the stout toed species, there are several grades of size, the posterior foot varying from that of fig. 2, to 2½ inches in length, with a stride of 10 inches.

Fig. 2.



Although the impressions of a single set of feet occur in the anomalous examples, shown by fig. 3, yet I do not doubt but they represent those of a quadruped. I have conjectured that they indicate animals included in the family Rana, and have given

Fig. 3.



a brief notice of them in Vol. xlix, page 80, of this Journal. No additional proofs have been discovered to confirm the opinion heretofore expressed; but to accumulate probabilities, the above sketches of two individuals from distinct strata, accurately reduced from the originals to one sixth the natural size, are added. The general resemblance is seen to be very striking, and it is a curious circumstance, that in each example, A and B, those depressions posterior to the *footprints*, which I have supposed to have been produced by the folded limb of the animal, have the right one projecting farther backward than that of the opposite side. These oblong elliptical impressions are deep at the lower extremity, and gradually become superficial at the other, and the papillose processes of the dermoid covering are apparent. The impressions, A, are remarkably distinct, showing the articulations of the toes, which is not distinctly the fact in B. Unfortunately, for a clear comprehension of this assemblage of impressions, they have not been found to occur in consecutive series; they are solitary, but this may nevertheless happen from the fact that the animals were able to leap to a considerable distance. Those represented by the diagram, individually occupy a space of 13 by 10 inches, and taking the frog as the representative of the animal, its leaps must have been truly wonderful. The impress of the posterior foot of a frog is nearly as much advanced in position as the former members; they occur upon the outer side, are superficial, and diverge considerably. The impress of the anterior foot is deep and points directly *inward*, while that of the fossil foot is just the reverse, the toes radiating from the tarsus outward. If these views be probable, these impressions constitute the second order of quadruped footprints found at Turner's Falls.

The third embraces those recently discovered, and differs essentially from the foregoing types; the feet are equal, divergent, fall

Fig. 4.

in separate rows, and are planted at regular distances. The impressions are imperfect, but it is probable that each foot comprised five toes, or four toes and a thumb. The specimen contains eight impressions, six of which are represented, reduced to one sixth the natural size. The animal was consequently small. The general aspect of the imprints, namely, the number, divergence and arrangement of the toes, appears to connect this species with the class represented by fig. 2, but they belong to a distinct family; perhaps, however, future discoveries may assign the animal to the order Chelonia. Thus, then, the preceding figures represent the footprints of three distinct orders of quadrupeds. They invariably occur in connection with those of birds.

Note.—We add here, for the purpose of calling attention to the subject, a very important observation by Prof. Agassiz, which was communicated to us in conversation, and has been hitherto unnoticed in connection with this subject, that the tracks of birds, when the impression is perfect, may be invariably distinguished by the number of joints of the several toes; the hind toe having uniformly *two* joints, the inner *three*, the middle *four*, the outer *five*.—Eds.

Art. X.—*Notes on the Algæ of the United States;* by J. W. Bailey, Professor of Chemistry, &c. at the U. S. Military Academy.

Scarcely any branch of natural history has been so much neglected in the United States as that which relates to the beautiful plants which are referred to the great group of Algæ. With the exception of six or eight species from the neighborhood of New York city, which were sent by Dr. Torrey to the elder Agardh, and which are mentioned in the *Systema Algarum*, I am not aware of any published account of any of the marine Algæ of the United States, prior to the following notice, which I find in the Proceedings of the Boston Society of Natural History, Vol. I, p. 13.

"The President (G. B. Emerson) exhibited (March 17th, 1841) dried specimens of the following marine plants found on our coasts, viz. Fucus vesiculosus; Fucus nodosus; Alaria esculenta; Agarum cribrosum; Laminaria digitata; Desmarestia aculeata; Dichloria viridis; Chorda filum; Asperococcus echinatus; Punctaria latifolia; Delesseria sinuosa; Rhodomenia cristata; Chondrus crispus; Ptilota plumosa; Porphyra several species; Ulva latissima and other species."

I can find no published notice of any of our fluviatile Algæ, although they appear to have been studied with some care by the indefatigable Schweinitz. I have seen in the herbarium of Dr. Torrey, a number of specimens of the fluviatile Confervæ of North Carolina, collected by Schweinitz, and with labels in his own hand-writing, indicating that he considered many of the species as new, and that he had assigned to them names of his own. If he ever published any notice of them, I cannot find it in the books to which I have access.

It appears then, that scarcely more than twenty species of Algæ have hitherto been accredited to our Flora. In this dearth of information, I am induced to hope that the results of my own study in this much neglected but most fascinating department of science, will be received with interest and indulgence.

My attention was first turned to this study at the request of Dr. Torrey, who wished me to prepare a notice of the Algæ of New York, to be included in his Report on the Botany of that State. He kindly placed the whole of his collection of foreign Algæ in my hands, and it is by the study of his authentic specimens received directly from Agardh, Greville, Harvey, Mrs. Griffiths, &c., that I have been enabled to proceed with some confidence in the determination of our own species.

My inland position has, however, prevented me from having many opportunities for collecting our marine Algæ. In fact, with the exception of two days spent on the sea-shore at Stonington, Conn., in the year 1838, and an excursion with Dr. Torrey for a few hours to the shores of Staten Island, I have had no chance to gratify my desire to study these beautiful productions in their native haunts, until this summer, when in company with Messrs. S. T. Olney, G. B. Thurber, and Geo. Hunt, zealous young botanists from Providence, R. I., I visited various parts of the shores of Rhode Island and Narragansett Bay, and made large collections of the Algæ. A residence of a few weeks at Providence and Newport, also afforded me an opportunity to add much to my collection, and to study microscopically many of the species in their full state of perfection.

It will be seen from the above statements, how slight an exploration has hitherto been made of the Algæ of our shores, and it is hoped that this will serve as sufficient apology for the incompleteness of the list which it is my object now to present.

I have included in the following list every species now positively known to me as growing in the United States, together with a few other North American species. Where no other authority is given, it will be understood that the plant was found by myself growing at the locality mentioned. Where the name of the collector is given followed by a (!), it is meant that authentic specimens from his locality have been examined by myself.

In the classification and names of most of the species, I have followed the excellent Manual of British Algæ, by the Hon. W. H. Harvey, and I must refer to that work for the synonyms of the marine species. Some of the freshwater genera and species are adopted from Ralf's papers in the Annals and Magazine of Natural History, or from Hassall's British Freshwater Algæ. For some of these, synonyms are given.

The principal localities will be referred to by the following abbreviations, viz. *Newport, R. I.* = the rocky sea-shore extending south from the bathing beach at Newport;* *Narr. Pier* =

* Those who feel desirous to visit Neptune's flower-gardens, and "where the sea casts up its briny ooze, to seek for weeds," will find the whole shore at the foot of the cliffs near the bathing grounds at Newport, well worthy of a visit. I presume that almost every marine species mentioned in my list and doubtless many others, may be found there, and I fully believe that Newport is yet to rival Torquay in England, as a locality for fine Algæ. My favorite spots along the shore, are in the small coves about half a mile below "the Stairs," where at low tide it is easy to get out upon

—— "the rocks where the sea-plants lift
Their boughs when the tides and billows flow,"

and where

—— "with its waving blade of green,
The sea-flag streams through the silent water,
And the crimson leaf of the dulse is seen
To blush like a banner bathed in slaughter."

The shores in this neighborhood are covered at low tide with vast quantities of rejectamenta, among which many of the most beautiful of the Algæ may be found;

the pier near Wakefield, R. I., on the west side of Narragansett Bay; *Seaconnet* = shores of Seaconnet Point, R. I., from the pier eastwardly for about two miles; *Ston. Ct.* = Stonington, Conn.; *Prov. R. I.* = Providence, R. I.; *Stat. I.* = Staten Island, N. Y., and *W. Pt.* = West Point, N. Y., and its vicinity for five miles around.

Series I. MELANOSPERMEÆ.

Sargassum vulgare, Ag. Seaconnet, Bristol Ferry, and Stone Bridge in Rhode Island. Specimens of this were found by Mr. Thurber and myself growing, *attached to stones*, below low water mark at Seaconnet Point, R. I. I afterwards found fine specimens at the other localities above mentioned. Harvey remarks, that it is "a native of the tropics," and only occasionally drifted to the shores of England; hence the discovery of it, growing attached to rocks on the coast of Rhode Island is one of considerable interest.

Sargassum bacciferum, Ag. *Gulf weed.* Floating in the Gulf Stream. My specimens were collected by Lieut. Knowlton, U. S. Army.

Halidrys siliquosa, Lyngb. Newfoundland. Edinburgh Encyclop. Fuci, p. 484.

Cystoseira ericoides, Ag. Nootka Sound. Dr. Scouler; v. sp. in herb. Tor.

Fucus vesiculosus, Linn. } These two species of Fucus grow
Fucus nodosus, Linn. } everywhere on our coasts in vast quantities. They are commonly known by the name of *rock weed*, and are extensively employed as manure. It is probable that several other species of Fucus are as common on our coast as they are on the eastern shores of the Atlantic; yet after the most careful search, these were the only species I could detect at Newport, or near New York city.

Himanthalia lorea, Lyngb. Massachusetts. G. B. Emerson.

Alaria esculenta, Grev. Shores of Newfoundland, M. de Pylaie. Massachusetts, G. B. Emerson.

Agarum cribrosum. Massachusetts. G. B. Emerson; Rev. J. L. Russell! Shores near Newburyport, Mass. J. W. Bailey.

Laminaria digitata, Lamour. Massachusetts. G. B. Emerson; Narragansett Pier, S. T. Olney!

Laminaria saccharina, Lamour. *Ribband weed, sole-leather-kelp, &c.* Very common on the shores of Rhode Island, Massachusetts and Connecticut. Fine specimens are often washed ashore at the bathing beach at Newport.

---

but I must caution the fair Algologists who may visit this spot, (some of whom I hope may yet rival in celebrity those distinguished English ladies, Mrs. Griffiths and Miss Hutchins,) that unless they are careful the tide may cut off their retreat from these rock bound bays, and leave them in a predicament from which no Edie Ochiltree could relieve them.

Desmarestia aculeata, Lamour. Mass. G. B. Emerson; Nantasket Beach, Rev. J. L. Russel! Newport, not rare.

Dichloria viridis, Grev. Mass. G. B. Emerson.

Padina pavonia, St. Domingo! It will doubtless be found on our southern coasts.

Punctaria latifolia, Grev. Mass. G. B. Emerson.

Punctaria tenuissima, Grev. Narragansett Bay, and Newport on leaves of Zostera.

Asperococcus echinatus, Grev. Mass. G. B. Emerson.

Chorda lomentaria, Grev. Narragansett Pier; Seaconnet and Newport, not rare.

Chorda filum, Lamour. Mass. G. B. Emerson. Common on shores of Rhode Island, and at Stonington, Conn., where I saw specimens from thirty to forty feet in length.

Cladostephus verticillatus, Lyngb. } Both these species (or as
Cladostephus spongiosus, Ag. } I believe *varieties* of the same species) occur abundantly at Newport.

Sphacelaria cirrhosa, Ag. Stonington, Conn.; Seaconnet, R. I.

Ectocarpus siliculosus. Very common everywhere on our shores, and also in the Hudson River at West Point, sixty miles from the ocean.

Chordaria flagelliformis, Ag. Mass. G. B. Emerson. Very common on the shores of Rhode Island and Connecticut.

Series II. Rhodospermeæ.

Mesogloia multifida, Ag. Common, with the preceding plant.

Halymenia furcellata, Ag. Newport.

Polyides rotundus, Grev. Newport and Seaconnet; Mass. Rev. J. L. Russel!

Delesseria sinuosa, Lamour. Mass. G. B. Emerson; Plymouth, Mass. Rev. J. L. Russel; abundant near "the Stairs" at Newport.

Delesseria Leprieurii, Montaigne. Shores of Hudson River at West Point, below low water mark. Specimens of this beautiful plant were sent by me to Montaigne, who pronounced them identical with the plant described by him from the coast of Cayenne.* It is *very abundant* at West Point; but I could only find a single specimen of it on the shores of the Hudson at Hoboken, N. J., near the ocean.

Delesseria americana, Ag. "Ad litus Americæ Septentrionalis." Ag. Syst. Alg., p. 248. I have not seen any figure or authentic specimen of Agardhs plant; but I suspect it to be the same as a fine species with fronds twelve to eighteen inches long, which grows abundantly near Providence, R. I., in Narragansett Bay. I also found a fragment of the same at Hoboken, N. J.

Rhodomenia cristata, Grev. Mass. G. B. Emerson.

---

* See Ann. Sci. Nat., 2d Series. Bot. tom. xiii, p. 196, pl. 5.

Rhodomenia palmata, Grev. "*Dulse.*" Mass. Rev. J. L. Russell! Common on shores of Rhode Island and Connecticut.

Plocamium coccineum, Lyngb. Mass. Rev. J. L. Russell!

Laurencia dasyphylla? Lamour. A species of Laurencia occurs abundantly at Newport and at Seaconnet, which appears closely allied to L. dasyphylla, and is perhaps only a variety of that species.

Chylocladia parvula, Hook. Common on shores of Rhode Island, from Providence to Newport and Seaconnet. Harvey remarks that he has seen specimens from North America, agreeing in every particular with British ones.

Gigartina purpurascens, Lamour. Stonington, Conn., Narragansett Pier, Newport, and Seaconnet.

Chondrus crispus, Lyngb. This plant, which is the Carrigeen or Irish moss of the shops, is abundant everywhere on the coasts of New England. At Newport, it is generally known by the name of "Curl" or "Currel."

Chondrus membranifolius, Grev. Newport and Narragansett Pier; Mass. Rev. J. L. Russell!

Sphærococcus multipartitus, Ag. δ *angustissimus*. New York. Ag. Syst. Alg. p. 216. Shores of Staten Island. Dr. Torrey!

Sphærococcus Torreyi, Ag. New York Ag. Syst. Alg. p. 218.

Ptilota plumosa, Ag. Mass. G. B. Emerson and Rev. J. L. Russell! Seaconnet, R. I. Particularly abundant and fine near "the Stairs," at Newport.

Polysiphonia subtilissima, Montaigne. Hudson River, below low water mark, at West Point, sixty miles from the ocean. Specimens of this have been sent to Montaigne, and he pronounces them identical with those he has described from Cayenne. It is remarkable that it is accompanied, both at West Point and Cayenne, by the *Delesseria Leprieurii*, Mont.*

Polysiphonia violacea, Grev. Narragansett Bay, R. I., Staten Island, N. Y. Common.

Polysiphonia fastigiata, Grev. Common on Fuci, at Newport and Seaconnet; Plymouth, Mass. Rev. J. L. Russell!

Polysiphonia stricta β. *atropurpurea*, Ag. New York. Ag. Syst. Alg. p. 150.

Polysiphonia nigrescens, Grev. Newport.

Polysiphonia Brodæii, Grev. Plymouth, Mass. Rev. J. L. Russell! Newport, R. I.

Besides the above, I have two or three species of Polysiphonia from Rhode Island, which I have not yet satisfactorily determined.

Dasya pedicellata, Ag. "Ad Noveboracum." Ag. Syst. Alg. p. 211. Very beautiful specimens occur in abundance near Providence, R. I., also at Newport, R. I. I have seen a fragment of

* See Am. Sci. Nat., 2d series, Bot. tom. 13, p. 196, pl. 5.

the same from New Haven, Conn., collected by Professor C. U. Shephard.

Ceramium rubrum, Ag. Only *too* common, every where on our coasts.

Ceramium diaphanum, Ag. Nearly as common as the preceding.

Griffithsia —— ? An undetermined species occurs at Providence and Newport.

Callithamnion Turneri, Ag. Parasitic on Cladostephus, &c., at Newport.

Callithamnion Rothii, Lyngb. On rocks under the Fuci, at Newport.

Callithamnion —— ? A delicately branched species, which I have been unable to determine, occurs plentifully near the Tockwotton House, at Providence, R. I.

Trentepohlia pulchella, Ag. Cascade at West Point; parasitic on *Lemania fluviatilis.*

Series III. CHLOROSPERMEÆ.

Lemania fluviatilis, Ag. Cascade at West Point; Mountain Run, Culpepper Co., Va.; and Falls in the Rappahannock River, above Fredericksbnrg, Va.

Lemania tortulosa, Ag. Foot of Crow's Nest, West Point; Mass. Rev. J. L. Russell.

Thorea viridis, Bory. N. America. Ag. Syst. Alg. p. 56. Agardh suspects it to be an Oscillatoria adhering to some aquatic plant.

Batrachospermum moniliforme, Ag. Salem, N. Ca, Schweinitz. Abundant just below the dam of Reservoir Pond, near West Point.

Batrachospermum Americanum, Schweinitz. Salem, N. Ca. Schweinitz! Common in small streams near West Point; Hingham, Mass. Rev. J. L. Russell.

Bulbochæte setigera, Ag. Common in ponds near West Point, Spectacle Pond, near Providence, R. I., Worden's Pond, R. I.

Draparnaldia plumosa, Ag.
Draparnaldia glomerata, Ag.
Draparnaldia tenuis, Ag.
} These species are all common at West Point, and I have specimens of them also from Massachusetts, sent by Rev. J. L. Russell, and from Chautauque Co., N. Y., sent by M. S. Petit, Esq.

Chætophora endiviæfolia, Ag. Mass. Rev. J. L. Russell! Ponds in New York and Rhode Island.

Coleochæte scutata, Breb. This most beautiful plant occurs abundantly in Round Pond, near West Point, where I found it in fruit in September. Both varieties, α and β, of Brebisson, (with every intermediate state,) occur, and *both with fruit.* The fruit of variety β is in the form of capsules on the ultimate ramuli, which do not appear to have been noticed by any previous writer.

(To be continued.)

ART. XI.—*On the Fossil Vegetation of America*; by J. E. TESCHEMACHER.

ON the 17th June, 1846, I read a paper before the Boston Natural History Society, on the fossil vegetation of America, which will probably be published in the forthcoming number of their Journal, with plates.

I propose the present communication as a continuation of that paper.*

Having recently received, by the liberality of Dr. L. Feuchtwanger, a number of specimens from the coal mines of Carbondale, Pa., I will proceed to describe a portion of them, after offering a few general observations.

The well understood and authenticated alternation of growth in the American forests, of resinous and hard wood trees,† must create surmises as to the probability of the existence of the same law during the growth of the successive forests which formed the successive layers of coal, a large portion of which were certainly of resinous woods. But we find no evidence or appearance of the same alternation taking place with the undergrowths of recent forests, particularly with the Fern and Equisetum tribes. The constituents of the Equisetaceæ are better known than those of the Filices; and silica, the chief inorganic ingredient of the former is usually in such quantity in most soils, particularly in those from the recent disintegration of early crystalline rocks, that it would not be easily exhausted so as to render this alternation of growth necessary.

Sigillariæ, (which I consider as the stems of Filices,) with leaves of Filices, and Calamites, (probably Equisetaceous plants,) are found in all coal deposits hitherto examined; whether the highly resinous tribe exists in all, is yet to be ascertained.

An important source of information is presented by the vegetable remains existing in the coal itself, leaving out of consideration those in the shaly roofs, and clayey floors of the mines. The Pennsylvania anthracites offer many specimens of these; what is termed charcoal is commonly found in seams and crevices in the coal, and in most of this, the vegetable tissues, although carbonized, are in perfect preservation. I have selected some specimens in which the indication of different kinds of wood is very clear;

---

* Fig. *a*, pl. 4, contained in that communication, is probably a *Brachyphyllum*, (Brongn.) although differing essentially in foliage from any yet figured.

† Alden Bradford, in a paper dated 1793, printed in the Massachusetts Historical Collections, vol. 2, on the topography of Duxbury, Mass., states the timber growing there to be white and pitch pine, maple, ash, beech, oak, walnut, &c., and says that Capt. Samuel Alden, who died there in 1780, aged 93, remembered the first white pine tree that appeared in the town, one eighth of which, in 1793, was covered with them.

amongst them is one Sigillaria of an undescribed species, a few impressions of leaves with forked veins, like *Sphenophyllum*, and several branches and stems unlike any I have seen figured, also groups of vegetable tissue resembling nothing in the present vegetable existences. But I have not had time to bestow on these the study they appear to merit, and merely mention them now to draw towards them the attention of others.

The analyses of these so-called charcoals of various forms, compared with analyses of charcoal artificially prepared from recent resinous and non-resinous woods, and particularly from arborescent ferns, might prove very interesting; indeed, we appear to be only just entering the threshold of the science of fossil vegetation.

From what I have hitherto observed, it seems altogether probable that intense and long continued pressure beneath water, has transformed the ancient forests into coal.

Coal Plants from Carbondale, Pa.

Calamarieæ.

Calamites Suckowii, Brongn. The longest diameter of this specimen is 3½ inches; it has been squeezed into a wedge-like form, and striæ caused by the pressure are quite distinct on the thin edge of the wedge on the carbonized surface, indicating the pressure to have taken place subsequent to carbonization. There has also been perpendicular pressure, as the vegetable is bent over at right angles to the upright stem.

C. ramosus, Artis and Brongn. A very beautiful and distinct specimen. The nearly circular scar at the articulation of the branches is not so tumid as in the figure given by Brongniart, but the striæ and their terminations are in exact accordance with it.

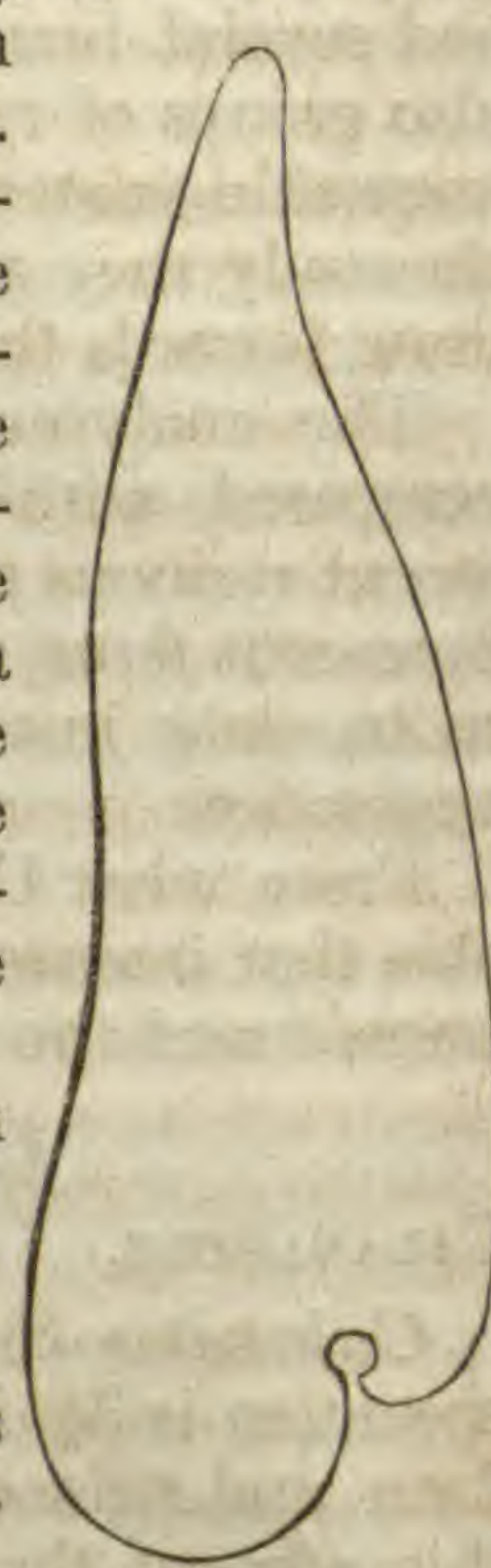
Calamiteæ? gen. and spec.? (fig. 1.) It is doubtful whether this belongs to this division, as in my specimen, which is 6½ inches long and more than 1 inch wide, there is no articulation. The texture appears to have been very thin and delicate, the striæ and the scar of the branch are beautifully distinct, and the opening of the striæ above the scar, and their rejunction below, have not at all the appearance of Calamites.

Fig. 1. (Nat. size.)

Sphenophyllum Schlotheimii, Brongn. Enveloped in and surrounded by leaves of this fossil, are very fine and clear impressions of jointed stems, with attached side branches, exactly resembling the figure in Lind. and Hutt., vol. 1, tab. 19, fig. 1, of *Bechera grandis;* it is not possible to doubt that the leaves belonged to these stems and branches.

Filices.

Fig. 2. (Nat. size.)



Neuropteris? spec. (fig. 2.) A large species; leaves cordate, with an extraordinary difference in the size of the lobes, the lowest being the largest. My specimen of a frond has 14 leaves, the terminating one acute and one lobed. Many of the leaves resemble those of the recent *Isoloma lanuginosa*, J. Smith, (Lindsea auctor.,) nor does the midrib in some of the leaves of Neuropteris, become indistinct sooner than that in this fern. The club-shaped termination of the veins of Isoloma does not exist in Neuropteris, although I have thought that I could observe a curving of the margin, with a slight appendage, as if it were possible that there might be a resemblance to the marginal fructification of Isoloma.

Neuropteris rotundifolia, Brongn. Specimen clear and distinct.

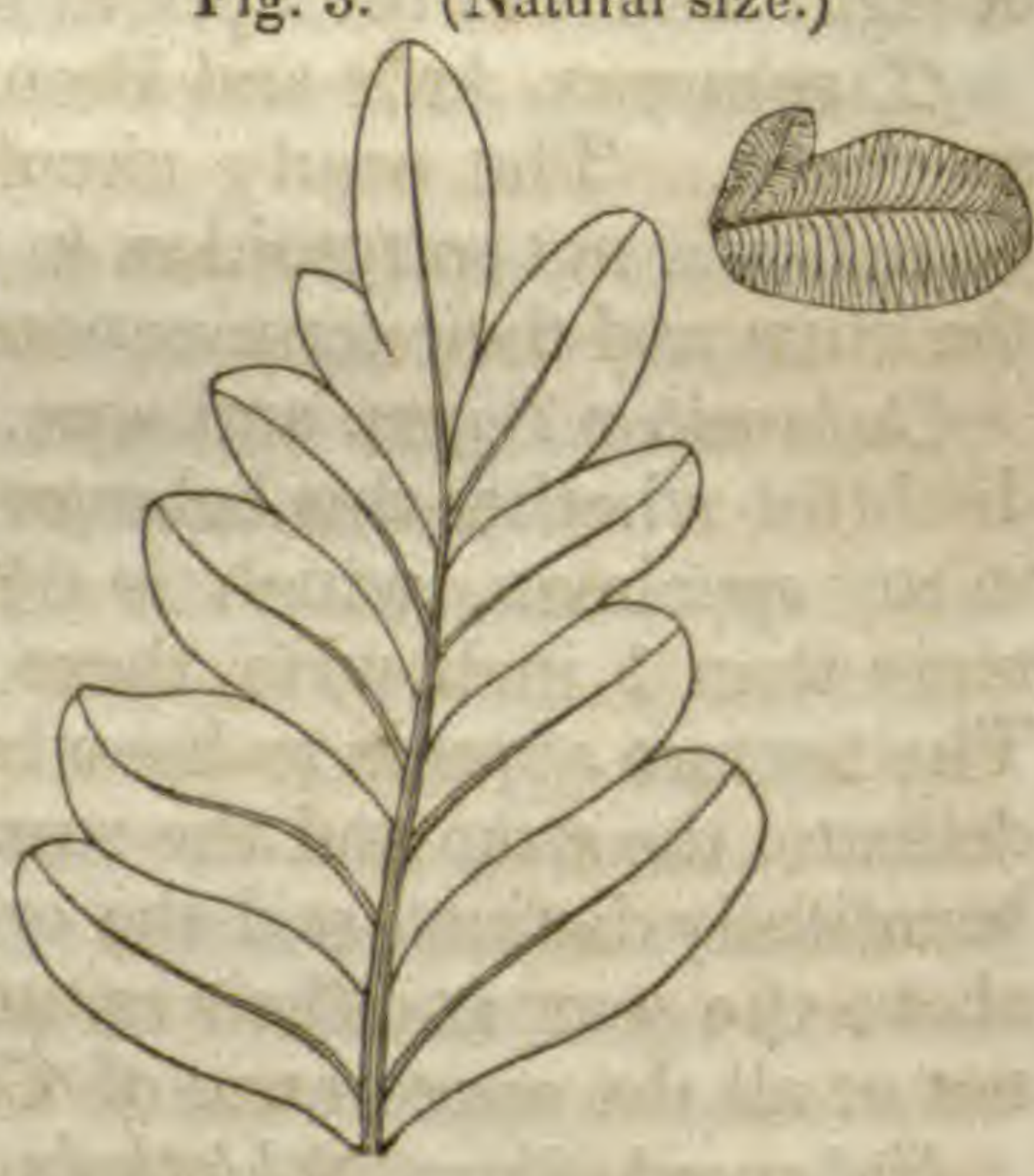
Cyclopteris orbicularis, Brongn. } Specimen
Adiantites cyclopteris, Göpp. } fine.

Sphenopteris latifolia, Brongn. } My specimens
Aspidites latifolius, Göpp. } agree in character and appearance with Brongniart's figures, but not at all with the figures of Lind. and Hutt., of this fossil.

Pecopteris unita, Brongn.

Alethopteris, Göpp. } ? spec.
Pecopteris, Brongn. } Fig. 3.

Fig. 3. (Natural size.)



This specimen bears a greater resemblance to *P. Serlii*, Brongn., than to any other fossil, but the leaves are quite obtuse, or may even be called round. The terminating leaf, as well as some of the others, are lobed, and the veins are quite as perpendicular to the midrib as in *Tæniopteris Betrandi*, Brongn. Hist. Veg. Fos., tab. 82, fig. 5.

Sigillarieæ.

Sigillaria Serlii, Brongn.
Saullii, do.
Schlotheimii, do.
oculata, do.
Syringodendron, Sternb.
Rhytidolepis, Cotta.

It seems to me almost impossible not to be convinced, by the arguments of Brongniart, that these are the stems of the aborescent ferns, whose leaves are scattered in such profusion around them, although I am aware that both Göppert and Lindley have withheld their full assent to this opinion.

The specimen of *S. oculata* is surrounded by leaves calculated to remove a portion of the doubt on this subject. Fig. 4 is a representation of what I consider the upper and under side of the leaf. On the upper side, *a* and *b*, there is the impression of a fine channel along the midrib, caused by the protuberance of what may be termed the receptacles of the fructification on each side of the midrib on the under side; the depression in the slate, letter *b*, caused by these protuberances, is very clear in the specimen. Fig. *c* represents the under part of the leaf; here the spaces corresponding to these protuberances are pitted, as represented by the dotted part. The space between these dots and the margin of the leaf, is *perfectly smooth and even*, and the separation between them well defined. I consider this pitted part to be the impression of the fructification of a species of Blechnum.

Fig. 4.

In order to make this clear, fig. 5 represents impressions in fine plaster of Paris, of leaves of the recent aborescent fern, *Blechnum braziliense*—*a* the under side, *b* the upper side. It is difficult in figures to give every character of the resemblance, but I am sure it is too perfect to be mistaken.

Fig. 5.

The veins in this species of recent Blechnum are internal and not very prominent, and the texture of the leaf is hard and coriaceous; in my first impressions in plaster, the veins were slightly exhibited, and there is no trace of them in the fossil; but on the application of slight pressure to the recent leaves prior to taking off the impressions, it became as smooth as the fossil. It is true that in *B. braziliense*, the sori, though contiguous and confluent, are not single and continuous along each midrib as they appear in the fossil, but in *Salpichlæna volubilis*, (J. Smith,) the *Blechnum volubile* of Kaulfuss, and in others, this continuous linear character exists.

I believe this to be the first fructification of a fossil fern resembling Blechnum that has been observed; I would, therefore, name this Blechnites oculata, but I am in hopes that careful observations of the coal deposits will ere long enable us to assign the foliage belonging to most of the stems, and then a revision of the nomenclature will become necessary.

I regret that in my specimen neither end of a leaf is present; but from the width, both of the leaf and the fructification, it is probable that it was a larger fern than *B. braziliense*.

If the specimen of *Sigillaria lepidodendrifolia* figured by Brongniart, Hist. Veg. Fos., tab. 161, were carefully examined, leaves like the above described would probably be found.

Among these specimens from Carbondale, are impressions of stems without any other marks than striæ of different sizes, and others marked in various ways, with irregular protuberances and indentations. Several of these exactly resemble a stem figured by Göppert, (Syst. Fil. Fos., tab. 39, fig. 1, without remarks,) and the outside bark of one of these being partially removed, exhibits the impression of a beautiful Sigillaria, somewhat like *S. macrodiscus*, Brongn., on a very small and delicate scale.

Of these stems, and many other appearances from the fossil vegetation from this locality, it is quite impossible to give descriptions that would be at all intelligible without very well drawn figures. There are also several probably undescribed Lepidodendra and Sigillariæ.

Art. XII.—*On the existence of certain Lacustrine Deposits, in the vicinity of the Great Lakes, usually confounded with the "Drift;"* by I. A. Lapham.

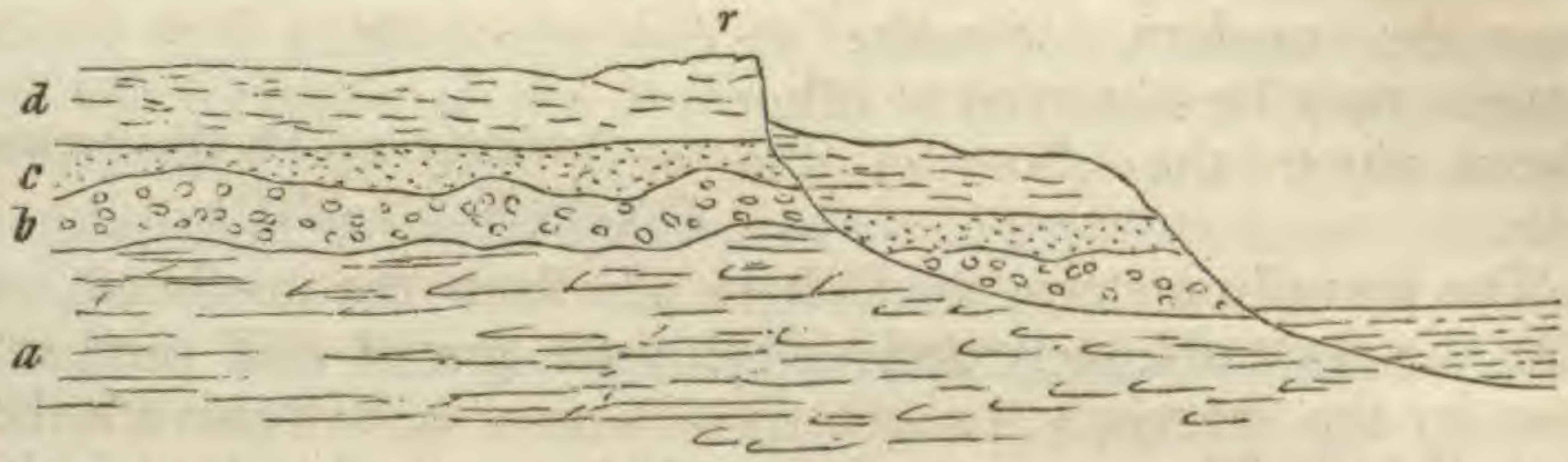
Of all the subjects investigated by the geologist, none are more interesting or have attracted more attention within the last few years, than those relating to the diluvial, or drift and boulder formation; and although much has been done to elucidate this obscure point in the history of the earth, and a vast amount of facts and observations has been collected and recorded, we are still without a satisfactory theory that will explain all the facts. One reason of this may be that no one theory *can* be found sufficient; the subject must be divided, and each portion may admit of a different explanation.

There is no doubt that much of what usually passes for drift in the region of the great lakes, must be attributed to a lacustrine origin of more recent date. These deposits consist of nearly uniform layers of fine clay resting upon irregular beds of sand, gravel, boulders and hard-pan, constituting the true drift. The layers are from a quarter of an inch to three or four inches in thickness, and lie nearly horizontal—not conforming with the irregular layers of drift. The beds sometimes attain a thickness of fifteen or twenty feet. It is evident that these layers were deposited when the water was calm, and not subject to those violent agitations that existed during the deposition of the drift.

An attentive examination of facts connected with the action of the waters of the present lakes, may throw some light upon this interesting subject.

The shore of Lake Michigan near this place, (Milwaukee, Wisconsin,) consists of clay, sand, gravel and boulders, rising almost perpendicularly from fifty to one hundred feet. The several layers are usually arranged as follows:

Fig. 1.



a. Hard-pan, or very tough blue clay with imbedded pebbles.

b. Irregular beds of gravel, at some places fine, at others coarse, approaching boulders.

c. Very fine sand, free from pebbles or clay.

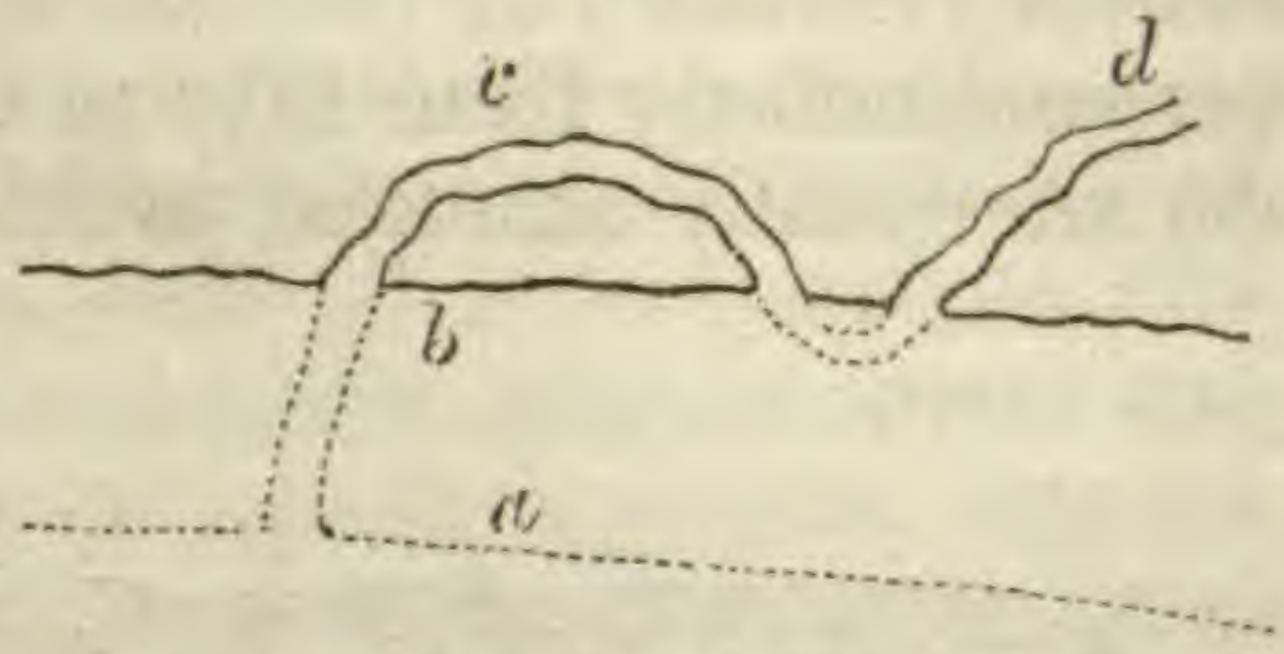
d. Fine reddish clay free from sand, pebbles, or boulders, having its base line nearly level.

Along the line between *a* and *b*, are numerous springs, usually of pure cold water, but occasionally impregnated with mineral substances. Some hold lime in solution in such quantities, as to cement the beds of gravel into a kind of *pudding-stone*, and incrust the moss, leaves, &c. over which they pass, affording many fine and beautiful specimens. On the canal, half a mile above the city, is a chalybeate spring issuing from a bed of gravel colored with the iron deposited by the water.

Every storm-wind dashes the waves against the base of this steep bank, carrying away the light materials of which it is composed, and causing the higher portions to slide down as represented in figure 1; an operation which is materially assisted by the springs above alluded to. This process is in some places quite rapid, and has been in operation for a great length of time. Many very interesting facts might be mentioned to illustrate this, and a few years of direct observation are sufficient to convince the most skeptical.

A road laid out nine years ago on the bank of the lake, is now so near the margin that it would be impossible for a wagon to pass along it in the tracks then made, without falling down the slope. (See fig. 1, *r*.) Walking along the sandy beach of the lake, we often find the clay has slid down upon it, so that it is necessary to clamber over the avalanche or wade around it in the waters of the lake. These slides, under favorable circumstances, are very extensive, carrying down with them the forest trees without disturbing their erect position. At other times, trees are thrown down towards the bank, presenting their roots to the water. At Southport, thirty-five miles south from Milwaukee, the bend of a stream has been carried away, so that its valley presents three openings to the lake, as represented in figure 2, where the dotted lines represent the ancient state of things and the black lines the modern. Similar instances may be observed at other places along the shore of the lake.

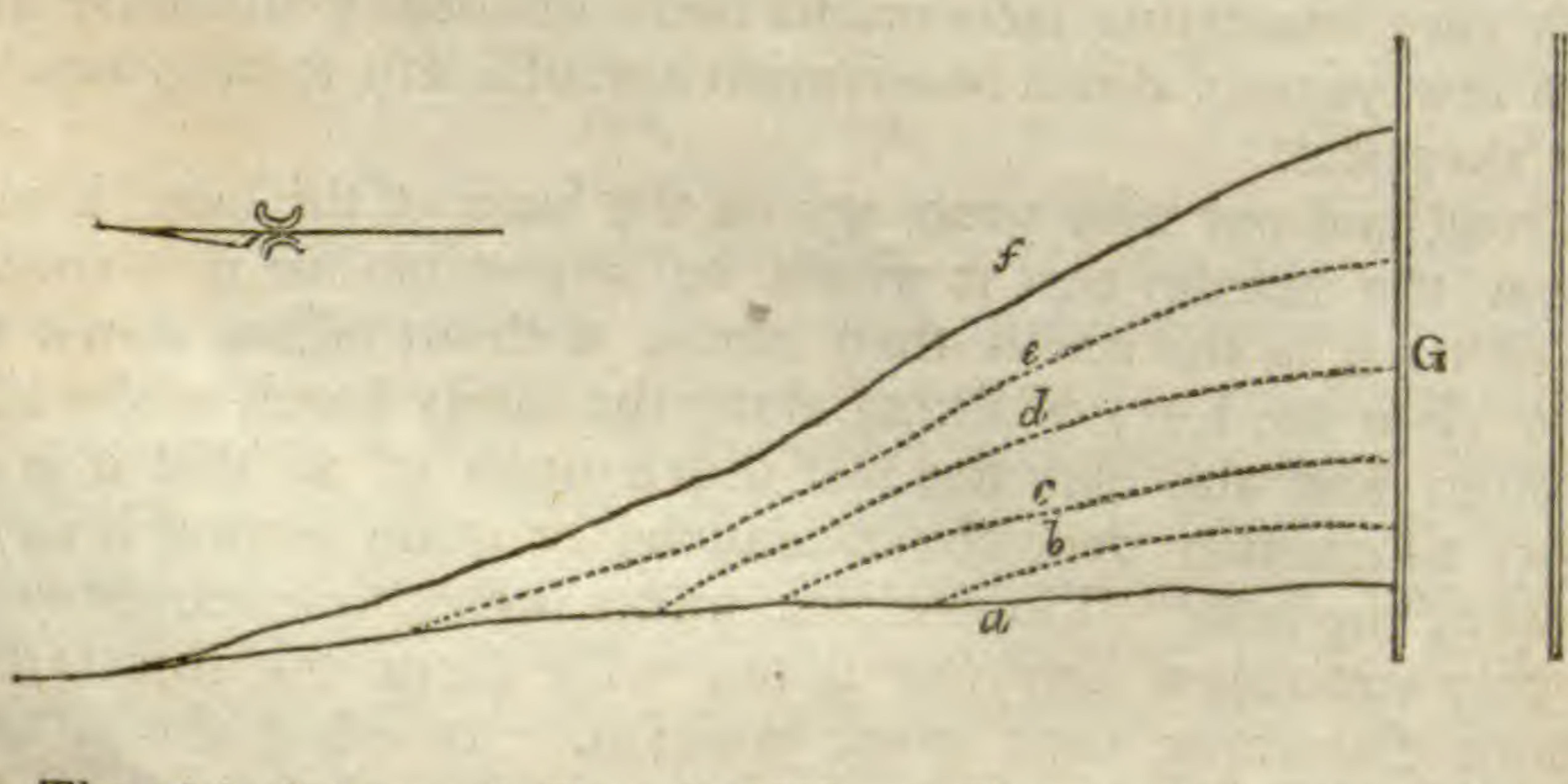
Fig. 2.



a. Ancient coast.—*b.* Present coast. —*c.* Bayou.—*d.* River.

The prevailing storm-winds here are from the northeast, striking the coast obliquely and carrying the gravel and sand acted upon by the waves in a southerly direction, or towards the head of the lake. The progress of the pebbles along the shore is slow, each storm carrying them but a small distance; yet the constant action of the waves through a long period of time, has been sufficient to accumulate vast fields of sand around the southern extremity of the lake. When a solid pier is built into the lake, this motion of the sand and pebbles causes a rapid accumulation on the north side of it. At Chicago, during five years, the accumulation of sand extended no less than seven hundred and twenty feet along the pier. As soon as the sand reaches the end of the pier, a bar is formed across the mouth of the harbor, rendering another "appropriation" necessary to extend the pier further into the lake. How far it will be necessary to extend the pier before the difficulty will cease, is not easily determined. It will be when the direction of the shore north of the pier is at right angles with the direction of the prevailing storms. Figure 3 represents the shore at this place in the different years from 1834 to 1839, and is copied from an official report of the Topographical Bureau at Washington. Since 1839, no reports have been made.

Fig. 3.



a. The original shore.—*b.* Shore in 1835.—*c.* Shore in 1836.—*d.* Shore in 1837. —*e.* Shore in 1838.—*f.* Shore in 1839.—G. North pier.

The immediate effect of these storms, as above stated, is to carry away the base of the steep bank along the shore, moving the sand and pebbles by successive steps towards the south. But the finer materials—the soft clays—are suspended in the water of the lake, causing it to be muddy for a great distance from the land. The quantity of matter suspended in the water, and the distance it is carried out, will of course vary according to the force and direction of the storm, the configuration of the coast, the material of the bank acted upon, &c. When the storm abates, the agitation of the water ceases, and the suspended matter is thrown down in the form of a thin deposit of mud, on the bottom of the lake. If it falls in water so deep as to be beyond the influence of the surface waves, it must remain as a permanent deposit. Another storm produces another layer, and should it come from a different direction, there may be a slight difference in the nature of the material deposited. By this process, continued through a succession of years, a large amount of fine sediment will be accumulated in the bottom of the lake. The analogy between deposits thus formed and those before mentioned, as found overlying the drift, in many places, cannot be doubted; thus affording one more instance where causes now in operation are found adequate to produce geological phenomena heretofore supposed to originate in convulsions of nature.

It has been shown, by various facts, that these lakes have at former periods occupied much higher levels than at present.—The existence of ancient lake beaches, at various elevations, (sometimes exceeding a hundred feet,) above the present surface, is sufficient proof of this. We may, therefore, expect to find these deposits of fine sedimentary matter at places much above the waters of the lakes, precisely as we now actually find them.

The lake deposits may be distinguished from the true drift by the greater uniformity and regularity of the layers, and the finer and more uniform texture of the material of which they are composed, and the absence of boulders and irregular beds of gravel and sand. They have been observed in places remote from the present lakes, showing that the waters were once even more extensively spread over the country than at present. They exist in greatest force, so far as is known to the writer, around the western extremity of Lake Erie. In passing over the railroad westward from Detroit, no boulders, or other indications of drift, are found on the surface until we pass the ancient lake beach at Ypsilanti, beyond which they begin to appear in great numbers. East of that beach was evidently once the bottom of a lake.

Some of the most interesting deposits of this kind are found within the limits of the city of Milwaukee; and it is from them that the material is taken for the manufacture of the much celebrated cream-colored brick, of this city. Such is the richness and beauty of these brick, that they are becoming an article of export. Strangers, upon landing here, are surprised that all the brick houses are *painted* of the same color; and their surprise is not abated when informed that they are not painted at all—the color being that of the bricks themselves.*

No fossils of any kind have yet been discovered in these lake deposits. Cylindrical concretions, of an interesting kind, are often found investing the fibres of roots that have penetrated the layers; more commonly the root has decayed, leaving only a small opening through the centre. On breaking across one of these concretions, it is seen to have a concentric structure, as if made of concentric cylinders. Their form is usually cylindrical, tapering at each end. They are much harder than the surrounding mass of clay.

ART. XIII.—*On the Origin of Continents*; by JAMES D. DANA.

IN a paper on the Volcanoes of the Moon, read before the Association of Geologists and Naturalists, in September last,† some suggestions were thrown out with regard to the Origin of Continents, drawn from the condition of a cooling globe. It was observed that the portions of the earth now constituting the great areas of land, were free, or nearly so, from volcanic action, even in the Silurian period: while the oceans appear to have been regions of eruption. Hence it was inferred that contraction must have taken place to the greatest extent over the parts now oceanic, just as any cooling sphere becomes depressed on the side which cools last. This was shown to correspond with the actual history of our globe, inasmuch as an increasing depth in the ocean cavity would necessarily leave more and more land above water in successive epochs, as accords with observations. It was observed that the hypothesis was *farther* borne out by facts: for while it appears that the land has, on the whole, been increasing in extent, even through the tertiary era and subsequent to it, the ocean's bottom has actually subsided several thousand feet within a late period, as shown by the coral islands scattered over the wide Pacific.‡

---

* This color is owing to the almost total absence of iron from the clay, and the very small quantity discovered by the usual tests, is sufficient to impart a very delicate cream tint to the bricks.—EDS.

† See this Journal, ii, ii ser., 352.

‡ If we consider that *two hundred islands* have subsided in the Pacific, which, had there been no corals, would have disappeared without a record, we perceive that the comparative absence of islands from the Atlantic, whose waters are, to a large extent, too cold for corals, proves nothing against the hypothesis. On the contrary, so large a bare surface of waters is probable evidence of the disappearance of some points of land by submergence. All existing Atlantic islands are of igneous origin except the Falklands, to the east of Tierra del Fuego.

By reference, therefore, to the principle of unequal contraction, and to those *subordinate* causes of change of level usually appealed to by Geologists, (though treated of commonly as primary in importance,) we may obtain a general view of the origin of the earth's features. I propose at this time to offer a few remarks in illustration of this subject, derived from the features of our own continent, reserving a fuller discussion for another occasion.*

The effects of contraction as a geological cause, though long admitted, have been first brought out in their various bearings by M. Constant Prévost, before the Geological Society of France.† The facts adduced substantiate his views, though, as we believe, with some limitations. They lead us farther to connect the various phenomena, and tell why the ocean and land have their present bounds.

In order to understand the bearing of the facts, we should bring to mind the effects of contraction. The more prominent are as follows:—

1. Depressions, provided the contraction be unequal in different parts.

2. Apparent elevations, as a consequence of the depressions; that is, elevations as compared with the lowest level, or with a body of water occupying the depressions.

---

* We may here mention one or two facts in corroboration of the general theory, that the more igneous portions of the globe have contracted most and thereby became submerged. For example, we find the continent of America reduced to a narrow strip of land, just where the great American tract is crossed from east to west by a region of igneous action, not yet entirely extinct; that is, about the West Indies and the adjoining isthmus. This region became thus depressed and submerged, in consequence of greater contraction below; and hence North and South America are nearly disjoined by a broad arm of the ocean. This single instance is the only one, through the continent of America, of volcanic eruptions east of the great western chain of mountains.

Again, the East Indies, another region of perpetual fires, in the earth's history, constitute a cluster of islands separating from Asia the large non-volcanic New Holland, properly a part of a southeastern extension of the continent. Moreover, we may account for the fact that this Archipelago has not farther subsided, so as to become a deep ocean with few islands, on the ground that extensive areas of land, without fires, exist in the midst of the group, Borneo being one example, equalling in extent half the United States, east of the Mississippi. The Indian Ocean, at the same time, bears evidence in its coral islands of a much more extensive subsidence.

† See this Journal, ii, ii ser., 355. While thus mentioning the name of M. C. Prévost, we should remember that the theory of contraction, as a cause of the earth's features, dates as far back as Leibnitz, many of whose speculations in science are proving to be as well founded as the rigid results of his mathematics. And among the geologists of the present day, De la Beche especially has insisted upon this agency as the general cause of the unevenness of the earth's surface, though he stops by stating some of the grand results, without allowing them their full influence as laid down by Prévost. Mr. Lyell, in his *Travels in North America*, has made a partial application of the principle to the Appalachians.

The writer does not claim to have presented any new principle, except it may be the special cause assigned for the oceanic depressions; and whether this holds true, remains for the future to determine.

3. Fissures.

4. Ejection of igneous matter, at times, through fissures.*

5. Upheaval along a line of fissure, the surface adjoining being more or less raised.

6. Upliftings and foldings from lateral pressure.—An arc of the exterior surface being greater than any corresponding arc below the surface, a depression of the hardened exterior, produced by the cooling beneath, would in some instances cause lateral displacements.

7. An *unequal rate* of subsidence over given areas in different periods.—Contraction tends to occasion a strain upon the cooled and unyielding exterior, accompanied generally by a consequent diminished rate of subsidence, or a cessation of it. This strain increases till it results in fractures; and following this crisis, subsidence would for a while be more rapid in rate. The strain, or state of tension, might also occasion elevations in some places, within or without the area; and at the time of fissuring, there might be other upheavals. It follows, hence, that—

a. There would be prolonged intermissions in the subsidence of given areas; and this must have been the fact throughout the history of the globe.

b. There must have been oscillations in the land as compared with a water level, the water at times rising gradually over land that, during a previous period, had emerged; and the reverse.

c. There might be in the same epoch, under such circumstances, an unequal retreat of the ocean from the coasts of different continents, or a rise in one place and a retreat in others: for the changes by contraction are supposed to have been every where in progress at the same time, and throughout different in character and extent.

d. Changes of level may in some cases have been *gradual*, and in other cases *paroxysmal;* for the opening of large fissures would often be of the latter character.

8. In an elliptical area of contraction, there will be two systems of fissures at right angles with one another, as follows from the calculations of Wm. Hopkins, Esq.† But if the area is bounded on one side by a region participating but little in the contraction, the effects would be most decided on the borders of such a region; and they would consist in extensive fissures ranging along

* Prévost argues that all eruptions of igneous matter have arisen from the collapsing of the surface upon the fluid of the interior, which is thereby pressed out. This is a probable effect of the contraction going on, though it seems to be extended too far to include with it all the eruptions of volcanoes.

† Trans. Camb. Phil. Soc., vii, 22.

the area, and an attending swelling of the surface, or else a rising of the strata into folds by lateral pressure.*

The effects of lateral pressure might in many parts be local or of very limited extent. A contracting area might be made up of several separate areas of contraction not acting together upon any particular line. Even supposing a whole quarter of our globe to exert laterally all the force possible, by a uniform contraction continued till the surface was depressed eight miles in depth, the whole effect would be equivalent to a lateral dislocation of only twelve miles. And in this calculation, we make no allowance for upliftings over the contracting area, which would diminish the action; nor for a diminution of breadth in the surface of the area, which diminution must be going on if the surface is losing heat. In the remarks which follow relating to this point, America, therefore, is not instanced as an example of what *must every where* have happened, but of what *has here* happened.

The foregoing are the obvious effects of contraction. A *Prince Rupert's drop* (a drop of unannealed glass) may be referred to for farther illustration. The exterior, owing to its cooling first, is under strong tension, and each particle (or section) in the surface, presses laterally upon its neighbor like a stone of an arch upon the one adjoining; and hence the effect of a simple scratch in causing it to break to pieces, explosively. The earth, had it cooled uniformly over the whole exterior, (and were it made of a uniform homogeneous material,) would have been in the same circumstances, the whole crust being under immense tension, yet every where balanced, and therefore not apparent; but cooling unequally, the same actual amount of force has been exerted, yet at different periods, producing, in different parts and in different periods, fractures, depressions and upliftings.

We comprehend the effects described more clearly if we remember, as we ought, the common statement, that the highest

---

* With regard to the *folding* of strata by lateral pressure, the theory was first presented by Sir James Hall, (Trans. Roy. Soc. Edinb., vii, 85,) and the injection of granite, coupled with the elevation of the land, was suggested by him as a probable source of the pressure in the instances he mentions. Scrope, reasoning on this subject, says, in his work on volcanoes, published in 1825, "There is reason to conclude that in most instances, the raised strata, particularly those which were only partially indurated, have been contorted and bent into repeated foldings, so as to give the appearance of frequent alternations of different series of strata to what is in reality but the replication of the same original series."—p. 201. De la Beche applies the theory to the structure of the Alps, (Geol. Researches, 129,) the possibility of which application was suggested by Sir James Hall.

Authors have generally followed Sir James Hall in considering that besides the lateral pressure, pressure *from above* is essential to this result. But since the soft strata are *inelastic*, and moreover, in themselves *are of vast weight*, we may conclude that there is sufficient vertical pressure independent of any foreign source. A small hand model appears to be as suggestive of error in this case, as a child's model of a bridge to the inexperienced bridge builder.

mountains of the earth are about equal in comparative altitude to the thickness of the cracked varnish on a twelve inch globe.

We remark, again, that we exclude none of those causes of elevation usually recognized, which facts show to have been in operation, though allowing them only a subordinate place.

From these explanations, we proceed to the application of them. If the reader will place before him a good map of North America, he will perceive at once the effects which have been alluded to exhibited on a grand scale, on both sides of the continent. On the *Atlantic* side, the Appalachians, from Maine to Georgia, consist of rock strata, which have been variously folded up into ridges, as has been made out with great beauty and fullness by Professors W. B. and H. D. Rogers.* These folds are in several series, but are nearly uniform or parallel in position. As should be expected from the nature of the cause, the plications are more frequent and abrupt on the side of the chain nearest the ocean, and gradually die out westward just beyond the limits of the Appalachians. As another result of proximity to the contracting area, the rocks on the eastern side have been most altered by fire. To so great a degree has the heat operated, (which escaped by the opened cavities and fissures, and was distributed laterally by the aid of the contained and incumbent waters,) that it is difficult in New England to distinguish the true igneous rocks from those that are metamorphic.

On the *Pacific* side of the continent, we observe the Rocky Mountain range rising with a gentle swell from the coast. From the mouth of the Kansas to the top, and on the opposite or western side, the average slope is hardly twelve feet to the mile.† The summit is about eight thousand feet high. But there are ridges which add five or six thousand feet to the chain: these form a crest to parts of the range, but are not properly the range itself, though often so recognized. The Rocky Mountains appear, then, to be another effect of contraction, viz. a gradual swelling of the surface, accompanied by fissures and dislocations over its area. These dislocations are very marked in the sandstone, just east of the summit. Thus each great oceanic depression, the Atlantic and Pacific, has its border range of heights thrown up by the very contraction which occasioned the depression; and between lies a vast plain, scarcely affected at all by these changes, the great central area of the continent. This view is farther sus-

* Trans. of the Assoc. of Amer. Geol. and Nat., 1840, 1842, p. 474, and this Journal, xliii, 177; xliv, 359.

† See the section of the region between the mouth of the Kansas and Fort Vancouver, by Captain Fremont, in the Report of his Exploring Expedition to the Rocky Mountains in 1842, and to Oregon and North California in 1843, 1844. Printed by order of the Senate of the United States, Washington, 1845.

tained by finding that the effects of fire are most apparent on the ocean side of the mountains, precisely as about the Appalachians, yet to a more remarkable extent.* Indeed, there are no remains of volcanoes, or their ejections, to the east of the summit; while to the west, the country of Oregon is in many parts buried beneath basaltic or other volcanic rocks, and several existing volcanic cones have been described. Still farther, we observe a second, a third, and even a fourth parallel range of heights from the summit of the mountains to the coast; and the third (the Cascade range) rivals the Rocky Mountains in the height of some of its snowy peaks. Vast fissures were opened to the fires below, as these ranges indicate, and some of the vents have not yet ceased action.† Here, then, are the natural effects of proximity to a region of contraction—the Pacific—in which the remains of igneous action every where abound.

It has been well established that the Appalachian folds or plications were made since the coal period, for the coal beds are enclosed in the folds;‡ and the rising of the Rocky chain was also subsequent to that era. The effect of contraction in producing these elevations, was therefore comparatively little felt in the very earliest ages, when the surface of the depressed (or igneous) portion was itself somewhat yielding, but subsequently, when it had become stiffened to a considerable depth by cooling. There appears hence to be a perfect harmony between the results and the causes adduced.

If these conclusions are correct, we must give up the popular idea (at least as a general theory) of the elevation of mountains by a force below causing at the time an irruption of igneous matter; for the irruption is in general an effect of a very different action, as has been urged by Prévost. This may be as true of the Urals, as of the Rocky Mountains and Andes.

Even the trap dykes of New England and New Jersey, whose general course corresponds with that of the Appalachians, may be a result of the contraction in progress subsequent to the coal

---

* The same is the general character of the Andes. In an account of the geology of Chile, M. I. Domeyko says, speaking of the Andes in the latitude of Copiapo, "En regardant du côté de l'Ouest, on voit un bouleversement complet dans le terrain soulevé: des failles et déchirements, des escarpments à pic, des stratifications contournées et interrompues. En portant ensuite la vue du côté de l'est, on voit des pentes douces, des bancs de rochers presque horizontaux et rarement interrompus."

"Tout announce que le principal mouvement qui survint à l'époque de la formation des Andes arriva *du côté de l'Ouest*, c'est-à-dire du côté où une ligne d'escarpments qui marquent le rivage actuel de l'Ocean depuis le Cap Horn jusqu' aux Montagnes Rocheuses, continue à se soulever d'une manière lente et à peine perceptible, au mugissement des bruits souterrains et sous l'influence des tremblements de terre répétés."—*Annales des Mines*, *iv ser.*, ix, 413, *2nd. liv.*, 1846.

† Granites may have been the earlier products; but the existing volcanic mountains have basalts and trachytes for their surface rocks.

‡ W. B. and H. D. Rogers, Trans. Assoc. Amer. Geol. and Nat., 1840–1842, p. 522.

era. The dip of the new red sandstone accompanying them is probably another effect. The Ozark mountains, forming a line parallel with the Appalachians, beyond the Mississippi, may be referred to the same system of changes.

The economical advantages belonging to the features of North America that have thus originated, are most remarkable, and this view of their origin gives them increased interest. The Silurian rocks indicate that before the coal period the region was comparatively level, and lay mostly beneath the sea. As it emerged it was still dripping with water, so that, under a climate peculiarly genial, coal vegetation might have grown luxuriantly. But had it continued thus flat to a later period, it would have had but small streams, and probably, for want of a mountain barrier to intercept the *drying* Pacific winds, the desert regions of the west would have traversed the land, as Sahara has spread over Africa. As if to prevent these results, and give a vastness scarcely equalled to its resources, the land was raised into mountains on either coast, those of the west, where the barrier was most needed, ascending even to the regions of perpetual snows. The whole interior is now enclosed by the Rocky Mountains on the one side and the Appalachians on the other, and a thousand streams are set in motion over the wide land from either bound, all to contribute to a common trunk, the great highway of the country. Thus the largest possible extent of intercommunicating inland waters has been secured; and for the same reason a great part have been made to flow so nearly on a plain as to afford navigation almost from one end of the territory to the other, and extend their fertilizing influence over the whole surface. A similar result has been produced on the narrow ocean side of the main chains by the succession of parallel coast ranges; for the waters have been compelled to flow far north and south between these ranges, and fertilize an extended country before the sea was reached. Thus the noble Columbia, with its wide spread tributaries, was made for Oregon; and in the same manner were formed the Willammet, the Sacramento, and the Joachim, which run in long courses between the Cascade and Coast ranges of heights. Thus on the Atlantic side, we have the Shenandoah and other head waters to the Potomac, and at the north, a Hudson, Connecticut and Merrimack flowing in parallel lines.

Note.—In connection with this article, it should have been earlier mentioned that the theory of "secular refrigeration" has been presented with much force, in many points of view, by W. W. Mather, in this Journal, vol. xlix. p. 284, (1845), and the foldings of the Appalachians are attributed by him to this cause.

ART. XIV.—*Description of two New Species of Shells;* by WILLIAM CASE, Cleveland, Ohio.

Helix annulata—(figs. 1, 2, 3.) Shell minute, much depressed—umbilicus showing all the volutions; aperture simple and some-

Fig. 1.

Fig. 2.

Fig. 3.

what oval; whorls four, banded by thin, sharp and parallel ribs, inclining slightly forward; intercostal space marked with waved lines, running parallel with the whorls; nearly transparent; diameter about one line.

This minute but beautiful shell was found by Captain B. A. Stanard, in the region about Lake Superior, and I have heard of its being observed in other places, but so far as I can learn, it is undescribed. It differs from any description of the *pulchella* I have yet met with, in having uniformly an *oval* aperture and *simple lip.* The *H. minuta* of Say, I believe never has the parallel ribs, and is supplied with a lip.

Planorbis multivolvis—(figs. 4, 5.) Shell about five-eighths of an inch in diameter; whorls seven, about half of the last whorl overlapping the preceding one, sometimes the last whorl suddenly distorted and expanded for the last half of its length; right side concave, left side slightly accuminate and considerably carinate; throat campanulate; aperture opening towards the left, but projecting on both sides beyond the preceding whorl.

Fig. 4.

Fig. 5.

This shell, also, I obtained from Captain Stanard, who found it in the northern part of Michigan. It is very distinct from any Planorbis I have met with, or have been able to find any description of. I have named it from its strong characteristic—a greater number of whorls than usual in the genus.

Note.—The Helix here described approaches the *pulchella*, (*minuta* of Say,) a ribbed variety of which is called *H. costata;* yet it appears to be a distinct species. The Planorbis is most nearly allied to the *P. campanulatus.*—A. A. G.

SCIENTIFIC INTELLIGENCE.

I. Physics and Chemistry.

1. *Gun-Cotton.*—It was announced last summer by Prof. Schönbein of Basle, that he had discovered a method of producing a substance from vegetable fibre, more explosive and powerful than gunpowder, and much interest was excited at the late meeting of the British Association, by an exhibition of its wonderful effects. It has since been made by many persons in Europe and throughout our own country.

It is now well known that the "Gun-Cotton" is only a form of the Xyloidine discovered by Braconnot in 1833, and subsequently more fully described by M. Pelouze* in 1838. The Xyloidine is produced by the action of strong nitric acid, specific gravity 1·5, upon starch or any form of vegetable fibre. M. Pelouze stated (in 1838) that it was very combustible, took fire at 360°, and burnt with vivacity. He also suggested that it might, from its extraordinary combustibility, prove valuable in artillery. Prof. Schönbein and his associate M. Böttger claim therefore only the application of this remarkable substance to useful purposes, for although the method employed by them in its production has not as yet been made public, there can be no doubt that it is chemically identical with the Xyloidine of Braconnot and Pelouze. The suggestion thrown out eight years ago by M. Pelouze, regarding its possible application in artillery, seems to have escaped attention, and to have been productive of no useful result.

The complete conversion of cotton into Xyloidine is somewhat difficult, and requires the strongest nitric acid. In principle, it is immaterial whether the strong nitric acid be procured by distillation; by mixture of sulphuric acid with the aqua fortis of commerce; or by the mixture of equivalent parts of nitre and sulphuric acid. The best action of the nitric acid is produced by mixing with it nearly its own volume of strong sulphuric acid, which by its attraction for water renders the nitric acid of the greatest strength without interfering with the result. If 100 grains of clean carded cotton are immersed for four or five minutes in a mixture of 1½ fluid ounces of strong nitric acid (Sp. Gr. 1·45) and an equal measure of strong sulphuric acid, it will be converted into Xyloidine. It is then removed from the acid, pressed with a spatula, and quickly washed in an abundance of cold water until it has no longer an acid reaction, when it may be carefully dried at about 200° F., again carded, and it is fit for use. As thus prepared, it retains the appearance and fibre of common cotton, but is harsher and more wool-like to the touch. It inflames at a temperature of about 350° F., and, as is lately asserted,† it sometimes happens that it is spontaneously inflamed at 212° F. The greatest caution is therefore required in the preparation, to avoid its accidental combustion.‡

---

* Comptes Rendus, Oct. 15, 1838. † L'Institut, No. 670, p. 367.

‡ It may not be amiss to mention in this place, that the writer and his assistant were both burned by the accidental combustion of about 1200 grains of gun cotton, which they were drying over a hot-air flue where the temperature was probably very little above 212°. At the instant when they considered the mass as dry, it took fire and was dissipated in a large volume of brilliant yellow flame, without

It burns with a voluminous yellow flame, very brilliant and rapid, produces no smoke or odor, and leaves little or no residue. If well prepared, the products of its combustion are only gaseous. It burns so much more rapidly than gunpowder, that the latter is not inflamed by it; and not the least inconvenience is felt by burning a flock of it on the naked hand. It detonates with some difficulty when struck with the hammer on an anvil, and only in the part receiving the blow, the remainder being scattered about. Wetting does not injure it, if it is again carefully dried. Its projectile force is much greater than that of gunpowder, and has been variously stated by different experimenters as from four to eight times more powerful.

Dr. Otto states that a charge of $1\frac{1}{4}$ to $\frac{1}{2}$ grain, propelled a ball through an inch board of hard wood; and with a charge of from 4 to 8 grains, balls were projected from a gun with the best effect at 45 paces distance.* Dr. Samuel L. Dana, of Lowell, has made the most extensive experiments on the power of cotton-powder which to our knowledge have been made in this country.† His trials were made at the powder mills of Mr. O. M. Whipple, near Lowell, with an eprouvette, or proof-mortar, carrying a 24 pound iron ball, at an elevation of 45°. The projectile force of the gun-cotton was greatest when it was loosely packed in the chamber of the eprouvette, leaving the greater portion at the breech, on which the ball rested. "Two balls were used differing a little in their windage. Four qualities of gun-cotton were used; the first was immersed 25 minutes in the mixed nitric and sulphuric acids. No. 2, the same immersed, after drying, in fresh acids for 25 minutes more. No. 3, dipped 25 minutes, and then a new portion of fresh acids added, and the dip continued for the same time longer. No. 4, called 'blasting cotton,' dipped 35 minutes. Two discharges of Mr. Whipple's best rifle powder F F F F, were first made, each one ounce. No. 1 threw the ball 288 yards. No. 2 threw it 272 yards. Average $281\frac{1}{2}$ yards. The chamber was then cleaned and charged with gun-cotton.

No. of discharges.	Quality of gun cotton.	Quantity in ounces.	Yards projected.	REMARKS.
1	3	$\frac{1}{8}$	7	Charge loose in chamber, that not full, ball No. 2.
2	3	$\frac{1}{2}$	100	Chamber full, hard rammed, and small wad over cotton, ball No. 1.
3	3	$\frac{1}{2}$	175	Loose, and a little for a bed for the ball, ball No. 2.
4	2	$\frac{1}{2}$	272	As in 3d shot, but more bed, ball No. 1.
5	$\frac{2}{3}$No. 2, $\frac{1}{3}$No. 1	$\frac{3}{4}$	453	Charge as in 4th, ball No. 1, buried 3 feet in the ground on falling.
6	1	$\frac{3}{4}$	100	Charge as in 4th, ball No. 2.
7	4	1	567	Charge as in 4th, ball No. 1.
8	4	$\frac{1}{2}$	50	Charge rammed hard home, ball

smoke or odor, and with so little noise as not to attract the attention of those in an adjoining room, although the doors were open. No nitrous acid fumes were observed as others have asserted, nor was the presence of this gas detected in the small apartment. Later experiments have convinced us the cotton-powder is sometimes inflamed at a temperature even lower than 212°. B. S., Jr.

* L'Institut, No. 670, p. 366. † Lowell Daily Courier, Dec. 8.

No. 1. This charge was about one hour after the 7th, during which period it had been carried, wrapped tight in paper, in my hand, while searching for the ball of the 7th shot. It may have absorbed moisture.

It appears from the 4th, 5th and 7th shots, that the distance projected increases faster than the quantity."

Dr. Dana also tried the gun-cotton in blasting rocks, in the line of a new canal now excavating in Lowell. The first trial was on a ledge of argillo-micaceous slate, very hard and tough. The portion selected was imperfectly stratified in an almost vertical direction, with a perpendicular face about 9 feet high. Two holes each $1\frac{3}{4}$ inches diameter, were drilled into this rock $5\frac{1}{2}$ and 6 feet from the face, 12 feet asunder, and about 9 feet deep. Gun-cotton (No. 4 above) was enclosed in cartridges of cotton cloth, $1\frac{1}{2}$ inches diameter, and respectively 2 feet 10 inches, and 5 feet long, holding 9 and 11 ounces. The holes were filled with dry sand over the cartridges, (5 feet over one, and 6 over the other,) which were then fired by an attached fuse. The explosions occurred within a few seconds of each other, with a sharp but not loud report, and very little smoke. The result was highly satisfactory to the engineer and contractors under whose inspection the experiment was tried. The mass of rock moved was $25\times5\times9$ feet $=$ 1125 cubic feet, or about 90 tons weight, moved by 20 ounces of gun-cotton! The contractors declared that 10 or 12 pounds of ordinary powder would have been required to do the same work, or eight times as much as was used of gun-cotton. In a second experiment, 78 ounces 6 drachms of gun-cotton were fired in a hole 5 inches diameter and $9\frac{1}{2}$ feet deep, and moved a mass of $45\times10\times9\frac{1}{2}$ feet $=$ about 350 tons. The gun-cotton used in these experiments was prepared by Dr. Dana after the method proposed, and successfully employed by Mr. A. A. Hayes, of Roxbury, which is substantially the same as that already described.

Some experiments on the cotton-powder in mining have been made in Cornwall by Prof. Schönbein and Mr. R. Taylor,* and with the most satisfactory results. It was found practicable to enter immediately after explosion into a narrow adit 600 or 700 fathoms from day, where it would not have been possible to have entered under three quarters of an hour, if a like amount of common powder had been burnt there.

The action of nitric acid in producing a highly inflammable substance, is by no means confined to cotton. M. Pelouze, in 1838, observed that common unsized paper, after similar treatment in strong nitric acid, became remarkably tough, quite impervous to water, transparent, resembling vellum, and very inflammable. He has lately informed the Académie des Sciences at Paris, (Nov. 2d,) that he has prepared an explosive paper, one and a half grains of which was as powerful in a pistol, as the common charge of best gunpowder. Flax and other fibres have been prepared in the same way.

The analysis of Xyloidine, by Pelouze, gives for its composition $C_6 H_4 NO_9$, or doubling the formula $C_{12} H_8 N_2 O_{18}$. Cellulose, starch, or clean cotton fibre, may be expressed by the formula $C_{12} H_{10} O_{10}$. Xyloidine may then be considered as cellulose, in which a part of the hydrogen is replaced by nitrous acid. Substitutions of this sort have

* Chemical Gazette, London, Nov. 1, 1846.

been fully established by the late researches of Laurent, Hoffman and Muspratt, which have shown that the elements of nitrous acid may, like chlorine and bromine, replace the hydrogen in many organic compounds. In conformity to this view, the formula of xyloidine will be $C_{12}\ H_8\ 2NO_4\ O_{10}$, in which the elements of two equivalents of nitrous acid are substituted for two of hydrogen in cellulose.

The arrangement of its elements is such as to produce in its combustion an immense volume of permanent gases and elastic vapor, on whose instantaneous evolution the force of the gun-cotton depends. In the production of the gun-cotton by the process described, two equivalents of hydrogen from the vegetable fibre react with two of nitric acid to form two of water and two of nitrous acid; the latter enter into the constitution of gun cotton, while the water formed remains in the acid mixture, and so far dilutes it as soon to render it unfit for use. Hence the necessity of changing the acid liquor. In dilute nitric acid the xyloidine dissolves, forming oxalic acid. When, in its preparation, the gun-cotton is seen to become gelatinous and semitransparent, it is a sign that the acids are no longer of a sufficient strength to produce the explosive compound.

2. *On the Compounds of Phosphorus and Nitrogen;* by C. Gerhardt, (Comptes Rendus, 1846.)—Two compounds of phosphorus and nitrogen have been supposed to exist, the one PN_2, the other a hydrate PN_2+HO. This composition being contrary to the views of Laurent and Gerhardt, the latter undertook the reëxamination of the subject. He found that the so-called phosphuret and its hydrate were mixtures of three substances named by him *phosphamide, biphosphamide* and *phospham*.

Phosphamide.—When ammoniacal gas is made to pass over chlorid of phosphorus contained in a long tube, the chlorid becomes heated and gives off much sal-ammoniac. The product (a white powder) treated with water, dissolves in part only; the insoluble residue is impure phosphamide, which is purified by boiling for several hours in a dilute solution of potash, then in weak nitric acid and lastly in water; dried at 212° its formula is $PH_3N_2O_2$.

This substance heated in a metallic bath loses not a trace of water; above 390° it gives off pure ammonia and is converted into biphosphamide.

The formation of phosphamide is represented by the following formula: $PH_3O_8+2(NH_3)-6(HO)=PH_3N_2O_2$.

Biphosphamide is formed when dry phosphamide is heated, all the hydrogen goes off as ammonia, and there is left PNO_2. Moistened with water and heated, this substance gives phosphoric acid and ammonia. Melted with caustic potash, this as well as the former forms phosphate and gives off ammonia. This is remarkable as being the first amide not containing hydrogen, and on this account Gerhardt says it "must sorely puzzle the advocates of radicals and the dualistic theory."

Phospham.—The product of the action of ammonia upon the perchloride of phosphorus gives off, when heated, sal ammoniac and hydrochloric acid. The white residue has been considered phosphuret of nitrogen, PN_2; it is however a mixture, and minute precautions are necessary to produce the pure phospham, PHN_2. The presence of hydrogen was supposed by Liebig and Wöhler to be accidental. There is, however, 1·5 per cent. of hydrogen in this substance. Fused potash converts it into ordinary phosphate; moistened and quickly raised to a red heat, it disengages much ammonia and is converted into metaphosphoric acid. G. C. SCHAEFFER.

3. *Experimental Researches on the Nutritive Power of green and dry Fodder;* by M. BOUSSINGAULT, (Ann. de Chim. et de Phys., July, 1846, and Comptes Rendus, Apr., 1846.)—It is generally thought that there is more nourishment in green fodder than in the dry hay derived from an equal weight of the fresh grass. The experiments of Boussingault show that this is not true. A heifer was weighed, and fed for ten days on green fodder, each day a quantity equal in weight to that consumed was put aside to dry. The animal was again weighed and fed for ten days on the dry fodder, then weighed again. The experiment was tried three times, and each time the animal weighed a little more after feeding on the dry fodder than after the green. The difference was not enough to prove that the dry food was the *more* nutritious, although the experiment proved beyond a doubt, that it was not inferior in effect to the other. G. C. S.

4. *On the progressive development of Vegetable Matter in Wheat;* by M. BOUSSINGAULT, (Ann. de Chim. et de Phys., June, 1846.)—M. Matthieu de Dombasle has endeavored to overturn the common opinion that plants exhaust the soil only during the formation of the seed; he asserts that a plant at the time of flowering, contains all the elements required to bring it to maturity.

The experiments made by Boussingault to decide this question, were carefully conducted. An equal number of plants drawn the 19th of May, the 9th of June when in flower, and the 15th August at harvest, furnished the data. The plants were not only dried and wiped, but submitted to organic analysis.

The results when calculated for a hectare, were as follows: The assimilation of dry vegetable matter, from the time of sowing to May 19th, was 6·8 kil. per day; from May 19th to June 9th, 32·9 kil. per day; and from June 7th to Aug. 15th, 36·3 kil. per day. Thus the most rapid growth was before the time of flowering, but still the crop had nearly doubled in weight from the time of flowering to the harvest. The increase of organic matter was nearly in the same proportion.

G. C. S.

5. *Memoir on Coffee;* by M. PAYEN, (Comptes Rendus, May and July, 1846.)—Our knowledge of this important substance, is as yet but scanty. Caffeine, legumine, oleic acid and palmitic acid, are almost the only ingredients, the existence of which has been satisfactorily proved; and the small quantity of these, shows how little of the active matter in coffee is really known to us. The researches of Payen, not yet concluded, are highly interesting, and have already brought to light a new and very singular compound, presently to be described.

The first part of the memoir consists of certain estimates of the amount of nutritious and soluble matter contained in the raw coffee and in that which has been more or less roasted.

Martinique coffee gave 40 per cent. soluble matter; 11·5 hygroscopic water, and 45·5 insoluble matter. The ease with which the soluble matter is removed, depends upon the fact, observed under the microscope, that the hard substance of the grain is traversed by irregular cavities opening into each other and containing the soluble matter.

Coffee roasted only until it becomes slightly red, preserves the maximum of weight and of aroma, but gives out less coloring matter. In this state, 100 parts are found to have lost 15, while 100 vols. have increased to 130. Roasted to a chesnut color, as is commonly done, the loss is 20 per cent., while the increase in volume is from 100 to 153. This swelling of the grain depends upon the property which the nitrogenous matter deposited within the tissue has, of puffing up remarkably when heated.

If the heat is continued until a dark brown color is produced and the grain becomes covered with a sort of glaze, the loss is 25 per cent., while the original quantity of nitrogen, 2·45 per cent., is reduced to 1·77, being a loss of one fourth.

The loss of soluble matter was found to be proportionate to the loss in weight, but in order to obtain results of practical value, instead of exhausting the coffee, the usual domestic process was tried. One litre of water (nearly 1 qt.) was filtered through 100 grammes (1500 grains) of each kind, and there was obtained of soluble matter from the brown coffee 16·15; from the chestnut, 19·00, and from the red, 25·00.

The difference in the aroma being nearly the same, the lower degree of roasting will produce not only the best and most nutritious beverage, but one free from the harsh and bitter flavor caused by action of too high heat upon the nitrogenous matter.

The nature of the substances dissolved, renders this beverage not only agreeable but nutritious, compared with tea (the coffee being 100 gram. to one litre of water, the tea 20 gram. to one litre); the former contains three times the quantity of solid matter and double the nitrogen, of the latter. With an equal bulk of milk, and the usual amount of sugar, this drink contains six times the solid, and three times the nitrogenous matter that broth does.

The partial substitution of succory for coffee, was proved to be without real advantage, as the latter substance contains a much smaller amount of nutriment and little or no aroma, but more coloring matter.

New double salt and acid of coffee. Direct extraction of caffeine.— The new compound discovered by Payen, appears to have escaped notice, by reason of its remarkable disposition to change. In fact this change is the first evidence of the presence of the matter. A simple infusion of the raw coffee, although nearly or quite colorless, on the addition of a few drops of ammonia, turns first at the surface, and gradually throughout, to a bright and finally to an intense green. By hastening this action, a very delicate test was obtained for the new substance, and at last after much trouble, the means for its separation were perfected.

The process adopted affords caffeine as well as the new substance. Coffee is reduced to powder, exhausted with ether, the solution evaporated to dryness, and the fatty residue well washed with boiling water. The washings evaporated, leave a yellowish brown substance, which, treated with absolute alcohol, gives on evaporation, crystallized caffeine—the usual washing with cold, and crystallization from hot alcohol, furnish it perfectly pure.

Having obtained the equivalent of this substance, Payen was able to control the analysis, which is different from that hitherto received. His formula is $C_{16} H_{10} N_4 O_3$.

The coffee which has been washed with ether is, in the next place, exhausted in the alcohol of 60 per cent., and the solution evaporated to a syrup is mixed with three times its volume of alcohol of 83 p. c. The liquid separates into two portions, the lighter and more fluid of which contains the new compound. After decantation, the further purification depends upon the solubility of this substance in weak alcohol and water, and its insolubility in absolute alcohol. The aqueous solution alters so rapidly that in all cases alcohol must be added, and even the alcoholic solutions must be evaporated without exposure to the air.

This remarkable crystalline compound when pure, contains a new acid, called by its discoverer, from its singular properties, *chloroginic acid*, besides caffeine and potash; in short, it is a *double chloroginate of caffeine and potash.*

The most striking properties of this salt are—1st, its alteration, marked by the development of an intense green color, under the influence of air and ammonia; and this property is the best guide to its preparation; 2dly, the action of heat, which increases its bulk five times, causes caffeine to sublime, and finally at a high temperature leaves a residue having twenty times the volume of the original substance. It is this property which occasions the swelling of the grain when roasted; the salt may be discovered by the microscope already formed in the coffee.

The alteration of the double salt, by ammonia, when carried to completion, or the moderate action of heat, permits the separation of the caffeine unchanged. Precipitated by tribasic acetate of lead, the chloroginate of lead may be obtained pure, and by decomposition by sulphuretted hydrogen the acid is easily obtained and purified. The formula of chloroginic acid is $C_{14}H_8O_7$.

(Caffeine is thus brought to resemble sugar of gelatine in its union with an acid, while the new acid itself differs from kinic acid by only one equivalent of oxygen. The further investigation of these substances will undoubtedly lead to some striking analogies.) G. C. S.

6. *Researches on Blood;* by M. Dumas, (Ann. de Chim. et de Phys., August, and Comptes Rendus, June, 1846.)—These investigations are based upon the process of MM. Lecanu and Figuier, by which the globules can be obtained free from all mixture or impurity. Their method consists in mingling the blood with three or four times its volume of a saturated solution of sulphate of soda. On filtration, the liquid passes clean and colorless, while the globules remain upon the filter. The blood however must be freshly drawn, or the addition of even large quantities of the saline solution will fail to give a colorless liquid. Moreover the attempt to wash the globules by a new quantity of the solution was not successful, and without this washing they retain a notable proportion of the serum.

In attempting to overcome this difficulty, M. Dumas discovered the remarkable property of the blood globules, that as long as they were in contact with the air or aërated water, in short as long as they were in the arterial condition, the saline solution containing them passed colorless through the filter, and left them upon it; on the contrary, as soon as the globules have assumed the violet tint of venous blood, the liquid passes colored.

It is only necessary then to pass a continuous and rapid current of air through the solution upon the filter, to maintain the globules in the proper condition. The blood as soon as drawn is defibrinated, mixed in the saline solution, and thrown upon a large filter. A tube in the point drawn out introduces the current of air, which also keeps the globules suspended—if they adhere to the filter they are no longer aërated. The solution is renewed as fast as it filters off. In this way the globules are obtained perfectly free from serum. The process should be conducted as expeditiously as possible.

Thus the globules of the blood seem to possess vitality, as they can resist the solvent action of sulphate of soda as long as their life continues, but yield to this action readily when they have fallen into asphyxia from privation of air.

Phosphate of soda and salts of organic acids are among those which best preserve the power of aëration in the blood corpuscles. On the other hand, the chlorids of sodium and potassium as well as sal-ammoniac, prevent the aëration of the globules even in oxygen. Salts of potash seem to have less of the preservative effect, than salts of soda. Dumas asks if there is any relation between these effects and the supposed liability to scurvy from the immoderate use of salt meat, or the poisonous effects of ammoniacal salts.

It appears from these experiments that even in the midst of a supply of air or oxygen, asphyxia may result simply from the introduction of salts which modify the action of oxygen upon the globules. Several curious points are suggested as subjects for experiment.

In conclusion, an analysis of the carefully purified blood globules is given—the results are, for those taken from the blood of a woman, carbon, 55·1 ; hydrogen, 7·1 ; nitrogen, 17·2 ; oxygen, 20·6—showing that these bodies belong to the albuminous class. The slight excess of carbon is probably owing to the presence of a coloring matter more carbonated than albumen or caseine. G. C. S.

7. *New Saccharimetric Process;* by M. Eug. Peligot, (Comptes Rendus, June, 1846.)—Peligot's method of estimating the quantity and kind of sugar, either solid or dissolved, or in vegetable juices, is unlike all others hitherto proposed. It is founded on the property the sugars possess of forming definite compounds with alkaline bases, and also upon the rapid conversion of grape sugar into acids by the action of alkalies.

Of the sugar to be examined, 10 grammes are dissolved in 75 centimetres of water; to the solution in a glass or porcelain mortar 10 grammes of slacked and sifted lime are added gradually, and the whole levigated for a few minutes. The solution is filtered, and had better be poured a second time into the filter, in order that the whole quantity of lime that the sugar can take up should be immediately dissolved.

By means of a graduated pipette, 10 cub. cent. of the solution are taken; these are to be diluted with 2 to 3 decilitres of water, a few drops of tincture of litmus are added, and the liquid is neutralized exactly by a normal solution of sulphuric acid. This solution should contain per litre, 21 grammes of pure monohydrate of sulphuric acid—one litre saturates the lime dissolved by 50 grammes of sugar. Simple inspection determines the quantity of the lime, and even of the sugar, if the division has been made for the purpose.

For sugars suspected to contain grape sugar, and also for molasses and inferior sugar, the process is conducted as before; and next an equal quantity of the solution is heated in the water bath to 212°. If nothing is presented but cane sugar, the saccharate of lime deposits, but is redissolved in cooling. If glucose is present, the liquid becomes deep brown and smells of burned sugar. A second alcalimetric trial gives only the quantity of cane sugar which remains, the whole of the glucose having been converted into acid, which neutralizes the lime in part.

When liquids are operated upon, it is convenient to have them of the density 1·05, or about that of cane or beet juice. They filter better than when denser, and dissolve the lime more rapidly than when more dilute. The quantity of lime used should be equal in weight to the sugar supposed to be in solution. G. C. S.

8. *Rapid Method of estimating Copper, by means of a Colorimeter;* by M. Jacquelain, (Comptes Rendus, June, 1846.)—A given quantity of pure copper, (0·5 grammes,) is dissolved in nitric acid, an excess of ammonia is added, with pure water, to make the volume of 1 litre. 5 cub. centimetres of this liquid are put into a glass tube, which is hermetically sealed. The color undergoes no change for many months. The assay is dissolved in nitric acid, and ammonia added as before. The solution is then made up to a determined volume by the addition of water, the color being kept darker than that of the normal solution. 5 cub. cent. of this liquid are placed in a tube, of the same diameter and internal thickness as those of the former. Water is then added until the tints are alike. The volume of water being known by a simple proportion, we can ascertain the quantity of copper in the assay solution and in the assay itself. The tints are best observed by placing the tubes against a sheet of white paper, and by looking through a small hole covered with a *blue* glass. The use of one eye only is necessary to success.

M. Cassaseca produced a paper on a similar process, at the same meeting of the Academy of Sciences of Paris. G. C. S.

9. *On the Molecular Phenomena of the Voltaic Arc;* by M. de la Rive, (Comptes Rendus, April, 1846.)—The experiments of the author were made with a Grove battery of seventy pairs. The influence of the form and substance of the conductors upon the length of the arc, the transport of the particles from the positive to the negative pole, and the nature of the deposit, were all thoroughly examined. In most of the experiments one pole had the form of a point, the other of a plate, and the distance was accurately measured by a screw.

The maximum length of the arc between a point and plate varied from two to six millimetres. In case both were of the same substance, the length of the arc, when the point was in connection with the positive, and the plate with the negative pole, was twice as great as when the order was changed. The distance was greatest with silver, iron and charcoal, least with platinum. Between different metals, that which formed the positive pole, as a point, determined the length of the arc. The plate at the negative pole was however not without influence.

The intensity as measured by a galvanometer was found to decrease as the poles were separated, until the luminous arc disappeared. The minimum deviation was the same, whatever the nature of the substance employed, although the maximum length of the arc varied greatly. The length of the arc probably depends upon the facility with which the particles of the substance are separated. The condition of the matter during its transport, whether liquid, solid, or gaseous, could not be determined. The appearance of the deposit, in some instances, indicated that the matter had been in a liquid or gaseous state.

The well known difference of temperature at the two poles was examined under various circumstances. M. de la Rive considers that the higher temperature of the positive pole and the separation of matter from that one alone, shows that the substance undergoes vibrations or mechanical actions, not communicated to the matter in connexion with the negative pole. A very curious experiment seems to prove that this supposition is correct.

If the poles are formed of two pointed, soft iron rods, the flame may be drawn out to a length of six millimetres. If the rods are then magnetized, (by a helix passing around them, or by contact with the poles of an electro-magnet,) the arc immediately disappears, and does not return unless the magnetic influence ceases before the rods can cool. If however the magnetism is kept up, on bringing the points together, the arc reappears, but totally different in character. The arc can now only be drawn out to one-third its former length, and consists of snapping sparks given out in every direction from the positive pole. As soon as magnetism ceases to operate upon the wires, the flame becomes quiet or assumes its original character. Two tempered steel points, before they have lost their temper by the heat, produce an arc precisely like that between the magnetized iron points. The arc is analogous to the effects of magnetism and temper upon the sound of wires.

M. de la Rive concludes with a still more curious experiment. The snapping sound produced by the magnetized rods may be greatly increased, when one of the irons is replaced by another metal, or still better by a point of coke or hard charcoal. The sound then becomes very shrill and intense, and is compared to that of a locomotive whistle; this is only while the iron is magnetized, otherwise the sound ceases, although the flame continues. But what is most remarkable, the sound is only heard when the magnetical iron is at the positive pole—at the negative pole it does not produce the slightest noise.

M. de la Rive does not appear to have examined the deposit on the *sides* of the vessels containing incandescent coal or coke points. This deposit always forms in vacuo or when the vessels are closed; it seems to indicate a much greater amount of dispersion of the matter from the positive pole, than is commonly thought to take place. With a battery of the same size as that used in the foregoing experiments, that deposit, in a short time, covered the sides of the glass vessels used to such an amount, that the light was greatly diminished. The purity of the carbon had nothing to do with this effect, which was produced when either gas-carbon, coke or charcoal was used. G. C. S.

10. *On Electro-Physiology;* by Prof. Matteucci.—(Proceed. Brit. Assoc., from Athen., Sept. 26, 1846.)—Prof. Matteucci submitted to the British Association a *résumé* of his latest researches in Electro-Physiology.—In the first place he described the experiments which prove that the development of electricity in living animals is a phenomenon peculiar to all organic tissues, and principally to muscular fibres, and

that it is a necessary consequence of the chemical processes of nutrition. Prof. Matteucci particularly wished to prove that the development of electricity in the muscles can never produce electric currents which circulate either in the muscular *mass*, or in the nerves. It is only by a particular arrangement of the experiment that we succeed in obtaining a muscular current. Further, all experiments contradict the opinion of an electrical current existing in the nerves. M. Matteucci proved that the current said to be proper to the frog, is, on the contrary, a general phenomenon which exists in all the muscles that have tendinous extremities unequally distributed, and that this current supposed to be peculiar to the frog, is only a particular instance of muscular current.

In the second place, the Professor laid before the Section his last researches 'On Electrical Fishes.'—He showed that the laws of the electrical shock of these animals, are a necessary consequence of the development of electricity which is produced in each cell of the electrical organ under the influence of the nervous power.

In the third place, Prof. Matteucci showed the relation which exists between the Electrical Current and Nervous Power. He proved that muscular contraction is always produced by a phenomenon analogous to the electrical spark, and that the electrical current does but modify the nervous excitability. On these facts, Prof. Matteucci establishes a simple theory of electro-physiological phenomena.

In the last part of his communication, the Professor treated of Inducted Contraction;—and, after having demonstrated that these phenomena cannot be explained in supposing an electrical discharge of any kind indiscriminately, he concluded, that Inducted Contraction is an elementary phenomenon of the nervous power, which acts in muscular contraction, and is analogous to all actions of induction of physical powers.

11. *Notices of the Progress of Experiments on the Influence of Light on the Growth of Plants;* by R. HUNT, (Proc. of Brit. Assoc., Sept., 1846, from the Athenæum, Sept. 19.)—The experiments described in former communications to the Association, had all been confirmed by the results obtained during the past year. It had been found that seeds would not germinate if all the chemical rays were prevented from acting on them—and that the influence of the actinic or chemical rays was such that seeds germinated at a depth below the soil, under the influence of concentrated actinic force, acting on the surface, at which they would not have germinated under the natural conditions. The leaves being developed, the action of the luminous rays then became necessary to effect the decomposition of carbonic acid and the deposition of woody fibre within the plant. Under the joint influence of light and actinism the plant arrived at maturity, and then the calorific, or heat-producing rays were brought more fully into action to produce the ripening of fruit and the development of seed.

12. *On the Results of an extensive series of Magnetic Investigation, including most of the known varieties of Steel;* by W. PETRIE, (Proc. Brit. Assoc., from the Athen., Sept. 26, 1846.)—

Process of manufacture to produce permanent magnets, having the greatest fixity and capacity conjointly secured.—1. The original iron should be the purest soft iron, *charcoal made* (not coke); the Swedish, from the *Dunnamore* mine, is better than any other. 2. Converted—with pure *charcoal;* it should be carbonized *lightly*, and the process to be stopped when the bars, of the usual thickness, are "*scarcely steel through*," yet so that it will harden with certainty, without an undue heat. 3. Sorted—with attention to homogeneous conversion, &c., according to the ordinary rules. 4. Melted—the pot kept covered, and not longer than necessary in fusion. 5. Cast—into a large ingot, so as to allow of its being *well* rolled out singly, before it becomes reduced to the requisite thinness. 6. Rolled—while hot from casting, to save a second heating; it should not be doubled over, nor sheared and fagotted; the rolling should be conducted at as low a temperature as convenient, as it thereby acquires a harder, closer texture, and finer grain. 7. In cutting into shape, the substance (if large or of varied form) should not be strained, as by boring with "*rymers*," or straightening (oftener than is unavoidable) with the hammer, as it is then apt to warp, and to have unseen commencements of cracks on becoming subsequently hardened. More carbonization than that previously described as best, is of little injury to the magnetic goodness of the steel, provided it be so prepared as to preserve a homogeneous and *white* appearance of fracture when hardened, which is not so easily managed as with that of lower carbonization; but if it be again carbonized *more* than usual, (as razor steel, or above that,) it rather improves; and again an increase deteriorates it as in cast iron, and a further increase again improves it. In short, *in the scale of carbonization there is a succession of continually decreasing maxima of advantage.*

On the physical properties which the steel should possess.—The fineness of grain is affected by many adventitious circumstances, which must be considered and allowed for in judging of it; and the most important fact is the difference between the appearance in the *hard* and *soft* states; for in the general properties, whether optical, mechanical, or magnetical, their order, in any set of samples, is *reversed* in the hard state, independently of the absolute change in each property. The steels should be examined by breaking with a *single* bend at a file notch, (notching with a chisel, bending back, &c., change the appearance.) A microscope of 6 or 10 lineal power is better than any other power for examining it. The *general* properties, without going into detailed description, should be as follows, the terms being comparative with other samples of less value, and not at all with the hard or soft states of the same steel:—

In a soft state.	*In a hard state.*
General appearance, uniform darkish grey.	Uniform white.
Rather a large grain, compared with razor steel, (or finer if much rolled.)	A smaller grain than it was before.
Rather irregular in size and shape of grain, unless fine. Rounded crystallization.	Rather more regular than before. *Rounded* crystallization disappears. Grains individually distinct, with good metallic lustre.
Close texture, without cavities.	Not particularly close.
Rather tough for steel.	Brittle, and very hard.
Attracted considerably before magnetizing.	Ditto.
Loses induced magnetism more freely than other steels.	Retains magnetism well and abundantly.

Care must be taken to discriminate between real cavities and indentations arising from the crystals being torn up by the breaking; pure iron often appears porous from this cause.

Then followed some peculiar considerations on the chemical constitution and molecular arrangement of certain sorts of steel; and on the molecular peculiarities of iron and other metals, in connexion with their magnetic capacity, illustrated by a tabular arrangement.

On hardening, &c.—In the ordinary process there is risk and difficulty for large work, owing to unequal heat, unnecessary time and heat applied, especially to fine edges, decarbonization, scaling, &c. These are obviated by a process which is new, as applied on a large scale, namely, heating in melted lead. It will be observed that the *precise* heat is imparted, quite uniformly, in half a minute or so; and the finest edge is heated momentarily no higher than the thickest part, rendering this process incomparable for all instruments where it is the edge or smaller parts that are of importance. *No scale is formed*, the finest polish or sharpest edge being preserved through the hardening. The previous preparation of the steel and some other points are described; and particulars of the manner of refrigeration in water (salt), and for securing hardness and great evenness, are also detailed. The process has been applied to steel sheets of 10 inches by 20, obtained quite flat, and as hard as a file throughout, even at the middle parts, which has hitherto been found very difficult—we may say impossible. Magnets, prepared by these means only, differ generally in magnetic power by $\frac{1}{40}$ part, many being absolutely equal. Particulars are then given of the advantage of certain high powers for magnetizing bars, and of an apparatus constructed, weighing 2 cwt., and possessing nearly as great aggregate power as the colossal magnet in possession of the Royal Society, (weighing, we believe, 2 tons.) A method is suggested for verifying the constancy of magneto-meteorologic instruments, by means of the terrestrial magnetism itself, independently of its own variations, or of the comparison of the mutual action of three or more bars.

13. *On the Mode of Developing the Magnetic Condition;* by Dr. Scoresby, (Brit. Assoc., from the Athenæum, Sept. 26, 1846.)—Dr. Scoresby stated that he had, at York, shown a new and superior mode of developing the magnetic condition in properly prepared and hardened steel bars, by interposing a thin plate of soft iron between the operating magnet and the bar of steel to be magnetized. He had, at that time, supposed it to be necessary to extend the thin plate of soft iron the entire length of the bars of steel to be magnetized. But he had since found this to be by no means the case; since by laying any number of unmagnetized bars of steel in a long line, and passing along them a horse-shoe magnet with its poles connected with a thin polished plate of soft iron, (he used common hoop iron,) the ends being slightly bent upwards to cause it to pass more freely over the steel bars, and then turning them over and renewing the process on the other face, he found he could communicate to the bars the full charge which they were competent to receive. The Rev. Doctor exhibited this experiment; and by simply passing a horse-shoe magnet thus armed with an interposed piece of sheet iron, once over each face of twelve previously

unmagnetized bars of steel, he communicated to them so much power that they sustained their own weight, when held up as a chain.

14. *On some Results of the Magnetic Observations made at General Sir T. M. Brisbane's Observatory, Makerstoun;* by J. A. Broun, (Proc. Brit. Assoc., from the Athenæum, Sept. 19.)—1st. *Magnetic Declination.*—The annual diminution of westerly declination at Makerstoun is 5′ 8″. When proportional parts of this have been added to the monthly means, from January, 1844, till August, 1846, their whole range is only 2′ 1″; that is to say, the mean position of the magnetic needle for any month, freed from secular change, has not been about 2′ 1″ farther west than the mean position for any other month. Mr. Broun conceives that he has found the *annual period* of westerly declination to consist of a minimum at the vernal, and of a maximum at the autumnal equinox: the mean range being under 1′ 2″. From the observations for 1843, Mr. Broun has concluded that there is a maximum of westerly declination when the sun and moon are in opposition, and a minimum when they are in conjunction; that there is a maximum of westerly declination when the moon has its greatest north, and also when it has its greatest south declination, minima occurring when it crosses the equator. In the *diurnal period*, the double maximum and minimum have been found to exist in each month of the year. In the 'Transactions of the Royal Society of Edinburgh,' Mr. Broun has given certain results relating to the horizontal and vertical components of the earth's magnetic force; but these results were obtained in scale divisions corrected for temperature by his method. In order to reduce the variations of magnetic dip and of the total magnetic force, from the variations of these components, it was necessary to determine the values of the scale divisions in known units. Mr. Broun had previously shown (Trans. Roy. Soc. Edin., vol. xvi) the inapplicability of the method given by the Committee of Physics for the Royal Society of London for the balance magnetometer. He now described a method by which the value of the micrometer divisions may be satisfactorily determined. This method will be found in the Introduction to the Makerstoun Observations for 1843. He has applied the same method to the bifilar magnetometer, and has found that the value of the scale divisions, obtained in the way recommended by the Committee of Physics, is also inaccurate for this instrument. With the aid of the values obtained by the new method, the following results have been deduced.

2d. *Magnetic Dip.*—The dip is a minimum when the sun and moon are in conjunction, and a maximum when they are in opposition. In the mean diurnal period for the year,

The principal	maximum	occurs at	$10^h\ 10^m$ A. M.
"	minimum	"	5 40 P. M.
A secondary	maximum	"	2 0 A. M.
"	minimum	"	5 40 A. M.

Makerstoun mean time being always used. These periods vary to some extent throughout the year, the principal minimum occurring at 6 A. M. in winter; the two minima being nearly equal to the equinoxes, and the diurnal curve being single in summer. Mr. Broun has found that there is a maximum of dip about four hours and a half before the moon's passage of the superior meridian; a minimum about half an hour after that passage; a secondary minimum about three hours after it; and a secondary maximum about eight hours after it.

3d. *Total Force of the Earth's Magnetism.*—A minimum occurs when the sun and moon are in opposition, equal maxima near the quadratures, and a secondary minimum at the time of conjunction. In the mean diurnal period for the year,

The principal	maximum	occurs at	5^h 40^m P. M.
"	minimum	"	2 10 A. M.
A secondary	maximum	"	7 10 A. M.
"	minimum	"	10 10 A. M.

The periods of maxima and minima shift about two hours in the course of the year, and in summer the principal minimum occurs at 10^h 30^m A. M. The variations of force with reference to the moon's hour angle were found by Mr. Broun as follows:—The principal maximum occurs about two hours after the moon's passage of the inferior meridian; a secondary minimum about four hours before the passage of the superior meridian; a secondary maximum about one hour after the superior passage; and the principal minimum about six hours and a half after that passage. Curves were exhibited illustrating these results, and also the diurnal motion of a magnetic needle freely suspended in the direction of the magnetic force. From the latter some curious results have been deduced, which will be found elsewhere. It will be enough to mention, at present, that in the mean for the year, the motion from 6 A. M. till 6 P. M. is very trifling; between midnight and 6 A. M., the needle is almost stationary, nearly the whole motion occurring between 6 A. M., noon, and 6 P. M. The end of the needle describes an ellipse whose major axis is at right angles to the magnetic meridian; but the direction of this axis varies throughout the year.

15. *Ilmenium*, (Jour. de Pharm. et de Chim., Oct., 1846, p. 304.)—This new metal has lately been discovered in a mineral which was at first mistaken for *yttro-tantalite*, but which M. Hermann (the discoverer) proposes to call *yttro-ilmenite*, because it is found to contain no tantalic or columbic acid, but in its place the oxyd of the new metal. Ilmenic acid partakes very much of the characters of columbic acid, but is distinguished by many peculiarities. Briefly—ilmenic acid has a density much less than columbic acid; it becomes very yellow by ignition; and its hydrate moistened with hydrochloric acid, acquires a blue color by the contact of zinc; it expels by fusion with carbonate of soda a much greater proportion of carbonic acid. From *niobic acid* it is distinguished by the absolute insolubility of its hydrate in concentrated hydrochloric acid, and that it does not color the bead of the blowpipe.

A characteristic reaction of *ilmenic acid* is that a solution of ilmenate of soda with hydrochloric acid, produces with nutgalls or ferrocyanid of potassium, *brown precipitates* much deeper than the hydrate of iron. Neither columbic nor niobic acid gives precipitates of so deep a color. Moreover the atomic number of ilmenium is much less than that of columbium or niobium. If we assume for ilmenic acid two equivalents of oxygen, the atomic number of ilmenium will be 62·4, (753 = Il.)

The *metal* is obtained by igniting the ammoniacal chlorid of ilmenium in an atmosphere of ammonia. It forms a porous mass, or small coherent flakes, with a soot-black color, like the carbon from burnt sugar. It does not decompose water; and is unattacked by strong nitric or hydrochloric acids, and even by aqua-regia. Heated in air it takes fire and burns, leaving white ilmenic acid. The specific gravity of this acid is 4·10 to 4·20. Its sulphates, chlorid, and several of its salts have been studied and described by M. Hermann.

[M. Hermann's researches on columbium, niobium, and the new metal ilmenium, seem to warrant the conclusion that the formula RO_2 is the proper expression for the oxyds or acids of a large class of metals, which are usually placed in distinct groups. Thus we may put together uranium, molybdenum, tungsten, titanium, tin, columbium (tantalum,) niobium, pelopium, and ilmenium. Farther study is required before we can determine the order in which these should be grouped among themselves. But titanium, tungsten, molybdenum, niobium and ilmenium are assimilated by the fact that their acids all produce a blue color with zinc and hydrochloric acid, which Dr. Wollaston described as characteristic of columbium. The mineral from which this chemist obtained his supposed columbic acid, was from Haddam, the variety which Rose has shown to be quite rich in niobic acid. Wollaston undoubtedly obtained the niobic acid in his trials, since the pure columbic acid has not this reaction.]

II. Mineralogy and Geology.

1. *Crystallized Carbonate of Lead, at Rossie, New York;* by G. Hadley, (communicated for this Journal.)—Small crystals, an eighth of an inch or less in length, are occasionally sprinkled thickly over the surface of the galena of Rossie, which, when this is the case, is deeply roughened or corroded. The crystals are striated prisms, terminating in four brilliant planes, two of which meet on an angle of 117° nearly, and the other two at an angle of 88°. The crystallization, as well as the blowpipe characters afterwards obtained, evince that the mineral is carbonate of lead. My attention was drawn to these crystals by Mr. O. Root.

2. *On Coracite, a new ore of Uranium*; by John L. LeConte, M. D., (from an article communicated for this Journal, which will appear in our next number.)—This mineral is from the north shore of Lake Superior, where it occurs in a vein two inches wide, near the junction of trap and syenite. It is allied to Pitchblend, from which it appears (from a quantitative analysis) to differ in the substitution of alumina for the sesquioxyd of uranium. It occurs massive without cleavage, and has a resinous lustre, an uneven conchoidal fracture, and a gray streak. H=4·5, G=4·378.

3. *Plumbo-resinite and Cupreous Sulphato-carbonate of Lead in Missouri;* by J. L. LeConte, M. D., (communicated for this Journal.) —Thin incrustations of plumbo-resinite occur on some of the specimens of the Missouri black cobalt. It has a pearly lustre, and sometimes appears metallic over the botryoidal cobalt ore, but is almost transparent when scaled off.

Among specimens from the Mine La Motte, I have detected a green mineral, varying in color from pale apple green to dark verdigris green, and having a radiated structure consisting of acicular crystals loosely aggregated. I have not yet seen perfect crystals, but from some trials have determined it to be the rare cupreous sulphato-carbonate of lead. It occurs with the oxyd of cobalt.

4. *On the Mississippi Delta;* by C. Lyell, (in a letter to the editors.)*—In a previous letter, I mentioned to you that the report of my discourse on the delta of the Mississippi, which appeared in the Athenæum Journal, Sept. 26th, 1846, although corrected by me, was no more than a brief and imperfect abstract of the Lecture which I delivered to the British Association at Southampton. It failed to embrace even the heads of many of the arguments and data, which I adduced, and as I find that it has not been so understood by all, I am desirous of supplying one or two of the most obvious omissions. In my conjectural estimate of the probable thickness of the alluvial deposit, I alluded not only to the ascertained depth of the Gulf of Mexico, between the southern point of Florida and the Balize, but also to some borings, 600 feet deep, made to the northward of New Orleans, near Lake Pontchartrain, in which the engineers say they failed to reach the bottom of the Mississippi mud. In regard to the depth of the alluvium, above the head of the delta, I remarked in my lecture, that the river, in its wanderings over the alluvial plain, had every where cut out deep channels from 60 to 250 feet deep, and that the excavations thus made had been filled again, with the exception of certain bayous and crescent-shaped lakes, which remain as monuments of some of the former positions occupied by the shifting stream. Even these lakes are by no means as deep as the ordinary channel of the river, and this kind of denudation must, I conceive, have given a considerable capacity to almost every part of the large basin, or receptacle of sediment, even if we suppose it to have been originally very shallow, which I know no reason for presuming.

I have lately received a letter from Dr. Carpenter of New Orleans, from which I am happy to learn that my friend, Dr. Riddell, is repeating his experiments on the quantity of earthy matter held in suspension in the waters of the Mississippi. It appears from the observations already made, that after duly allowing for the greater clearness of the stream when at its lowest level, the annual mean quantity of solid matter will be less than was before inferred. If, as is now anticipated, the mean should prove as low as $\frac{1}{1700}$ in weight, instead of $\frac{1}{1245}$, this diminution of nearly a fourth in the quantity of sediment brought down, will require us to lengthen proportionably the period, or minimum of time, which the Mississippi has taken to accumulate its alluvial formations. The new result will still differ remarkably from that obtained by Mr. Horner, in his measurement of the quantity of earthy matter in the Rhine at Bonn, which in volume was $\frac{1}{16000}$;† but it contrasts still more strikingly in an opposite way, from the conclusions of Mr. Everest, in regard to the Ganges, where the proportion of solid matter, during seven months of the year, (a period in which nearly the total annual discharge of water takes place,) was found to be $\frac{1}{428}$ in weight, or $\frac{1}{856}$ in bulk.‡ But in this case, we have to bear in mind not only the great height of the Himalaya Mountains, but also how much nearer the

* Dated London, Nov 6. 1846, and intended as an addition to the article on p. 34.
† Edin. New Phil Jour., Jan., 1835.
‡ Jour. of Asiatic Soc., No. 6, p. 238, June, 1832. See also Mr. Prinsep, Gleanings in Science, Vol. iii, p. 185. Also Principles of Geology, Book II.

course of the Ganges lies to the Equator than the Mississippi, and consequently the enormous quantity of rain which falls in the hydrographical basin of the Indian river. We must also attend not only to the number of inches which descend annually, but also to the extraordinary quantity which sometimes pours down in a single day in Bengal. If some of your numerous correspondents would ascertain the annual amount of rain in different parts of the valley of the Mississippi and its tributaries, and would publish the same in your Journal, together with all the facts hitherto known on the subject, they would render an acceptable service, not merely to the meteorologist.

5. *On the Origin of the Coal of Silesia*, (Proc. Brit. Assoc., from the Athenæum, Sept. 19, 1846.)—Prof. Göppert, in his elaborate essay, endeavored to show from the number and condition of the coal fossils, and the character of the strata, that the material was tranquilly deposited; and that a large part of the coal was accumulated after the manner of peat. He has ascertained that by keeping vegetables in boiling water for three months or a year, they are converted into brown coal, and with sulphate of iron, a salt which occurs commonly in coal, it acquires at last a totally black coal-like condition. Sir R. I. Murchison expressed his readiness to receive this explanation for the origin of many coal strata; but there were other large coal fields to which the explanation would not apply at all—the materials having certainly been drifted to a distance by currents of water.

6. *Remarks on the St. Louis Limestone;* by G. Engelmann, M. D., (communicated for this Journal.)—The St. Louis limestone underlies the western edge of the great Illinois coal field. It is a very hard, light yellowish or grayish rock, mostly pure carbonate of lime, in some strata mixed with sand, in others including irregular siliceous masses of a dark color, or light colored thin siliceous strata. The limestone is perfectly compact and fine-grained in some strata, so as to furnish tolerably good lithographic stones; in other strata it is coarser and even completely crystalline. Its stratification is nearly horizontal, having in this neighborhood a slight inclination to the north or northeast. Its whole thickness may be between two and three hundred feet. The coal-bearing strata overlie it; below, directly upon the limestone, we have a sandy, and above an unctuous clay or shale, the whole about forty feet thick. On this shale rests a coal bed of three to five feet, the only workable one in this neighborhood, covered by a thin stratum of clay, which itself is overlaid by ten or fifteen feet of a blue or brown limestone, the uppermost palæozoic stratum in our region. The clay near our coal stratum is nearly destitute of vegetable fossils.

The St. Louis limestone forms the uppermost bed of the carboniferous or mountain limestone on the Mississippi. It is divided from the lower beds by a sandstone formation and another thin seam of coal, which here at least is quite thin. This sandstone is soft, friable, light yellowish, without mica; it forms thick banks, and may be seen in perpendicular cliffs forty-five to fifty miles below St. Louis, near Prairie du Rocher in Illinois, where its strata show a southerly dip. In its upper part, or rather between it and the St. Louis limestone, occurs the lowest bed of coal. It may be seen in Prairie du Long, 40 miles southeast of St. Louis, in Illinois, where a small stream, the Richland creek, which higher up, near Belleville, has denuded the workable upper coal bed and the overlying limestone, exposes after cutting through the St. Louis limestone, this seam of one to two feet thickness; it then enters the sandstone, which here is not as thick as at Prairie du Rocher, and at last exposes the lower carboniferous limestone strata with their peculiar fossils. This sandstone may have a thickness of from fifty to a hundred feet. It rests on the lower limestone formation, which is of much greater thickness than the upper one and is probably near a thousand feet thick, at least where the Mississippi cuts through it from twenty to sixty miles below St. Louis. This lower carboniferous limestone is mostly of a gray color, often bituminous, and mostly crystalline in texture. In some strata it is more or less oolitic, and the large banks of the beautiful white oolite near St. Geneviève, which is worked there and is frequently sent down the river, are in the lower part of this formation. Only the lower carboniferous limestone contains the beautiful pentremites so common in that part of Illinois, and the Archimedes found there and on the lower Ohio. The pentremital limestone of Dr. Owen is therefore the lower part of the carboniferous limestone of eastern Missouri and southern Illinois, and our St. Louis limestone is its upper part.

Dr. H. King, who has seen this formation in the southwestern parts of Missouri, thinks that on the Osage river, this lower limestone formation dwindles very much; but that the sandstone and coal stratum above it is much more developed, and that the fine coal mines worked there, sometimes not far above and distinct from the lead-bearing magnesian strata, are in this same lowest coal bed.

7. *Cause of the absence of Ancient Marine Formations from certain regions;* by Charles Darwin, (Geological Observations on South America, p. 136.)—Can any light be thrown on this remarkable absence of recent conchiferous deposits on these coasts, on which, at an ancient tertiary epoch, strata abounding with organic remains were extensively accumulated? I think there can, namely, by considering the conditions necessary for the preservation of a formation to a distant age. Looking to the enormous amount of denudation which on all sides of us has been effected,—as evidenced by the lofty cliffs cutting off, on so many coasts, horizontal and once far extended strata of no great antiquity (as in the case of Patagonia),—as evinced by the level surface of the ground on both sides of great faults and dislocations, by inland lines of escarpments, by outliers, and numberless other facts, and by that argument of high generality advanced by Mr. Lyell, namely, that every *sedimentary* formation, whatever its thickness may be, and over however many hundred square miles it may extend, is the result and the measure of an equal amount of wear and tear of preëxisting formations; considering these facts, we must conclude that, as an ordinary rule, a formation to resist such vast destroying powers, and to last to a distant epoch, must be of wide extent, and either in itself, or together with superincumbent strata, be of great thickness. In this discussion, we are considering only formations containing the remains of marine animals, which, as before mentioned, live, with some exceptions, within (most of them much within) depths of a hundred fathoms. How, then, can a thick and widely extended formation be accumulated, which shall include such organic remains? First, let us take the case of the bed of the sea long remaining at a stationary level: under these circumstances, it is evident that *conchiferous* strata can accumulate only to the same thickness with the depth at

which the shells can live; on gently inclined coasts alone can they accumulate to any considerable width; and from the want of superincumbent pressure, it is probable that the sedimentary matter will seldom be much consolidated : such formations have no very good chance, when in the course of time they are upraised, of long resisting the powers of denudation. The chance will be less if the submarine surface, instead of having remained stationary, shall have gone on slowly rising during the deposition of the strata, for in this case their total thickness must be less, and each part, before being consolidated or thickly covered up by superincumbent matter, will have had successively to pass through the ordeal of the beach; and on most coasts, the waves on the beach tend to wear down and disperse every object exposed to their action. Now, both on the south-eastern and western shores of South America, we have had clear proofs that the land has been slowly rising, and in the long lines of lofty cliffs, we have seen that the tendency of the sea is almost every where to eat into the land. Considering these facts, it ceases, I think, to be surprising, that extensive recent conchiferous deposits are entirely absent on the southern and western shores of America.

Let us take the one remaining case, of the bed of the sea slowly subsiding during a length of time, whilst sediment has gone on being deposited. It is evident that strata might thus accumulate to any thickness, each stratum being deposited in shallow water, and consequently abounding with those shells which cannot live at great depths: the pressure, also, I may observe, of each fresh bed would aid in consolidating all the lower ones. Even on a rather steep coast, though such must ever be unfavorable to widely extended deposits, the formations would always tend to increase in breadth from the water encroaching on the land. Hence we may admit that periods of slow subsidence will commonly be most favorable to the accumulation of *conchiferous* deposits, of sufficient thickness, extension, and hardness, to resist the average powers of denudation.

III. Botany and Zoology.

1. *Hillocks of Bolax glebaria, of the Falkland Islands*, (extract from J. D. Hooker's Flora Antarctica.)—" Long before the Falkland Islands were colonized from Britain, the present plant had excited considerable curiosity by the very remarkable mode of growth it there assumes, and its forming a feature in the landscape that strikes the most casual observer. Now that these islands have been annexed formally to the British dominions, the *Bolax* or *Balsam-bog*, is a production of still greater general interest. In whatever portion of this country the voyager may land, he cannot proceed far along the beach without entering groves of Tussac, whose leaves often wave over his head; nor turn his steps inland, without seeing, scattered over the ground, huge, perfectly hemispherical hillocks of a pale and dirty yellow green color, and uniform surface, so hard that one may break the knuckles on them. If the day be warm, a faint aromatic smell is perceived in their neighborhood, and drops or tears of a viscid white gum flow from various parts of these vegetable hillocks. They stand apart from one another, varying from two to four feet in height, and though often hemispherical, are at times much broader than high, and even eight or ten feet long.

"The very old ones begin to decay near the ground, where a crumbling away commences all around, and having but a narrow attachment, they resemble immense balls or spheres laid upon the earth. Upon close examination, each mass is found to be herbaceous throughout, the outer coat formed of innumerable little shoots rising to the same height, covered with imbricating leaves, and so densely packed that it is even difficult to cut out a portion with a knife, while the surface is of such uniformity that lichens sometimes spread over it, and other plants vegetate on its surface, in the occasional holes or decayed places. If at a very early period, a young plant of the *Bolax* be removed and examined, the origin of these great balls may be traced; for each of them, of whatever size, is the product of a single seed, and the result of many, perhaps of hundreds of years' growth. In a young state, the plant consists of a very long slender perpendicular root, like a whip lash, that penetrates the soil. At its summit are borne two or three small branching stems, each densely covered for its whole length with sheathing leaves. As the individual increases in size, the branches divide more and more, radiating regularly from the rooting centre, instead of prolonging rapidly; these send out lateral short shoots from their apices and in such numbers that the mass is rendered very dense, and by the time the plant has gained the diameter of a foot, it is quite smooth and convex on the surface. The solitary root has become evidently insufficient for the wants of the mass of individuals, which are nourished by fibrous radicles, proceeding from below the leaves, and deriving nutriment from the quantity of vegetable matter which the decayed foliage of the lower part of the stems and older branches affords."—p. 286.

2. *On the Vertebrate Structure of the Skull;* by Prof. OWEN, (Brit. Assoc., from the Athen., Sept. 26, 1846.)—Prof. Owen commenced by referring to his previous definition of a typical vertebra, or primary segment of the endo-skeleton (Ath. No. 986, p. 969). He considered that the bones of the skull consisted of a series of four such segments;—but before entering into the details on which his conclusions were founded, he reviewed the previous classifications of the cranial bones from the early anthropotomical one into those of the *cranium* proper and those of the *face*, to the latest classification by M. Agassiz, based upon the embryological researches of Dr. Vogt. With regard to the division into bones of the cranium and those of the face, he observed that this having been originally founded upon the exclusive study of the most extremely modified skull in the whole vertebrate series,—that of man, the characters of such primary divisions were artificial, and applicable to the same bones in only a small proportion of vertebrata. Thus the facial series in fishes includes an extensive system of bones—the lugoid—of which part only, viz., the "styloid" element, is admitted into the skull by the anthropotomist, who describes it as a process of the temporal bone;—his "temporal" bone being, as Prof. Owen showed in his previous communication [Ath. p. 988], originally and essentially an assemblage of bones, which are always distinct in fishes and reptiles, and all of which appertain to distinct natural systems of groups of bones, though so strangely blended for a special object into one osseous mass in the human subject. The petrous process (petrosal) is the spinal capsule of the acoustic organ; the mastoid

process is the transverse process (parapophysis) of the parietal vertebra: the styloid process is the proximal piece (pleurapophysis) of the hyoid arch; the tympanic or external auditory process is the modified proximal element of the mandibular arch; the squamous process (squamosal) is a diverging appendage of the maxillary arch. Amongst the bones of the head might be recognized in most vertebrate animals some belonging to the system of the splanchno-skeleton, and some to the dermo-skeleton; those of the endo-skeleton constituting the chief and most important part of the skull, Prof. Owen believed, with Ohm and Bajanus, to be naturally arranged in a series of segments, each consisting of an upper (neural) and a lower (hœmal) arch, with a common centre, and usually with diverging appendages. The bones entering into the composition of each segment had, in fact, the same relative position, and were similar in number with those of the typical vertebræ of the trunk—the excess in number arising from subdivision of peripheral elements; he should, therefore, continue to apply the name vertebra to these segments. Homologists differed as to the number of cranial vertebræ; and the skull might differ, like the neck, the back, and other regions, in different animals, as to the number of its vertebral segments, but Prof. Owen had not seen good evidence of a greater or less number than four, in which he agreed with Bajanus. He enumerated these segments in a direction contrary to those of the trunk, because, like the vertebræ of the tail, they lose their typical character as they recede from the trunk: the chief condition of these terminal modifications being the circumstance of the contained nervous axis shrinking and receding centripetally at both its ends. He retained for the cranial vertebræ the names applied to them, in conformity with those given by the anthropotomist to their neural spines, viz., *occipital*, *parietal*, *montal*, *nasal;* the upper or neural arches of each he termed, respectively, *epencephalic*, *mesencephalic*, *prosencephalic*, and *rhinencephalic*; the lower or hæmal arches were the *scapular*, the *hyoidean* the *mandibular*, the *maxillary;* the diverging appendages of these hæmal arches are, respectively, the *pectoral*, the *branchiostegal*, the *opercular* and the *pterygoid;* the maxillary arch likewise supporting, in higher vertebrata, a *zygomatic* appendage, for its more complete fixation. The special homology of the pectoral fins of fishes with the fore-limbs of quadrupeds was indicated by Aristotle, and first definitely pointed out, in later times, by Artedi. Geoffroy St. Hilaire had devoted special memoirs to the determination of the bones of the pectoral fins; but had no knowledge of the primary homology of the pectoral fin as the radiated appendage of the inferior arch of a cranial vertebra, or of its serial homology with the branchiostegal and opercular fins. He consequently spoke of the junction of the scapular arch to the cranium as something very strange. Ohm's latest published idea of the essential nature of the arms and legs is, that they are no other than "liberated ribs." Carus, in his ingenious endeavours to gain a view of the primary homologies of the locomotive members, sees in their several joints repetitions of vertebral bodies—vertebræ of the third degree. But Prof. Owen remarked, that such transcendental analyses sublimated all differences, and definite knowledge escaped through the unwarrantable extension of the meaning of terms. He recognized a vertebra as a natural group of bones forming a primary segment of the skeleton ; in each segment he also recognized a centrum, a neural arch, a hæmal arch, with sometimes diverging appendages: each of these were parts of a vertebra, and each different parts ; to call them all "vertebræ" was to abdicate the powers of appreciating and expressing their differential and subordinate characters. With regard to the term "rib," though it might be given to each moiety of the hæmal arch of a vertebra, Prof. Owen would restrict it to that part of such arch to which the term "vertebral rib" is commonly applied; but, admitting the wider application, yet the bony diverging and backward projecting appendage of such rib or arch was a different thing from the part supporting it. Arms and legs might be developments of costal appendages, but were not the ribs themselves liberated,—although liberated ribs might perform analogous functions, as in the serpents and draco volans.

3. *Remarks on the Melonites multipora;* by G. Engelmann, M. D., (communicated for this Journal.)—On a single slab of limestone about four square feet in size, in the possession of the Western Academy of Natural Science of St. Louis, there are fifteen specimens of the Melonites, described in the last number of the American Journal of Science. The slab was presented to the Academy by Dr. B. B. Brown in the year 1841. Dr. B., undoubtedly the first scientific gentleman who saw this fossil, found the slab with several others similar on a heap of building stones. Other specimens were presented by him to the Academy of Natural Science of Philadelphia, to Mr. J. Hall of New York, and others. He could not ascertain the precise locality where these stones were obtained, but is under the impression that they came from one of the quarries near the river bank. I have for years examined all the quarries in and about St. Louis, without meeting with even a trace of this fossil, except in some situated northwest of the town, more than a hundred feet above the Mississippi, where single scutellæ, which it is impossible not to recognize, are common in some strata, together with corallines, joints of encrinital stems, a few shells, and spines very similar to those of a true Echinus.

The specimens of Melonites before me are all flattened, but present different views, either one side or an upper or lower end, so that it is not difficult to reconstruct the animal. It would appear that it was not completely spheroidal or ovoid, but rather somewhat of the shape of the Pentremites; thicker at the lower than at the upper end, but suddenly somewhat contracted. I can well distinguish the two ends. What I take to be the lower end, shows both kinds of areæ of equal width, and the different plates are so closely connected that they cannot be any longer distinguished. At the upper end the *areæ majores* run out quite narrow, and the *areæ ambulacrorum* are wider; the plates are all small there, and in many specimens distinctly separated. I could see nothing of the oral or anal openings, except the deep impression at both ends of the animal.

The *areæ majores* are composed of five to seven or rarely eight rows of mostly hexagonal, more or less regular plates, those in the middle being transversely elongated. The *areæ ambulacrorum* are not much narrower than the others, and as I have already said, become even wider than them near the upper end. They have, as Drs. Norwood and Owen have correctly remarked, two vertical rows of larger hexagonal plates in the middle, which constitute a prominent vertical ridge, on the summit of which they interlock, forming a serrated suture. The other plates of the *areæ ambulacrorum* are much smaller, of more irregular shape and disposition, but always, like all the other plates, are more or less *hexagonal*. *All the plates* of the *areæ ambulacrorum* are pierced by two holes, side by side, and *all* of them—not only those of the two larger central rows—very decidedly near the *outer* angle, or that angle farthest from the central ridge. These holes are placed irregularly; and generally I can only distinguish an inner vertical row of double pores, (those of the larger central plates,) and an outer one, next to the *areæ majores;* all the other pairs of pores are distributed more irregularly over the surface, and it is with difficulty that I can make out something like four or five rows on each side of the middle ridge, which dwindle down to two or three rows towards the ends.

The specimens are from three to five inches in vertical diameter, and very little less in the transverse. No trace of a stem has been found near them.*

4. *Hippopotamus at Sierra Leone.*—T. P. Thompson, Esq., in a letter to J. E. Gray, Esq., mentions the existence of a small Hippopotamus at Sierra Leone, which, as Mr. Gray states, is a fact of peculiar interest, since a new species from Liberia, of corresponding size, has been described by Dr. S. G. Morton. (See Proc. Acad. Nat. Sci. Phil., Feb., 1844, and this Journal, xlvii, 406.)

5. *Tracks of Alligators;* (Proc. Acad. Nat. Sci. Philad.)—Dr. Dickeson exhibited to the Academy at Philadelphia, at a meeting in October last, impressions of the feet of living alligators on clay, which resembled closely in form the so-called bird tracks.

6. *Wings of Locustæ;* (Proc. Acad. Nat. Sci. Phil., iii, No. 5.)—From the microscopic examinations of J. Leidy, it is shown that the wings of locusts, (which when at rest are folded up like a fan,) are closed by spiral ligaments, one of which winds around each of the transverse veins. They act by their own physical properties alone, on the relaxation of the muscles which open the wing.

7. *Harlanus, a new genus of fossil Pachyderms;* (Proc. Acad. Nat. Sci. Philad. Aug. 1846.)—Richard Owen, Esq., has instituted the genus Harlanus for the species called *Sus americanus* by Harlan. It is described as approaching most nearly the tapiroid Pachyderms. The species is named by Mr. Owen, Harlanus americanus.

IV. Astronomy.

1. *Observations on Shooting Stars, August* 10, 1846.—During the nights of August 8–9th and 9–10th, 1846, the sky at this place was overcast. The sky remained cloudy on the evening of the 10th, but nevertheless, the observers (Messrs. L. W. Hart, J. H. Lane, W. Manl. Smith, and myself) sat up, in the hope of more favorable weather during the night. Not long before midnight the clouds passed off. Taking our station in the open air, we watched from 0^h A. M. to 2^h A. M. of the 11th, and observed shooting stars as follows:—

	N. E.	S. E.	S. W.	N. W.	
Aug. 11, 0^h A. M.—1 A. M.	5	1	2	6	=14
" 1 A. M.—2 A. M.	9	9	9	5	=32

* An account of the St. Louis rocks, by Dr. Engelmann, will be found on p. 120.

The encouragement for further observation seemed so small, and the presence of the moon was so embarrassing, that we retired at the end of the second hour.

The evening of the 11th was beautifully clear. Mr. Francis Bradley and myself observed from 9^h to 10^h P. M., and saw in the hour *forty-one* different shooting stars, viz. 18 in the N. W. and 23 in the S. E. The moon did not rise until about half an hour after nine, and of course interfered but little. Many of these meteors were brilliant, and in their direction and general character were similar to those heretofore observed at this period. It is perhaps worthy of mention, that the Aurora Borealis (which had not been seen here with certainty since the 14th of June previous,) was visible on the evenings of the 11th and 12th. These displays were slight; the streamers few in number, not reaching an altitude of more than 4°.

The observations of the morning of the 11th, (even supposing that the moon-light obscured half of the meteors,) appear to indicate but a slight recurrence of the exhibition usual at this period. The results of the evening of the 11th seem however to justify the inference that the display did not fail this year; and perhaps, in favorable circumstances, we might have seen the meteors nearly as abundant as on former anniversaries.

In regard to the November meteoric period, it may be stated that the clouds here permitted no observation on the mornings of the 12th, 13th, or 14th, in 1846. A faint Aurora Borealis was seen here during the evening of the 11th of that month. A writer in the *Albany Evening Journal* states that on the morning of November 20, meteors were unusually numerous. A communication signed B., in "*The News*" of Jacksonville, Florida, (of Nov. 13, 1846,) alleges that on the morning of Oct. 20th, 1846, numerous shooting stars were seen and explosions heard. As no numbers are given in either case, it is not easy to decide how remarkable these displays really were. E. C. H.

New Haven, Conn.

2. *Ancient returns of Halley's Comet.*—In a paper read May 8, 1843, to the French Academy of Sciences, (*Comptes Rendus*, xvi, 1003,) M. Laugier announced that among the notices of comets, extracted by M. Edouard Biot, from Chinese historians, (and communicated to the *Bureau des Longitudes*,) were observations in 1456, and also in 1378, of a body which was undoubtedly the comet of Halley.

Laugier gives the following elements for 1378, which very well represent the Chinese observations.

Perihelion passage, A. D. 1378, Nov. 8·77.		
" distance,	0·5835.	
Inclination,	17° 56′.	
Longitude of ascending node,	47 17	Equin. of 1378.
" " perihelion,	299 31	Equin. of 1378.
Motion,	Retrograde.	

He adds the following table of the comet's revolutions.

1378 to 1456	-	-	77·58 years.
1456 " 1531	-	-	75·21 "
1531 " 1607	-	-	76·15 "
1607 " 1682	-	-	74·91 "
1682 " 1759	-	-	76·49 "
1759 " 1835	-	-	76·68 "

In a communication made July 27, 1846, (*Com. Ren.*, xxiii, 183,) Laugier announces as a result of further investigations among Biot's extracts, the discovery of three earlier returns of this comet, viz: (1.) A. D. 1152, perihelion passage, Sept. 23, giving to 1378, three revolutions of 75·3 years. (2.) A. D. 760, per. pas. June 11, giving to 1378, eight revolutions of 77·25 years. (3.) A. D. 451, per. pas. July 3·5, giving to 1378, twelve revolutions of 77·25 years. In addition to the usually recognized perturbing causes, which may have operated in producing this change of period, he suggests the possible diminution of the comet. On the supposition that this body has lost, in certain given conditions, as much as the 23000th part of its mass, a quantity not very extraordinary, Bessel found that the period of revolution would be diminished 1107 days.

3. *Prof. Peirce's Catalogue of Comets.*—The American Almanac for 1847, (Boston, pp. 352, 12mo,—the 18th No. of a series well known as furnishing, together with much other important matter, the most reliable statistics of our country,) comprises a very valuable catalogue, by Prof. Peirce of Harvard University, of the comets whose orbits have been computed. The catalogue by Rev. Mr. Hussey, intended to include every comet, whether the elements of its orbit were known or unknown, (*Lond. and Edin. Phil. Mag.*, vols. ii, iv, vii,) appears not to have been continued later than the year 1744. The catalogue by Olbers and Schumacher, (republished from Schumacher's *Astronomische Abhandlungen*, in the *Quar. Jour. Sci. Lit. and Arts of Roy. Inst.*, Lond. vols. 16, 17, 20,) ended with May, 1825. Since that time, the investigations of astronomers have determined the elements of several comets previously observed, and have made more exact the elements of others already enrolled. To collect and arrange these, adding all those discovered up to the present time, was a work much needed, and Prof. Peirce has rendered an important service to astronomy, by executing the task.

His catalogue comprises I, a *chronological arrangement* of the elements; the longitudes of the ascending node and the perihelion being referred to the mean equinox of Jan. 1, 1850; and II, a *systematic arrangement*, in which the elements are grouped in twelve tables, with reference to the longitude of the ascending node. Each table has four subdivisions (none comprising more than eleven comets) in each of which "are given all those orbits which properly belong to it, and also those which have, or may have, any resemblance to them; so that in order to compare a new orbit with the old ones, it is only necessary to inspect that subdivision to which the new orbit would properly belong; that is, to look into that table which has the same name as the sign of the ascending node of the new orbit, and into the first, second, third or fourth subdivision of the table as the inclination may be in the first, second, third or fourth octant." This plan of classification greatly abridges the labor of determining whether any newly-discovered comet is identical with any of those already known.

Prof. Peirce's catalogue contains five comets whose elements have not been hitherto published, but are by himself computed from ancient observations, with such precision as they may warrant, viz: B. C. 137, 69, 12, and A. D. 1366 and 1491. The following orbits (most of them recently published,) are not found in the catalogue, and are perhaps worthy of a place therein, although they are confessedly somewhat uncertain, on account of the looseness of the observations upon which they are founded.

The longitudes of the perihelion and node are not reduced to 1850, but belong to the mean equinox of their respective years.

Date of Perih. pas. Gr. m. t.	Long. asc. node.	Long. perih.	Incl.	Perih. dist.	Motion.	Computer and time.	
A. D. 770. June 6·6.	89°	2°	60°	0·603	R.	Hind.	Dec. 1845.
962. Dec. 30·16.	350 35′	268 3′	79 33′	0·5518	R.	Hind.	Jan. 1846.
H. 1378. Nov. 8·76.	47 17	299 31	17 56	0·5835	R.	Laugier.	May 1843.
1468. Oct. 7·41.	61 15	356 3	44 19	0·85328	R.	Laugier.	Jan. 1846.
* 1490. Dec. 24·47.	288 45	58 40	51 37	0·7376	D.	Hind.	Jan. 1846.
1506. Sept. 3·662.	132 50	250 37	45 1	0·38598	R.	Laugier.	Jan. 1846.
1668. Feb. 28·8.	357 17	277 2	35 58	0·004786	R.	Henderson.	Apr. 1843.

Prof. Peirce's catalogue contains 174 comets, reckoning that of April, 1556, as identical with that of July, 1264, and that of Aug. 13, 1770, as identical with that of October, 1585; and omitting in the enumeration the three comets which have returned agreeable to computation, viz: those of Halley, Encke and Biela. If we add these four, (the latter having become double,) and also include five of those above given, and that of May 14, 1846, (discovered too recently for insertion,) we have, down to the middle of 1846, 184 different comets whose elements are determined with more or less certainty. The whole number of which we have any record is about 600.

4. *Le Verrier's Planet.*—In our last number (vol. ii, p. 439) was announced the discovery of the planet beyond Uranus, in accordance with the predictions of Le Verrier. This discovery must be considered one of the most remarkable recorded in the annals of science, and elevates Le Verrier to the first rank among astronomers. Of its history, we have room at present only for the following brief sketch.

Omitting to cite various notices which indicate that for several years past there has been among astronomers a growing suspicion of the existence of some unknown body in our system, by which the motions of Uranus is disturbed, we may quote the following as one evidence.

In the Comptes Rendus Acad. Sci., (Session Sept. 1, 1845,) xxi, 524, is an extract from the preface to *New Tables of Uranus*, by Eugene Bouvard, communicated to the Academy, in which, after speaking of the impractibility of reconciling, by any existing theory, the computed and the observed places of this planet, he adds: "the discordances between the observations and the theory induce me to believe that there is much probability in the idea proposed by my uncle, (Alexis Bouvard, whose tables of Uranus, &c., were printed in 1821,) as to the existence of another planet, disturbing Uranus. This opinion, moreover, is further strengthened by the analogy which appears in the periodicity of these discordances, and those which Saturn would present if we should suppose Uranus unknown."

At the session of Nov. 10, 1845, (Comp. Ren., xxi, 1050,) Mons. U. J. Le Verrier presented his *First Memoir on the Theory of Uranus.* Having alluded to the discrepancies between the observed and computed places, he says, "in the course of the last year, M. Arago represented to me that the importance of this question made it the duty of every astronomer to do his best to clear it up. I abandoned at once, in order to investigate Uranus, the researches on comets which I had undertaken, and of which several portions have already been communicated. Such is the

* This may be the same as Prof. Peirce's No. 28; yet the orbits differ widely.

origin of the work which I have the honor to day to present to the Academy." He proceeds to state in general his investigations of all the known perturbing causes operating on Uranus, and his determination of the actual amount of departure of Uranus from the places assigned by the theory.

In his second communication to the Academy, (at the session of June 1, 1846,) Le Verrier presents a history of the observations upon Uranus, and of the mode in which the tables of its motions have been constructed, and the errors which they involve; and a sketch of various hypotheses proposed to account for the inequalities of the motions of the planet. Having set these aside, he asks—*Is the other hypothesis of the existence of an unknown planet disturbing Uranus, more plausible?* After showing where this new planet cannot be situated, he arrives at this question—"Is it possible that the inequalities of Uranus are due to the action of a planet situated in the Ecliptic, at a mean distance double that of Uranus? And if so, where is this planet actually situated? What are the elements of the orbit which it traverses?" As one result of a rigorous discussion of this question, he gives, as a first approximation, this momentous conclusion, *that in assigning to the planet a heliocentric longitude of* 325° *for Jan.* 1, 1847, *there cannot be an error of* 10°. This assigned place he then promises to bring within narrower limits, by new computations. In recapitulating the labors required by his undertaking, he adds—"The existence of a planet hitherto unknown being thus established beyond a doubt, I have reversed the problem hitherto proposed in computing perturbations. Instead of measuring the action of a given planet, I have been obliged to set out from the inequalities observed in Uranus, in order to deduce the elements of the disturbing body, to give the place of this planet in the heavens, and to show that its action perfectly accounts for all the apparent inequalities of Uranus."

This remarkable prediction of the position of a planet hitherto entirely unknown, uttered with calm confidence by the mathematician in his closet, seems to have been received with faint faith even by the astronomical observers of Paris. For it is evident that the observer furnished with a good map of that region of the Ecliptic, which might have been made in a few hours from star-catalogues, would have quickly detected a bright star not laid down. With a large telescope and a high power, this stranger would have presented a plain disc, and would thus have instantly disclosed its true character. Or if, with a smaller instrument, its place had been carefully measured, the observation of the next morning would have shown its proper motion.

On the 31st of August, 1846, Le Verrier, with implicit reliance on the truth of his computation, presents to the Academy, a memoir "On the planet which causes the anomalies in the movement of Uranus," *with a determination of its mass, its orbit and its actual position*, (Comp. Ren., xxiii, 428.) In this paper he gives the elements at which he had arrived, as follows:

Semi-axis major of the orbit,	36·154
Period of sidereal revolution,	217yrs·387
Excentricity,	0·10761
Long. of perihelion,	284° 45′ M. Eqx. 1847·0
Mean long. Jan. 1, 1847,	318 47
Mass,	$\frac{1}{9300}$

From which he derives the following position of the planet, Jan. 1, 1847.

True heliocentric longitude,	326° 32′
Distance from the Sun,	33·06,

and remarks that the planet was in opposition August 19th previous, and that the present was a favorable time to discover the body.

The semi-axis major might vary from 35·04 to 37·90, and the period from 207 to 233 sidereal years. The brilliancy of the planet ought to be about one third that of Uranus at its mean distance, and its angular diameter at opposition 3″·3.

The action of the new planet, with elements as above determined, reconciles with theory, within very narrow limits, the observations of Uranus, both modern and ancient.

Even this memoir seems not to have overcome the incredulity or the indifference of astronomical observers, for it appears hardly possible that search could then have been made in the place pointed out by Le Verrier, without immediate success.

On the 5th of October, (Comp. Ren., xxiii, 657,) Le Verrier presented the fifth and last part of his researches, in which he gives his reasons for concluding that the plane of the orbit of the new planet is inclined at least 4° 38′ to the plane of the orbit of Uranus. In a postscript, he adds, that on the 18th of September, he addressed a letter to M. Galle of Berlin, asking his aid in discovering the planet, and that this astronomer discovered the body on the very day on which the letter reached him. Its observed place Sept. 23, $12^h\ 0^m\ 14^s$, Berlin m. t., was R. A. 328° 19′ 16″ and S. dec. 13° 24′ 8″·2; only 52′ from the place assigned by Le Verrier. M. Galle was furnished with the Berlin Academy Star-map of the 21st hour, (by Bremiker,) then just published, yet other astronomers could with very little labor have made for themselves from the star-catalogues, charts abundantly sufficient for the detection of a new body of such brilliancy. The whole history of the affair evinces much distrust or apathy on the part of the astronomical observers, and undoubting confidence on the part of the mathematician,—confidence which the event has most fully justified.

The annals of science show that a discovery has often been made about the same time in different countries, and by persons unconscious of each other's labors. The present case offers another instance of this nature. In the Lond. Edin. and Dub. Phil. Mag., Vol. xxix, No. 197, Suppl. No., Dec., 1846, G. B. Airy, Esq., the Astronomer Royal, has published numerous letters and other documents, (most of which had already appeared in the London Athenæum of Oct. 3, 17, 31, and Nov. 28, 1846,) proving that Mr. J. C. Adams, of St. John's College, Cambridge, undertook, as long ago as 1843, an investigation of the anomalies of Uranus. As a result of his labors, he left, on one of the last days of October, 1845, at the Royal Observatory, Greenwich, a paper of which the following is an extract:—

"According to my calculations, the observed irregularities in the motion of Uranus may be accounted for by supposing the existence of an exterior planet, the mass and orbit of which are as follows:—

Mean distance, (assumed nearly in accordance with Bode's law,)	38·4
Mean sidereal motion in 365·25 days, - - - -	1° 30′·9
Mean longitude, Oct. 1, 1845, - - - - -	323° 34′
Longitude of perihelion, - - - - - -	315° 55′
Excentricity, - - - - - - - -	0·1610
Mass, - - - - - - - - -	0·0001656."

If the English astronomers had now searched the Ecliptic, through but a few degrees on each side of the point here indicated by Mr. Adams, they would, with clear weather, undoubtedly have discovered the new planet within a week. That they did not do this, must probably be attributed to a want of confidence in the computation. Or if Mr. Adams's note had then been printed, he would have secured the glory which is now, according to the recognized rule, due to M. Le Verrier. So easily is a glorious opportunity lost forever!

The coincidence between the position for the planet assigned in Le Verrier's paper of June 1, 1846, and that which Mr. Adams had given, was so remarkable, that Prof. Challis undertook to search for the body, with the aid of the Northumberland telescope of the Cambridge Observatory, one of the largest refractors in the world. He commenced his sweeps July 29, 1846, and between this date and the time of the arrival of the news of the discovery at Berlin, he actually secured two observations of the planet, but without recognizing them until then. These places are

	R. A.	N. P. D.
1846, Aug., 4^d 13^h 36^m 25	21^h 58^m $14^s{\cdot}70$	102 57 32·2
12 13 3 26	21 57 26·13	103 2 0·2

In a letter to Mr. Airy, dated Sept. 2, 1846, Mr. Adams gave results somewhat different from those communicated in October, 1845; the difference being due to the assumption of a mean distance about one-thirtieth less. He suggested, moreover, that "by still farther diminishing the distance, the agreement between the theory and the late observations might be rendered complete, and the eccentricity reduced at the same time to a very small quantity."

The new planet has doubtless been seen at all the observatories in this country, and may be easily detected by a good spy-glass. In the *Sidereal Messenger*, Vol. i, No. 6, Prof. Mitchel, the director of the Cincinnati Observatory, has given an interesting account of his first observation upon the body with the large refractor. Having received, Oct. 28th, the news of the discovery, he directed the telescope, soon after 6 P. M., to the region of the heavens occupied by the planet, taking his place at the finder, the assistant being seated at the large telescope. "The planet was described as a star of the 8th magnitude. On placing my eye to the finder, four stars of this magnitude were seen. The first was brought to the centre of the field of view of the Equatorial, and after examination by my assistant was rejected—a second was examined critically, and in like manner rejected. The third star, a little smaller and whiter than the other two, was now brought into the field of view, and instantly I heard the exclamation from my assistant—'There it is! there's the planet! with a disc round, clear, and beautiful as that of Jupiter!' My own eye was now placed to the eye piece of the great refractor, and to my unspeakable pleasure, I found a beautiful disc, so well defined, that without any knowledge of a previous discovery, it never would have been passed over for a moment." Prof. Mitchel immediately proceeded to measure the diameter of the disc, six measures being made by his assistant, and six by himself; the mean of the whole gave 2″·523. This is somewhat less than the result given by Schumacher. The real diameter of the planet is probably more than 40,000 miles.

The name of the new planet seems not yet quite determined. The mythological designations of *Janus*, *Oceanus*, *Neptunus*, *Atlas*, &c. have been proposed. M. Le Verrier, to whom the right of imposing the name undoubtedly belongs, has delegated this right to M. Arago. The latter declares that it ought to bear the name of its illustrious discoverer, and denominates it *Le Verrier*. It seems unwise thus to depart from the received system of nomenclature; as *Uranus* and the five small planets must then change their titles; and it is also quite possible that the names of future discoverers may be either unpleasantly short or immoderately long, or otherwise unsuited for this celestial use.

5. *New Comets.*—A comet was discovered (Com. Ren., Oct. 5, 1846) in *Ursa Major*, by De Vico at Rome, about 8 P. M., Sept. 23, 1846. Its R. A. and N. decl. were diminishing. Its approximate place, Sept. 23, 10^h 11^m 29^s, was, R. A. 23^m 6^s less than *tau Ursæ majoris*, and N. declination 7′ greater.

A telescopic comet was detected (Lond. Athenæum, Oct. 24, 1846) in the constellation *Coma Berenices*, by Mr. J. R. Hind, London, about 4 A. M., Oct. 19, 1846. It was a faint nebulosity, 2′ or 3′ in diameter, with a central bright spot. Daily motion, in R. A. about 3^m 12^s increasing; decl. diminishing 12′. The following are two positions obtained by comparison with *Beta Leonis.*

	R. A.	N. Decl.
Oct. 18, 16^h 15^m 11^s, Gr. m. t.	11 59 49·1	14 59 32
17 2 23	11 59 57·5	14 59 8

It is supposed to be a different body from that discovered by De Vico, Sept. 23.

V. Miscellaneous Intelligence.

1. *Smithsonian Institution.*—As this Institution is now taking on a definite form, under the law of Congress approved Aug. 10, 1846, it may be desirable to give an outline of its leading features, and to designate the valuable objects which we trust will be accomplished under it. It will be remembered that James Smithson, Esq., of London, gave his whole property to the United States of America, to found at Washington, under the name of the Smithsonian Institution, an establishment for the increase and diffusion of knowledge among men. The sum of *money* paid into the United States Treasury under this bill, was $515,169, which has been on interest at 6 per cent. since September 1st, 1838, yielding, on the 1st of July, 1847, the additional sum of $242,129.

By the bill, the President, Vice President, Secretary of State, Secretary of the Treasury, Secretary of War, Secretary of the Navy, the Postmaster General, the Attorney General, the Chief Justice, and Commissioner of Patents of the United States, and the Mayor of Washington, are, for their respective terms of office, constituted an "establishment," by the name of the "Smithsonian Institution." They have perpetual succession, and power to choose certain other persons as honorary members. The business of the Institution is to be controlled by a "Board of Regents," who are the Vice President and Chief Justice of the United States, Mayor of the city of Washington, during the terms of office, three members of the United States Senate, and three members of the House of Representatives, together with six other persons, other than members of Congress, two of whom shall be members of the National Institute, in the city of Washington, and resident in the said city, and four others, inhabitants of States, and no two of them in the same State. In our Nov. No. (vol. ii, p. 440,) we gave the list of these officers as chosen according to law, last September. The Board of Regents have power to elect one of their own number as "Chancellor," a "suitable person" as Secretary, and three of their own body as an Executive Committee. It is provided that the Board shall at once cause to be erected, out of the accumulated interest of the fund, a suitable building of sufficient size, and with proper rooms or halls for the reception and arrangement, upon a liberal scale, of objects in all departments of natural history, a chemical laboratory, a library, a gallery of art, and the necessary lecture rooms. All objects of art, and of foreign and curious research, and all objects of natural history, plants, and geological and mineralogical specimens, belonging, or hereafter to belong to the United States, which may be in the city of Washington, are to be placed under the control of the Institution.

The duties of the Secretary of the Board of Regents, are to take charge of the building and property of the Institution, keep its records, and act as Librarian, and keeper of the museum. To aid him in discharging those numerous and important duties, he is permitted to employ assistants. The current expenses of the Institution are to be paid out of the annual income of the foundation, which will be over $30,000. Of this sum the Regents are authorized to appropriate not exceeding an average of $25,000 annually, for the gradual formation of a library, composed of valuable works pertaining to all departments of human knowledge. To aid in this most important work, the bill provides that the owner of every copyright work in the United States, shall within three months after its publication, deposit one copy of it in the library of the Institution, and also one copy in the library of Congress.

Such, in brief, is an outline of this Institution, which as yet is undeveloped in its details, but contains the germ of usefulness and honor for science and literature in this country. We hail with pleasure the election of Prof. Joseph Henry of Princeton, to the post of Secretary of the Board of Regents. He has been chosen from a conviction of his unequalled merits for the office, although more than one hundred applications for the post were before the Board.

Prof. Henry's election to this important office, will at once command the confidence of all scientific men in the success and permanent value of this noble Institution. Under his auspices, we have a sufficient guaranty that charlatanism and pretension, in all forms, will be held aloof, while science and sound learning, with the true spirit of investigation, will be fostered to the utmost, and the object of the testator—"the increase and diffusion of knowledge among men"—be signally accomplished.

We regard the organization of this Institution (aside from the testamentary obligations which rested upon them) as an act highly honorable to our Government, as well as to the distinguished gentlemen whose intelligence and untiring energy have planned and carried through Congress the act of incorporation.

2. *British Association.*—The meeting of the British Association in September last, from the 9th to the 16th, is said to have exceeded in interest any that had preceded it. Besides a large number of the distinguished men of science of Britain, there were many present from

the continent; among whom are mentioned, Messrs. Agassiz, Œrsted, Forchhammer, Svanberg, H. Rosé, Schönbein, Matteucci, Koninck, von Middendorf, and Wartmann. The proceedings of the Association are to some extent noticed through the pages of this number, and will be further detailed in a future number. The receipts into the treasury during the past year amounted to 12,235 dollars, of which 4,500 dollars were received from members and others attending the Cambridge meeting, and the rest from dividends on stock, sale of the volumes of reports, and other items. Among the payments, we observe that 3,300 dollars were given on account of grants to aid in scientific researches, in various departments, 2,500 dollars to an assistant secretary, accountant, &c. for 18 months; and 1,000 dollars, for the expenses of the meeting at Southampton, in connection with sundry disbursements for advertising, &c.

The annual address, delivered by Sir R. I. Murchison, the President elect, presents a lucid review of the investigations in science promoted by the Association, and spirited sketches of the recent labors of some of the distinguished men present at the meeting. Of Agassiz, he says: "Switzerland has again given to us that great master in palæontology, who has put arms into the hands of British geologists, with which they have conquered vast regions, and who, now on his road to new glories in America, brings to us his report on the fossil fishes of the basin of London, which will, he assures me, exceed in size all that he has ever written on ichthyolites." Of Prof. von Middendorf: "Among these sources of just pride and gratification, no one has afforded me sincerer pleasure than to welcome hither the undaunted Siberian explorer, Prof. von Middendorf. Deeply impressed as I am with the estimation in which science is held by the illustrious ruler of the empire of Russia, I cannot but hope that the presence of this traveler, so singularly distinguished for his enterprising exploits, may meet with a friend in every Englishman who is acquainted with the arduous nature of his travels. To traverse Siberia from south to north and from west to east—to reach by land the extreme northern headland of Taimyr—to teach us, for the first time, that even to the latitude 72° north, trees with stems extend themselves in that meridian—that crops of rye, more abundant than in his native Livonia, grow beyond Yakutsk, on the surface of that frozen subsoil, the intensity and measure of cold in which, he has determined by thermometric experiments—to explain, through their language and physical form, the origin of tribes now far removed from their parent stock—to explore the far eastern regions of the Sea of Ohkotsk and of the Shantar Isles—to define the remotest northeastern boundary between China and Russia—and, finally, to enrich St. Petersburgh with the natural productions, both fossil and recent, of all these wild and untrodden lands, are the exploits for which the Royal Geographical Society of London has, at its last meeting, conferred its Gold Victoria Medal on this most successful explorer. Prof. v. Middendorf now visits us to converse with our naturalists most able to assist him, and to inspect our museums, in which, by comparison, he can best determine the value of specific characters before he completes the description of his copious accumulations; and I trust that during his stay in England he will be treated with as much true hospitality as I have myself received at the hands of his kind countrymen."

After speaking of the labors of Œrsted and Faraday in one and the same field, he proceeds as follows, honorably noticing one of the first names of this land :

"And thus shall we continue to be a true British Association, with cosmopolite connections, so long as we have among us eminent men to attract such foreign contemporaries to our shores. If, then, at the last assembly we experienced the good effects which flowed from a concentration of profound mathematicians and magneticians, drawn together from different European kingdoms—if, then, also, the man of solid learning, who then represented the United States of America, and who is now worthily presiding over the Cambridge University of his native soil, spoke to us with chastened eloquence of the benefits our institution was conferring on mankind—let us rejoice that this meeting is honored by the presence of foreign philosophers as distinguished as those of any former year."

3. *On Boring for Artesian Wells;* by M. Fauvelle, of Perpignan, in France, (Brit. Assoc., from the Athenæum of Sept. 19, 1846.)—In this paper, which was sent to the British Association by Arago, through Mr. Vignolles, M. Fauvelle observes as follows :—"In 1833, I was present at the boring of an artesian well at Rivesaltes; the water was found, and spouted up abundantly. They proceeded to the tubing, and for that purpose enlarged the bore-hole from the top downwards. I was struck by observing that it was no longer necessary to draw the boring tools to get rid of the material, and that the water, rising from the bottom, brought up with it, in a state of suspension, all the soil which the enlarging tools detached from the sides. I immediately observed to my friend, M. Bassal, who was with me—'This is a remarkable fact, and one very easy to imitate ; if, through a hollow boring rod, water be sent down into the bore-hole as it is sunk, the water, in coming up again, must bring with it all the drilled particles.' On this principle I started to establish a new method of boring. The apparatus is composed of a hollow boring rod, formed of wrought iron tubes screwed end to end ; the lower end of the hollow rod is armed with a perforating tool, suited to the character of the strata which have to be encountered. The diameter of the tool is larger than the diameter of the tubular rod, in order to form around it an annular space through which the water and the excavated material may rise up. The upper end of the hollow rod is connected with a force-pump by jointed or flexible tubes, which will follow the descending movement of the boring tube for an extent of some yards. This boring tube may be either worked by a rotary movement with a turning handle, or by percussion with a jumper. The frame and tackle for lifting, lowering and sustaining the boring tube, offer nothing particular. When the boring tube is to be worked, the pump must be first put in motion. Through the interior of the tube a column of water is sent down to the bottom of the bore-holes, which water, rising in the annular space between the exterior of the hollow boring rod and the sides of the bore-hole, creates an ascending current which carries up the triturated soil : the boring tube is then worked like an ordinary boring rod ; and as the material is acted upon

by the tool at the lower end, it is immediately carried up to the top of the bore-hole by the ascending current of water. It is a consequence of this operation that the cuttings being constantly carried up by the water, there is no longer any occasion to draw up the boring tube to clear them away, making a very great saving of time. Another important and certainly no less advantage, is, that the boring tools never get clogged by the soil; they work constantly (without meeting obstructions) through the strata to be penetrated, thus getting rid at once of nine-tenths of the difficulties of boring."

Sir John Guest asked Mr. Vignolles to explain the system of percussion boring, for the information of those gentlemen present who might not be acquainted with it. Mr. Vignolles said, instead of boring with augers or rods, there was a heavy weight suspended by a rope and pulley; and fixed to the bottom of the weight was a tool of the crown form, viz. a circular tool of iron, indentated at the bottom. There was no description of rock on which he had tried it that this tool did not penetrate with facility. The prejudice of English workmen, however, had hitherto prevented its introduction into this country; but he had no doubt it would make its way, particularly if it could be combined with Fauvelle's system.

4. *Discussion on the Potato Disease*, (Brit. Assoc., from the Athenæum, Sept. 19.)—Mr. W. Hogan read a paper "On Potatoes raised from seed, as a means of preventing the extension of the prevailing disease." He first read extracts from German publications, giving the result of the trial of growing potatoes from the seed of the plant, which had been found to be successful as far as the production of tubers, and also the prevention of the prevailing disease. Mr. Hogan had also tried the same process with success. The proceeding consisted in growing the seeds first in a hot-bed, and then transplanting. He considered this to be a successful way, because the most natural.

Mr. M. Stirling stated that he had, some time since, recommended to the government of Sweden the plan of procuring potato seed, and deriving thence the crops. He had advised giving prizes for the best seedling potatoes, and he also recommended hybridizing the potato as a means of improvement.—Mr. W. Ogilby thought growing potatoes from the seeds might prevent the scurf and dry rot, but not the present wet rot of the potato. He quoted several instances in which seedling crops had been destroyed. He had been most successful in growing potatoes from a little tuber which sprung from the "eyes" of the old ones going to decay.—Dr. Crook attributed the attack in the year 1845 to "cold." The cold burst the vessels; and then came the disease. Heat produces the same effects as cold; it bursts the tissues of the vessels, and the consequence is disease.—Dr. Daubeny did not think that atmospheric changes had any thing to do with the disease at all. He thought that the most satisfactory theory was that which referred the disease to fungi. He had understood that there was no potato disease in the neighborhood of the copper furnaces in Swansea.—Dr. Buckland had lately visited Prof. Payen, who advocated the doctrine that the disease arose from fungi; and he (Dr. Buckland) believed so too. There was, in fact, a fungiferous miasm existing, which, like cholera, attacked not all, but those who were predisposed. It was the weak and intemperate that were attacked with cholera; it was the debilitated potato that had the disease. Extreme conditions of temperature debilitated the potato, and then it became diseased. The potatoes were suddenly attacked. He knew a case in which a whole field became diseased in three days. He believed the only remedy was mowing down the haulm of the potato the moment it was attacked.—Prof. L. PLAYFAIR was certain of one thing—and that was that the disease was not due to fungi. The nature of it was evident, as it could be produced artificially. If you scraped a potato and placed it in the open air, it became diseased; and, in the course of a few hours, the fungi would appear on it.—Mr. E. SOLLY believed that the disease depended on chemical changes, not on the attack of a fungus.—Mr. BUSH had examined the diseased potatoes under the microscope, and in the early stages had always failed to discover the slightest indication of the existence of a fungus. As the disease advances, first one fungus appears, and then another,—and at last animal life. This was the progress of all vegetable decay. The disease always commences on the outside of the potato, and proceeds to the centre. He had also found the disease constantly attended with the development of crystals of oxalate of lime.—Prof. BALFOUR stated that some fungi attacked living and healthy structures,—others only diseased ones. The fungus of the potato was a Botrytis; which he believed attacked healthy structures.—Mr. A. STRICKLAND said, in reference to Dr. Buckland's recommendation to mow down the potatoes, that when his neighbors mowed down their potatoes he dug his up. They had lost nearly all theirs, whilst he had saved nearly all his.—Dr. LANKESTER remarked on the want of evidence to support the theories of either cause or remedies that had been brought forward. Cold and heat had been said to act, by destroying the tissues of the potato; but no destroyed tissues had been shown to exist. Debility had also been supposed to exist; but no proof was given of the existence of debility: and the Dean of Westminster himself had admitted that he had seen the healthiest potatoes destroyed in three days. Positive observation was evidently opposed to the fungus theory. As to the remedies recommended, seedlings had been known to be attacked in more cases than they had escaped; and, therefore, sowing the seeds could not be recommended. Mowing down the stalks had not been more successful than letting them alone; and it ought now to be known, that this meeting had done nothing more valuable than to show the insufficiency of all theories and remedies hitherto advanced.

5. *On the Educational Statistics of Oxford*, (Proc. Brit. Assoc., Sept., from the Athenæum, Sept. 19, 1846.)—Mr. HEYWOOD described the almost exclusive attention paid to classical studies, and the neglect of mathematical and physical pursuits. But he particularly directed attention to the results of the examination called the "Great Go," with which a theological examination is connected at Oxford, including not merely the historical books of the Bible, but also an accurate knowledge of the thirty-nine articles and of the texts usually quoted in proof of their several propositions. Some criterion of the working of the system may be found in the number of unsuccessful candidates. The annual average of candidates for degrees is 410—of whom only 284 pass, while 126 are rejected. Thus about one-third are unsuccessful,

after having kept fifteen terms, which require a residence of three years and a half. In this examination Aristotle appears to be the favorite author at Oxford; and the examiners appear to pride themselves in selecting the most difficult and abstruse portions of his rhetorical and ethical works, looking rather to the difficulties of grammar and philology than to their ethical value. Science is the technical term at Oxford for moral philosophy, and each separate treatise is called a science; —thus a student who has read Aristotle's Ethics and Rhetoric, a Dialogue of Plato and Butler's Analogy, is said to have got up four sciences. Aldritch's Compendium and Aristotle's Organon are the chief authorities in logic, and a power of commenting upon them can be acquired only by a long and painful course of minute study. Mr. Heywood's object was to call attention to the neglect of the mathematical and physical sciences, and to the great proportion of persons rejected or plucked at the final examination, and contended that these evils were avoided by the system pursued at Cambridge.

6. *Modification of Dr. Whewell's Anemometer, for measuring the Velocity of the Wind;* by Dr. Robinson, (Brit. Assoc., from the Athenæum, Sept. 19, 1846.)—Dr. Robinson explained to the section verbally the nature of the various anemometers hitherto employed to measure the *force* of the wind, and distinguished Whewell's from them, as a measure merely of comparative *rate*. The fault of it was, that the instrument gave no absolute measure of velocity in miles per hour, and that it reduced the rates to no standard, and therefore the observations made at one observatory were not capable of comparison with those at another. He had applied an observation of Mr. Edgeworth, who was a family connexion of his own, to the construction of such an addition as would render Whewell's anemometer more perfect in this respect. He mounted on a vertical axis three or four arms, carrying hemispherical cups at their extremities. These cups opposed much less resistance to air acting on the concave sides than on their convexities, and in such ratio that uniform revolution was produced at the rate of *one-third* of the velocity of the wind. From this measure, which would be the same for all sizes of the instrument, and at all places, the mean velocity of the wind during a given period could always be obtained in miles per hour. He concluded by reading some of the determinations of his own instrument at the observatory at Armagh.

7. *On the Ethnological Distribution of Round and Elongated Crania;* by Prof. Retzius, (Proc. Brit. Assoc., from the Athenæum, Sept. 19.)—On this paper a lengthened discussion arose on the degree to which physical peculiarities of races may become modified by climate, education, progress of civilization, and the effect of dwelling with higher races. Mr. Lyell gave it as the result of his recent observations in the Southern States of America, that the negro race is much altered by living even for a few generations with the white races, and always for the better, even when no mixture of races exists; and that where it does exist, the result is ever to retain and propagate the higher developments of the white races.

8. *On the Deviation of Falling Bodies from the Perpendicular;* by Prof. Oersted, (Brit. Assoc., from Athen., Sept. 26, 1846.)—I shall give a short history of these experiments, as far as this can be done by

memory, without any assistance of books. The first experiments of merit were made, I think in 1793, by Prof. Guglielmini. He made bodies fall from a height of 231 feet. As the earth rotates from west to east, each point in or upon her describes an arc proportioned to its distance from the axis; and, therefore, the falling body has, from the beginning of the fall, a greater tendency towards the east than the point of the surface which lies perpendicularly below it. Thus, it must strike a point lying somewhat east of the perpendicular. Still, the difference is so small, that great heights are necessary for giving only a deviation of some tenth parts of an inch. The experiments of Guglielmini gave indeed such a deviation; but at the same time, they gave a deviation to the south, which was not in accordance with the mathematical calculations. Laplace objected to these experiments, on the ground that the author had not verified his perpendicular, until some months afterwards. In the beginning of this century, Dr. Benzenberg undertook new experiments, from a height of about 240 feet. The book in which he describes his experiments contains, in an appendix, researches and illustrations upon the subject from Gauss and Olbers; to which several abstracts of older researches are added. The paper of Gauss is ill printed, and therefore difficult to read; but the result is, that the experiments of Benzenberg would give a deviation of 395 French lines. The mean of his experiments gave 399; but they gave a still greater deviation to the south. Though the experiments here quoted seem to be highly satisfactory in point of the eastern deviation, I cannot consider them to be so in truth; for it is but right to state that these experiments have considerable discrepancies among themselves, and that their mean, therefore, cannot be of great value. In some other experiments made afterwards in a deep pit, Dr. Benzenberg obtained only the easterly deviation; but they seem not to deserve more confidence. Greater faith is to be placed in the experiments tried by Prof. Reich in a pit of 504 feet, at Freiberg. Here the easterly deviation was also found in good agreement with the calculated result; but a considerable southern deviation was observed.—Prof. Oersted added various reasons and suggestions with reference to repeating the observations.

Sir J. Herschel said, that from a conversation with M. Oersted he had been inclined to think that the deviation of falling bodies towards the south in these northern latitudes—which was an observed fact, although hitherto unaccounted for—might receive an explanation from the circumstance that electrical currents were known to be in circulation around the earth in the direction of parallels of latitude; and as a current is always excited in a body moving across such a current, these would give rise to a mutual repulsion, causing the deflection towards the south. But inasmuch as their action would be but momentary were the velocity constant, and is developed in proportion to the variation of the velocity, hence, since the velocity increases uniformly with the time, a uniformly-acting force is the result; and the total deviation, therefore, towards the south would be in the proportion of the height from which the body descended, since it is easy to see that its entire course would be rectilinear. This fact, therefore, which could readily be determined by well conducted observations, would be a decisive test of the soundness of the opinion ; and this was the chief object which M. Oersted had in view. From a subsequent conversation, however, with Mr. Grove, he was inclined to be more doubtful of this explanation. Mr. Grove said, that inasmuch as a falling body was moving between electrical currents, placed both north and south of its line of fall, in his opinion the effect of the one would counterbalance that of the other, so as together to produce no effect.—M. Oersted said that his present object was merely to induce competent persons to undertake well-directed experiments for ascertaining whether there truly was a southerly deviation of falling bodies or not.

9. *Method of Measuring the Height of Clouds ;* by Dr. WHEWELL, (Proceedings Brit. Assoc. in Athen. Sept. 26.)—I do not know whether it has been observed how easily the height of clouds may be measured when the reflection of them can be seen in a lake from a station above it. In that case the angle of elevation above the horizontal plane for any selected point of a cloud is not equal to the angle of depression of the image ; for the latter angle is the angle of elevation of the cloud *at the point of the lake* where reflection takes place, and is, therefore, greater than the former. The difference of these two angles gives us the means of determining the height of the cloud. If α be the angle of depression of the image of the cloud-point, β the angle of elevation, and h the vertical height of the station of observation above the level of the lake, it is easily shown by trigonometry that the height of the cloud above the level of the lake is

$$h\frac{\sin.(\alpha+\beta)}{\sin.(\alpha-\beta)}$$

The angles α and β may be measured by any contrivance for measuring elevations and depressions : for instance, a graduated quadrant with a plumb line, or hanging *alidade* and plain sights. No great accuracy is attainable or is needed in this inquiry.

10. *Gauss's Magnetic Constants*, (Proc. Brit. Assoc. in Athenæum, Sept. 19, p. 962.)—M. ERMANN presented a report to the British Association, containing the reduction of various magnetic observations made by him between the years 1828 and 1830, applied to determining the Constants for 1829. The observations were made at 650 nearly equidistant stations around the globe, between the parallels 62° N. and 60° S. ; of this number, those of 283 stations had been reduced, and at great labor, as is seen from the fact that they involved 180,000 calculations, each of which required the table of logarithms to be consulted five times.

11. *Hydrodynamics*, (Proc. of Brit. Assoc., in Athenæum, Sept. 19, p. 963.)—An elaborate report on fluid motion, waves and tides, discharge of gases through small orifices, sound, simultaneous oscillations of fluids and solids, and other points in Hydrodynamics, was read before the British Association, by G. B. STOKES. Under the head of waves, the researches of Mr. Green, Prof. Kelland, and Mr. Airy were particularly alluded to, and the accurate agreement of theory with the experiments of Mr. Scott Russell, was pointed out.

12. *Refraction and Diffraction of Waves of Sound*, (Brit. Assoc., from the the Athenæum, Sept. 19, 1846.)—Mr. WHEWELL concluded some remarks on waves, before the British Association, by saying, that

as waves of sound were reflected echoes, so he conceived they must suffer refraction; though the observing of this was attended with experimental difficulties; but that these waves were *diffracted*, he conceived no one could doubt who would attend to the varying sound of a cascade, as you approached it round a bending course, it being at first hidden from sight by interposed rocks, banks or other obstacles.

13. *Weather.*—M. Arago in a recent memoir, (Jameson's Edinb. Jour., xli, 2,) announces and supports the opinion that "whatever the progress of the sciences, never will observers who are trustworthy and careful of their reputation, venture to foretell the state of the weather." In a previous memoir he had shown that the influence of the moon and of comets is not appreciable, and that predictions of the weather cannot therefore become a branch of astronomy properly so called.

14. *North Pole.*—Capt. Parry and Sir John Barrow urge the importance and practicability (Jameson's Jour., xl, 295) of reaching the North Pole. The plan proposed by Capt. Parry is to leave the ship at Hakluyt's Headland (where a previous winter had been spent) in the month of April, when the ice would present a hard, unbroken surface. It is supposed that the party might make good thirty miles a day, and complete the enterprise in the course of the month of May, before the ice broke up. Sir John Barrow suggests that two vessels properly constructed and furnished with screw propellers, might sail to the pole, starting from latitude 80° in the month of August. Making but twenty miles a day, it would take but a month to go the 600 miles from Hakluyt's Headland to the point of the axis on which the earth turns; and they might remain there a month, and within a fortnight after reach Spitzbergen.

15. *Dust falling on Vessels in the Atlantic.*—This phenomenon is most frequent near the Cape Verds, and it is shown by Mr. Darwin, (Proceed. Geol. Soc. London, No. 5, p. 27,) to be derived from the African coast. Ehrenberg found sixty-seven species of infusoria in dust collected by this traveler and Lieut. James. They were with one exception of known species, and all but two were of freshwater origin. It was remarked that among them were African species, but no characteristic African forms.

16. *The first Atlantic Steam Navigation.*—In the Gentleman's Magazine for June, 1845, is published an epitaph from the monument lately erected over Capt. Roberts, the lamented commander of the ill-fated steamer President, in which the statement is made that Capt. Roberts was the first who ever crossed the Atlantic in a steam ship. A reference to Vol. xxxviii, p. 155 of this Journal, will show the error of this assertion. The steam ship Savannah, Capt. Moses Rogers of Savannah, Ga., in 1819 successfully crossed and recrossed the Atlantic, using steam during the greater part of her voyage. It was nearly twenty years after this event that Capt. Roberts made his first voyage in a steam ship to the United States.

Our attention was called to the passage alluded to, in the Gentleman's Magazine, by a letter from William Goodman, Esq., of New York, author of "The Social History of Great Britian."

17. *Fall of Meteorites;* (L'Institut, No. 666, Oct. 7.)—A fall of meteorites took place, on the 8th of May last, on both banks of the river Potenza, in Italy, to the northeast of the village of Monte-Milone, eight miles from Macerata. A quarter after 9 A. M. there was a violent report heard,

which was followed after three minutes by a fall of stones, one of which was dug out immediately after from a hole 66 centimeters in depth. It weighed about a pound. A great number of pieces fell, and the greater part in the bed of the river. The largest obtained weighed six pounds. The exterior is a black crust; within the color is grayish white. The texture is semi-crystalline, and it presents small metallic points. Some trials indicated the presence of magnetic pyrites, nickel and cobalt, but no chrome. The grayish white mass appeared to be Labradorite or Albite. It resembles, it is stated, the meteorite which fell the 16th of Sept., 1843, near Nordhausen, of which a complete analysis has been given by Rammelsberg.

18. *Footmarks in the New Red Sandstone of Storeton, near Liverpool;* by John Cunningham, (Jour. Geol. Soc., No. 8, p. 410.)—Mr. Cunningham has detected small footprints in the Storeton sandstone, which from their form he refers to the order Grallæ of birds. The tracks were ten inches apart, and as far as in view were right and left successively.

19. *Explosive Paper.*—M. Pelouze mentions a discovery by which it is easy to ascertain whether the paper has been well prepared. If the paper dissolves in ether it is perfect; if not it has been badly prepared.

20. *Gun-Cotton*, (Athenæum, No. 996.)—Gun-cotton has been rejected for military purposes by the British Board of Ordnance, on account of its exploding at a much lower temperature than gunpowder, and also its producing moisture within a gun.

Prof. Schönbein has lately stated that his Gun-cotton is not identical with the Xyloïdine of Braconnot and Pelouze. The latter is soluble in acetic acid, while Gun-cotton is wholly unaffected by it. He also says that there are other differences, which will, after a while, be made known.

The Bavarian Government have made Gun-cotton, like gunpowder, a government monopoly.

Gun-sawdust has lately been made, which has the same properties as Gun-cotton, though less effectual.

21. *Railways in Italy*, (Athenæum.)—The net of railway in Italy which the Pope seems disposed to grant, will embrace six principal lines; from Rome to the frontier of Naples; from Rome to Civita Vecchia; from Civita Vecchia to the frontier of Tuscany; Bologna to Ferrara; Forli to Ravenna. There is talk also of two great lines from Civita Vecchia to Ancona, and from Ancona to Bologna.

22. The opening of the *Eighth Congress of Italian Savans* took place on the 13th of September. The Prince of Canino brought a message from the Pope to the effect that his Holiness recognized the value of such associations, for the promotion of science, and saw gladly his subjects of the Roman States engaged in them. The meeting was less fully attended than the former one at Naples.

23. A *monument to Columbus* is now erecting at Genoa, in the centre of the Piazza del Acqua Verde. In the four angles of the basement there are to be emblematic figures, representing Science, Piety, Prudence, and Constancy, and on the sides bas-reliefs, expressing incidents in the history of the Genoese hero. Above there will be a group representing Columbus in the act of discovering America. The design is by Michele Canzio, and the execution of the principal group by Bartolino.—*Athen.*

24. The present depth of the *Artesian well in the Duchy of Luxemburg* is 2336 feet, or 984 feet greater than that of Grenelle near Paris.

It is said that this immense work has been undertaken for the purpose of reaching a large stratum of common salt.

25. *Native gold* is reputed to have been found in South Australia in a shaft undertaken for the discovery of copper ore.—*Athen.*

OBITUARY.

26. *T. Monticelli*, (from the Address by T. Horner Esq. before the Geol. Soc. London, Quart. Jour. Geol. Soc., No. 6, p. 146.)—THEODORE MONTICELLI of Naples, the Foreign Member whom we have lost, was born in 1759, in the celebrated city of Brundusium, the modern Brindisi. He was educated in the Benedictine College at Rome, in which Chiaramonte, afterwards Pius VII, was then professor, and where he made so much progress in his mathematical studies as to be able, while yet a very young man, to deliver a course of lectures on Natural Philosophy at Naples. In 1792 he was elected Professor of Ethics in the University there, but soon after, getting involved in the political troubles of that time, he was thrown into prison, and was confined six years. When he recovered his liberty in 1800 he went to Rome, where he was very kindly received by his old tutor, by that time raised to the Popedom; and some years afterwards he was nominated by Napoleon to be employed with others in the re-establishment of the University and Academy of Sciences of Naples, of which latter body he was in 1808 elected Perpetual Secretary.

About this time he directed his attention with great earnestness to the study of Vesuvius, forming a very rich collection of its products. He contributed many memoirs to the Academy, in which he described the active volcanic phenomena which he watched with unceasing assiduity, their modern products, and those of the earlier history of this celebrated mountain. In 1813 he published an account of a great eruption of that year, which he dedicated to Sir Humphry Davy, with whom he was intimately acquainted; and Davy, during his residence at Naples some years afterwards, studied the structure and phænomena of Vesuvius under his guidance. Some years afterwards Monticelli published his 'Storia de' fenomeni osservati nelle eruzioni del Vesuvio,' and in 1825, in conjunction with Covelli, his 'Prodromo della Mineralogia Vesuviana,' which deservedly added to his reputation. In 1827 he was one of a committee appointed by the Academy to draw up a geological description of the island of Ischia; a work which was accomplished, and illustrated by several topographical and geological maps, but which has not yet been published. He also drew up for the Academy a memoir, which was printed in Latin, entitled 'Commentarius in agrum Puteolanum Camposque Flegræos.' He continued to the last an ardent cultivator of science, and died Secretary of the Academy, having filled the office thirty-seven years. He was alive during the Scientific Congress at Naples last September, but was too infirm to take a part in its proceedings. He was living in retirement at his favorite Pozzuoli, and in the month of October, when a few friends had assembled to celebrate his 87th birthday, he was seized at dinner with apoplexy, which terminated his life.

27. *M. Aimé.*—The French papers mention the death of M. Aimé, a young scientific gentleman of distinction, and director of the Observatory at Algiers. While proceeding to Medeah to establish an observatory at

that place, he had the misfortune to fall into a ravine, breaking his leg and several of his ribs. He died a few days afterwards, in the 33d year of his age.—*Athen.*

28. *Mr. Isaiah Lukens*, an eminent philosophical artist, died at Philadelphia, his place of residence, Nov. 13th, 1846, aged 69 years. He was, at the time of his death, Vice President of the Franklin Institute, a post which he had held for many years. His death is a serious loss to the scientific arts in this country.

VI. Bibliography.

1. *First Principles of Chemistry, for the use of Colleges and Schools;* by Benjamin Silliman, Jun., M. A., Professor of Science applied to the Arts, in Yale College. 492 pp., 12 mo., with more than 200 illustrations. Philadelphia, Loomis & Peck, 1847.—In connection with the announcement of this work, we cite a few paragraphs from the author's preface.

"The object of this work is sufficiently indicated by its title. It has grown out of the exigencies of instruction, and has been received as the Text Book in the Public Lectures at Yale College.

"It has been a leading object in its composition not to anticipate the student's acquirements, but to carry him forward, step by step, in a series of consecutive propositions. To aid him as much as possible in applying the knowledge already acquired, the paragraphs have been numbered and constant reference has been made throughout the work to previous sections, wherever the subject could be illustrated by so doing. The questions at the foot of each page are designed to aid those whose experience in teaching Chemistry may not be sufficient to enable them at all times to determine what is most important for the pupil to know."

2. *Second Annual Report on the Geology of Vermont;* by Prof. C. B. Adams. 8vo, pp. 267. Burlington, 1846.—This survey has been prosecuted with great activity during the past year, by its energetic head. The amount of detail set forth in the present report, shows that no time has been misspent, and no means misappropriated in accomplishing the great object in view. There are many geological topics which the rocks of Vermont are peculiarly well suited to illustrate—of which none are more conspicuous than the phenomena of drift and the effects of metamorphic action: while the resources of the State in its metallic ores, marbles and soils are calculated to excite great interest in the results of the explorations.

3. *Chemical Essays relating to Agriculture;* by E. V. Horsford, A. M.: or analyses of grain and vegetables, distinguishing the nitrogenous from the non-nitrogenous ingredients, for the purpose of estimating their separate value for nutrition. Also, on ammonia found in glaciers; and on the action and ingredients of manures. Boston, James Munroe & Co., 1846. pp. 68.—The principal research embraced in these important investigations, relates to the value of different kinds of vegetable food, as based upon their per-centage of nitrogen. This subject was taken up at the suggestion of Baron Liebig, and has been prosecuted in his Laboratory, where for two years past Prof. Horsford has been a student. Some notice will be found of his results in Vol. ii, p. 264, of this Journal. It is truly honorable to the science of this country, to have presented to the world such papers as this by Mr. Horsford, and that by Mr. Norton on oats. Original chemical research among us has been uncommon; nearly every thing of the sort heretofore done in this country has been either in the

line of Mineral analysis, or of the proper *physics* of Chemistry, rather than in the path which these gentlemen have followed.

4. *On the Analysis of the Oat;* by John P. Norton, Professsor of Agricultural Chemistry, &c., in Yale College. This essay was prepared at the request of the Highland Agricultural Society of Scotland, and received last spring their premium of fifty sovereigns, offered for the best essay on the chemical constitution of the great staple of Scotch agriculture. Our countryman, Mr. Norton, in the laboratory of the Agricultural Chemistry Association in Edinburgh, and under the direction of Prof. Johnston, enjoyed great advantages for the prosecution of such an investigation. Mr. Norton commenced with the young plant, and followed it through its successive stages of growth and development to maturity. The results are presented in thirty-nine tables, containing hundreds of accurate and minute analyses, giving the composition of the oat from the different parts of the plant separately, viz. the leaf above and below, the stalk, the knots, the grain, &c., besides the organic constitution of the grain; and thus illustrating interesting points in the constitution of the plant, and its relation to the soil.

5. *Encyclopædia Americana;* supplementary volume; by Henry Vethake. Vol. xiv, pp. 663. 8vo. Lea & Blanchard, Phil. 1847.—The "Conversations Lexikon" has become a household book in all the intelligent families in America, and it is undoubtedly the best depository of biographical, historical, geographical, and political information, of that kind, which discriminating readers require. There is in the present volume much matter purely scientific, which was all the more acceptable to us that it was unexpected. Prof. Vethake has shown good taste and skill, with great research, in compiling this important continuation of the original work. Among the scientific heads are well digested articles on geology, electricity, and magnetism; the telegraph; the causes which produce the explosions of steam boilers, &c., in which we find much information not elsewhere to be met with in a condensed form. The personal sketches are confined, in case of Americans, to those who are dead, but many very entertaining and instructive biographies are given of living Europeans of eminence in science and letters.

6. *Chemistry of the Four Seasons, Spring, Summer, Autumn, and Winter;* an essay principally concerning natural phenomena admitting of interpretation by chemical science, and illustrating passages of Scripture; by Thomas Griffiths, Professor in the Medical College of St. Bartholomew's Hospital. Author of "Recreations in Chemistry," &c., &c. London. Philadelphia. Lea & Blanchard. 1846. 12mo. pp. 451.—The design of this little volume is good, the style pleasant and familiar, and the illustrations copious. The scope of the work is well expressed in the title, and the tendency of such books when well written and by competent hands, is favorable to the popularity and progress of science.

7. *Précis de Chemie Organique;* par M. Charles Gerhardt, (tome deuxième.) Paris. Fortin Masson, et Cie. 1846. 8vo.—Chemists will be glad to see the second volume of Gerhardt's Précis, &c., a work which is looked upon with great interest by all who follow the progress of organic chemistry, whether they adopt the views of the new French school, (of which Gerhardt and Laurent are the exponents,) or those of the school of Giessen; or the still older opinions of the great Swede. This author is, beyond doubt, one of the bright lights of organic chemistry, and so thought Liebig when Gerhardt translated the "Traité de

Chemie Organique" from the author's manuscripts, although the Professor of Chemistry at Montpelier (Gerhardt) seems at present to be held in light esteem at Giessen.

8. *Geological Observations on South America*, being the third part of the Geology of the Voyage of the Beagle, during the years 1832–1836; by CHARLES DARWIN, M. A., F. R. S., F. G. S., Naturalist to the Expedition. 268 pp., 8vo, with numerous plates. London, 1846.—This work, just from the London press, is one of the most valuable contributions to geological science of late years, evincing throughout the careful and accurate observer, and a mind that can appreciate the bearings of facts in their various relations. The citation on page 120, is from this volume. The author's observations were made with system and fullness, and the work is valuable, as well for its illustrations of general principles in geology, as for details respecting the structure of the regions of which it treats.

9. *The Trees of America;* by D. J. BROWNE.—We are authorized to announce that the success of the work by Mr. Browne, on the trees of America, has been such as to warrant the preparation of a second volume, of the size and character of the first, and that nearly one half of the engravings are already executed. We are also pleased to learn that another edition of the existing volume will soon be issued, with such additions and emendations as will render it the most useful and entertaining work of any on the subject.

10. *Eureka, or the Journal of the National Association of Inventors;* published by W. H. Starr, New York.—This Journal, recently established, is a monthly quarto, devoted to the discoveries in science and inventions in the arts; and as such, as well as for its own merits, it is entitled to the patronage of all friends of improvement.

11. *The London Geological Journal and Record of Discoveries in British and Foreign Palæontology.* 40 pp., 8vo, with 8 lithographic plates; 3*s*. 6*d*. London.—This is the title of a new Geological Journal, the first number of which, printed in an elegant style, made its appearance in September last. This number contains several Palæontological articles of interest, handsomely and more expensively illustrated than is usual in scientific periodicals.

12. *Lichenes Exsiccati Amer., Sept.*—Under this title, Mr. Edward Tuckerman, of Cambridge, Mass., proposes to publish descriptions of North American Lichenes, in successive volumes, if sufficient matter shall be supplied to warrant the undertaking. Considerable labor has been devoted by him to this branch of botany during the last eight years, and he has received some important collections from others interested in these plants. The object of this notice is to commend the proposed work to botanists, and especially to those at the south, and southwest, from whence scarcely any specimens of Lichenes have reached him. He hopes moreover, that enough may in this way be accomplished to enable him to prepare a *Synopsis* of our Lichenes and Byssaceæ, with full descriptions. Specimens sent should be pressed sufficiently for the herbarium. If gathered dry, this can be done by slightly moistening them.

13. *Sertum Petropolitanum; seu Icones et Descriptiones Plantarum, quæ in Horto Botanico Imperiali Petropolitano floruerunt*, 1846: Auct. F. E. L. FISCHER et C. A. MEYER.—Of this work we have the first fasciculus, in imperial folio, published in a style of imperial magnificence. There is a prefatory account of the palm house, now in the course of erection at St. Petersburg Garden, which is 266 feet long, 80 feet broad, and 67 in

height. Besides this, the combined length of the other conservatories amounts to hardly less than 3750 feet. Of the ten species illustrated in this fasciculus, the following are natives of California, and were raised from seeds gathered near the Colony Ross, on the Bay of St. Francisco, at the time the Russians occupied that station; viz., *Callichroa platyglossa*, F. and M., the closely allied *Calliglossa Douglasii*, Hook. and Arn., and *Baeria chrysostoma* F. and M.; appended to which is an interesting note proposing to constitute of these genera and their near relatives *Lasthenia*, *Burnellia*, *Hymenoxys*, &c., along with Monolopia and Coinogyne, a separate section in the tribe Anthemideæ. Lastly, with a fine illustration of *Nemophila liniflora*, F. and M., a new arrangement of that genus is given under these sections, and eight species are characterized. Among them a new one, *N. microcalyx*, is proposed, founded on *Ellisia microcalyx*, Hook., a little plant of Louisiana, Alabama, and Georgia, which has been supposed to be merely a form of *N. parviflora*. A. GR.

14. ENDLICHER and MARTIUS, *Flora Brasiliensis*.—The sixth part, published in July last, comprises the *Solanaceæ* and *Cestrineæ* of Brazil, by Dr. Sendtner of Munich, pp. 227, fol., with nineteen plates, to which Prof. Von Martius has added an interesting excursus on the geographical distribution and the history and uses of the Solanaceæ, especially of tobacco. Of the six physognomic plates which this fasciculus contains, two are devoted to views from the summit of the Concorado, and a third is a fine illustration of a Brazilian forest, taken from some part of the slope of the same mountain. A. GR.

15. TRAUTVETTER, *Plantarum Imagines et Descriptiones Floram Russicam Illustrantes*. Munich. Fasc. 1–7, (1844–6,) pp. 54, tab. 1–35. 4to.—These are the earlier fasciculi of a work designed to illustrate a considerable number of plants of the vast flora of the Russian dominions, which have not yet been figured, at least in a sufficient manner. The plates, like the text, are in small quarto, and are neatly engraved on stone in the style which is so well executed at Munich. The work is dedicated to the Prof. Trautvetter's former preceptor, the accomplished Ledebour, the author of the *Flora Altaica*, the splendid *Icones Pl. Fl. Ross. Illustr.*, and the *Flora Rossica* now in progress. A few of the plants that have been figured belong to North West America, viz., *Cupressus Americana*, Trautv. t. 7, (the Thuja excelsa of Borgard,) which, however, was long ago referred to Cupressus (Nutkatensis) by Lambert, and was taken up under this name by Hooker. *Phlox Sibirica*, L. t. 24; *Primula Sibirica*, Jacq. t. 30; *Saxifraga serpyllifolia*, Pursh, var. *viscosa*, Trautv. t. 31; and *S. stellaris*, var. *foliolosa*, *R. Br.* t. 35. A. GR.

16. HOOKER, *Species Filicum*, being *Descriptions of all known Ferns*, illustrated with plates, part iv, London, 8vo, pp. 193–245, tab. 60–70.—To this fasciculus, which completes the first volume of a work which has long been a desideratum, the learned and indefatigable author has added a preface which will be read with interest. It would appear, contrary to the opinion which has generally prevailed, that the species of Ferns often have a very wide geographical range, and are found to inhabit points of the earth's surface the most remote from each other. For example, the habitat of *Cistopteris fragilis* embraces North Europe, North America, West Indies, Mexico, Chili, Northern India, Abyssinia, Madeira, the Azores, and the Cape of Good Hope! A. GR.

17. *Plantes Nouvelles ou Rares d'Amerique;* par STEPH. MORICAND, fasc. 1–8, pp. 140, plates 1–84. 4to. Geneva, 1833–44.—The greater

part of the plants illustrated by M. Moricand are from tropical America; but there are several from Texas, selected from Balandier's collections, viz., tab. 2, *Trifolium Bejariense*, Moric., which is the T. macrocalyx of Hooker's Icones, t. 285. The former name must take precedence, as it was published several years earlier than the other. Tab. 25, *Sida filiformis* (from Tampico) seems to be very nearly the same as S. filicaulis, *Torr.* and *Gr.*, but it has not a hisped stem. Tab. 26, *Platanus Mexicanus*, from Mexico, needs to be compared with the California species. Tab. 44, *Dalea agastachys*, Moric., is Petalostemon obovatum, *Torr.* and *Gr.* Tab. 45, *Dalea penicillata*, Moric., is D. laxiflora, *Pursh.* Tab. 69, *Berberis trifoliolata*, Moric., is a species which was gathered by Drummond without flowers or fruit, and is mentioned in the Flora of North America, p. 662. A. Gr.

18. Ledebour, *Flora Rossica*, fasc. 7; (Stuttgard, 1846.)—This fasciculus completes the second volume of the work. It contains the remainder of the *Compositæ*, and the *Lobeliaceæ*, *Campanulaceæ*, *Vaccinieæ*, and *Ericaceæ*. A. Gr.

19. *Symbolæ Caricologicæ of* Drejer.*—It has been the great effort of the author in his work on Carices, to exhibit the affinities or natural relations of the various species of the genus he has so faithfully studied. While the result evinces great care and extended examination and comparison, as honorable to himself as to the learned society which has published the work, it is likely to meet with some opposition, as Drejer himself so freely and abundantly differs from some of the most distinguished European writers on this subject. It is due to some American authors at least to state, that he has given an erroneous view of their arrangement of the American species. For the sake of more ready access to the species, they took certain *artificial* characters, as was then usually done, for the outline of their arrangement, and associated those species which nearly resembled each other according to these artificial characters. This was the plan adopted by myself. Thus *C. Shortiana*, Dew., upon which Drejer employs much effort, was referred to the same section as *C. formosa*, Dew., *C. gracillima*, Schw., and *C. virescens*, Muh., because the stigmas are three, the terminal spike androgynous and pistillate above, and the other spikes pistillate—all obviously artificial, but rendering the species readily accessible by the examiner. Drejer refers this species to his family, *Melananthæ*, or the *black-flowered*, a distinction not wholly removed from the *artificial*. The reader of the *Symbolæ Caricologicæ*, will carry this explanation to the remarks on the affinities of *C. glaucescens*, Ell., *C. stenolepis*, Torr., and *C. Cherokeensis*, Schw., and be satisfied how utterly the distinguished Drejer has misapprehended those American writers on Carices. In the opinion of Drejer, *C. undulata*, Kzc., is not a distinct species, and is unnecessarily separated from *C. pallescens*, L., in which he will be approved by some American botanists. He also maintains the strong affinity of *C. Deweyana*, Schw., with *C. Cherokeensis*, thus confounding the so often repeated distinction between the *Vigneæ* and the *Legitimæ*, two great natural divisions of Carices.

Amidst the confusion of synonyms, it is gratifying to hear from Drejer that "this is a matter of less importance, since it is not so difficult to refer the plants published under diverse names to the true synonyms, provided they have been well and clearly described." C. Dewey.

---

* See this Journal, last volume, page 302.

20. *Instruction in Chemical Analysis* [*Quantitative*]; by Dr. C. Remigius Fresenius, edited by J. Lloyd Bullock. I. Churchill; London, 1846. 8vo, pp. 626.—This is essentially an elementary work, as only the more commonly occurring substances are mentioned; yet it will prove acceptable even to the proficient.

The characteristic feature of the work is its minute and systematic arrangement, by which all repetition is avoided, and facility of reference is promoted. The portion of the work treating of "Operations" and "Reagents," although in part a continuation of the former volume, is exceedingly valuable. The most minute precautions are given, and above all, the true spirit is inculcated—that of never trusting to chance or to compensation of errors, for correct results.

The inorganic elements are treated under three heads—1st, The composition and properties of the forms in which substances are separated and weighed. 2d, The process of determination. 3d, The separation of substances from each other. The subject of organic analysis is well treated, but with too little notice of the methods not of the Giessen School. This is indeed the fault of the whole work.

The chapter on calculation of analyses and formulæ is full, and together with the tables, forms one of the most serviceable parts of the work to the student. The "Special Part," treating of the analysis of mineral waters, of ashes, of soils, and of atmospheric air, is the most complete treatise on these subjects in the English language. An Appendix contains a series of well arranged "Examples for Practice," particularly useful to those who are deprived of the advantage of personal instruction.

21. *Taschenbuch für Freunde der Geologie;* von Karl Cäsar v. Leonhard; Erster Jahrgang; mit einem Stahlstiche, einer Lithographie und mehreren Zwischendrücken. 240 pp., 8vo. Stuttgart, 1845.—This work is properly a geological annual, and is intended to give a popular view of the more important geological facts, discoveries and theories. It brings within a small scope, truths and principles which are scattered through the periodicals and published works of various languages, and thus offers to the general as well as scientific reader, in an attractive style, the results to which this rapidly advancing science has arrived. It is literally, what the title signifies, a book for the Friends of Geology. The volume before us—the first of a proposed series—contains essays on gold, silver, and the other metals; on fossils; the artificial formation of minerals; facts relating to the various rocks, and their economical uses; on caverns; coal deposits, mountains, meteoric stones, the sea, rivers, land, coral islands, snow, ice, and various other topics, about which much valuable and entertaining information is given.

22. *Astronomical Observations made at the Naval Observatory, Washington;* by Lieut. J. M. Gilliss, U. S. N., Washington, 1846, 8vo, pp. xxv, and 671.—This volume contains the results of four years observations with a transit instrument, which although unequal in power and precision to the demands of a fixed Observatory, appears to have been used with promising fidelity. The instrument was constructed by Troughton for the United States coast survey in 1815. The object-glass has a clear aperture of 3·75 inches with a focal length of 63 inches. The length of the axis is about 35 inches. In the principal focus are five vertical lines and one horizontal; and the eye piece moves in a slide so that it may be brought opposite each wire in succession.

The primary object of these observations was the determination of the longitude of places visited by the United States Exploring Expedition, by means of corresponding moon culminations. These were observed by Lieut. Gilliss with great fidelity and during the last two months of 1838 he obtained 24 Moon culminations.

the year 1839	"	"	80	"	"
" 1840	"	"	104	"	"
" 1841	"	"	113	"	"
six months of 1842	"	"	44	"	"
Making in all			365	"	"

In connection with the moon, Lieut. Gilliss not only observed the prescribed stars of the Nautical Almanac, but a great many others in various parts of the heavens, amounting in all to 1248. These have been reduced by Prof. Bradford under the direction of the Secretary of the Navy, and thus furnish us with a large catalogue of stars, to which the polar distances have been appended from the British Association Catalogue. The observations of the same stars on different nights agree remarkably well with each other, almost as well as those made at Greenwich. This Catalogue must prove highly useful and convenient to those who have not access to larger collections.

We cannot but admire the promising industry of Lieut. Gilliss, and we trust that so laudable a zeal for scientific observation may hereafter find full scope for its exercise.

23. *Astronomical Observations made during the year* 1845 *at the National Observatory, Washington; under the direction of* M. F. Maury, *A. M., Lt. U. S. N., Superintendent.* Vol. i. *Published by authority of the* Hon. Geo. Bancroft, *Secretary of the Navy.* Washington, 1846, 4to, pp. clvi, and 392, and 13 plates.—We have received this volume too recently to give such an account of it as its importance demands. It evinces great industry and ability on the part of the Superintendent and his associates, and does much credit to the scientific character of our country. We hope to present a notice of the work in our next number.

J. Casselberry, M. D.: Description of certain fossil bones found near Evansville, Ia., with speculations concerning the animal of which they are the remains: 8 pp. 8vo.: *Evansville*, 1845.

J. Barratt, M. D.: Report on the Season of 1846, with a table showing the flowering of fruit trees, also tables of late spring and early fall frosts; published by request of the Middlesex Co. Agric. Soc.; 14 pp. 8vo. *Middletown, Conn.*, 1846.

Charts of the U. S. Coast Survey, viz., of New Bedford and Annapolis.

W. C. Hewitson: Colored illustrations of the eggs of British birds, with descriptions of the eggs, nests, &c.; 2 vols. 8vo, 486 pp., 131 pl. *Lond.*, 1846. £4.10s.

Liebig: Animal Chemistry, edited from the author's MS. by Wm. Gregory, M. D., 3d edit., part i, 8vo, 276 pp. *London*, 1846.

Liebig: Chemistry and Physic in relation to Physiology and Pathology, 8vo, 116 pp. *London*, 1846.

W. H. Harvey, M. D.: Nereis Australis, or Illustrations of the Algæ of the Southern Ocean; *London*—(now in press; to be published in four quarterly parts, imp. 8vo., each containing 25 colored plates, with corresponding letter press.)

R. Patterson: Introduction to Zoology, for schools; part i, Invertebrate animals, with upwards of 170 illustrations, 12mo. *London*, 1846.

Lieut Spratt, R. N., and Prof. E. Forbes: Travels in Lycia, Milyas, and the Cibyratis; 12 vols. 8vo, with numerous illustrations (including many of fossils and geological sections.) *London*, 1846. 36*s*.

L. Jenyns: Observations in Natural History, with a calendar of Periodic Phenomena; post 8vo. *London*, 1846. 10*s*. 6*d*.

H. Berghaus and A. K. Johnston: The Physical Atlas; a series of maps illustrating the Geographical distribution of natural Phenomena. *London.*

W. Francis and J. W. Griffith. Fourth edition of Beckmann's History of Inventions, Discoveries and Origins. *London*, 1846.

E. Doubleday: Genera of Diurnal Lepidoptera, part i, imp. 8vo, with two colored plates. *London*, 1846. 5*s*. (To be continued monthly.)

C. F. Peschel: The Elements of Physics; 3 vols. 8vo. *London*. 21*s*.

C. Matteucci: Leçons sur les phénomènes physiques des corps vivants; in French from the 2nd Ital. edit., with additions; 1 vol. in 18mo, with 18 figures. *Paris*, 1846. 3*fr*. 50*c*.

MM. Danger and Flandin: De l'Arsenic, suivi d'une Instruction proper à servir de guide aux experts dans les cas d'empoisonnements; 1 vol. in 8vo, 320 pp., with a plate and wood cuts. *Paris*. 5*fr*.

Boudin: Etudes de Géologie Médicale. Pamphlets in 8vo. *Paris.*

H. Hogard: Aperçu de la Constitution Mineralogique du Departement des Vosges. 130 pp. 8vo. *Epinal*, 1845.

Die lebenden Mineralogen, &c., 8vo. *Cassel*, 1844.

W. Dunker and H. V. Meyer: Palæontographica; Beiträge zur Naturgeschichte der Vorwelt, part i, 4to, 44 pp.

W. Haidinger: Handbuch der Bestimmenden Mineralogie; 2 vols. 8vo. *Wien*, 1845.

J. C. Freisleben: Die sächsischen Erzgänge in localer Folge nach ihren Formationen Zusammengestelt, 8vo. *Freyberg*, 1845.

Klipstein: Beiträge zur geologischen Kenntniss des westlichen Alpen; 4to, plates. *Giessen*, 1845.

L. Pfeiffer: Symbolæ ad Historiam Heliceorum.

Menke and Pfeiffer: Journal of Malacozoology, (in German) vols. i and ii, 1844, 1845; volume iii, 1846.

A. Gray: Chloris Boreali-Americana; Illustrations of new, rare, or otherwise interesting North American Plants, selected chiefly from those recently brought into cultivation at the Botanic Garden of Harvard University; by Asa Gray, M. D., Fisher Prof. Nat. Hist. Decade I. From the Memoirs of the American Academy of Arts and Sciences, vol. iii, new Ser.: *Cambridge*, 1846.—Contains full descriptions and notes, illustrated by elegant colored figures and elaborate dissections of the following imperfectly known species: *Oakesia Conradii*, (shown by the author to be a Corema,) *Schweinitzia odorata*, *Obolaria virginica*; *Gaillardia amblyodon*, *Brazoria truncata*, *Sullivantia ohionis*, *Thermopsis caroliniana*, *T. fraxinifolia*, *T. mollis*, and *Gaylussacia ursina*.

A. A. Gould: Synopsis of the Shells of the Exploring Expedition, Part i; from the Proceedings of the Boston Society of Natural History: *Boston*, 1846—Includes species of the genera Chiton, 14 sp., Patella 11, Lottia 5, Siphonaria 5, Emarginula 4, Fissurella 3, Rimula 2, Crepidula 3, Calyptræa 3, Hipponyx 1, Pileopsis 1, Helix 31 species.

J. Bigelow: The Useful Arts, considered in connection with the application of Science, with numerous engravings; by Jacob Bigelow, M. D., Prof. in Harvard University; 2 vols. *Boston*, 1847.

Proceedings of the Acad. Nat. Sci. of Philadelphia, Vol. iii, No. 4, July and August, p. 80. Anatomy of the Spectrum femoratum, with figures; *J. Leidy*.—p. 84. Anatomy of the Harpyia destructor; *E. Halowell*.—p. 93. On certain fossil bones belonging to the collections of the Academy, with the institution of the new genus Harlanus for the so-called Sus americana; *Richard Owen*, Esq.—No. 5. p. 100. A new genus and species (Cryptobia helicis) of Entozoa, with figures; *J. Leidy*.—p. 101. On two living hybrids between Gallus and Numida; *S. G. Morton*.—p. 104. On the mechanism which closes the membranous wings of the genus Locusta; *J. Leidy*.—p. 110. Remarks on the birds of Upper California; *W. Gambel*.

Transactions of the Lynn Natural History Society, Massachusetts, No. 1.—Catalogue of birds noticed in the vicinity of Lynn during the years 1844–1846; *J. B. Holder*.

Annals and Magazine of Natural History, *October*, 1846, *No.* 119. British Libellulidæ; *E. de S. Longchamps*.—Arrangement of the hollow horned Ruminants; *J. E. Gray*.—Shells and other Invertebrata of the coast of Northumberland

and Durham; *W. King.*—Birds of Calcutta; *C. J. Sundevall.*—Growth of cell-membrane; *H. v. Mohl.*—Hypotropis, a new genus of sea snake, from Port Essington; *J. E. Gray.*—British Pulmograde Medusæ; *E. Forbes.*—*Zoological Society. July* 14. Appendix on the Dinornis; *R. Owen.*—*Aug.* 25. On the relation of the Edentata to Reptiles; *E. Fry.*

November, No. 120. New or rare naked British mollusca; *Alder* and *Hancock*, (with a plate.)—Notices of the birds of Corfu; *Capt. Portlock.*—New Araneidea; *J. Blackwall.*—Birds of Calcutta; *C. J. Sundevall.*—Additions to the Fauna of Ireland; *W. Thompson.*—Male of Cheirotonus MacLeaii; *F. J. S. Parry.*—Development of the Chelonians; *H. Rathke.*—New shells from Davis Straits: *A. Hancock.*—On the Insects of the Carinthian Highlands; *Nickerl.*—*Zoological Society.* Six new species of birds (S. American, Australian and one, the Callipepla venusta, Californian.)—*Entomological Society.* On the genus Holoparamecus of Curtis, and on two new genera of Carabidæ; *J. O. Westwood.*

December, No. 121. On the crania of Crocodiles from Sierra Leone; *H. Falconer.*—Development of vegetable cells; *A. Henfrey.*—New Diurnal Lepidoptera; *E. Doubleday.*—Additions to the Fauna of Ireland; *W. Thompson*—Birds of Calcutta, *C. J. Sundevall.*—On the Fructification of the Rhizocarpeæ, new Indian Lizards; *J. E. Gray.*—*Zoological Society.*—New genus of Lophidæ; *R. T. Lowe.*—New Australian birds and a new species of Trochilidæ; *J. Gould.*

Hooker's London Journal of Botany *for Sept.* 1846—Remarks on new species of Musci, &c; *W. Wilson*, (continued.)—Contributions towards a Flora of Brazil, (Compositæ, Eupatoriaceæ); *Geo. Gardner.*—Botanical Information, (extract from Travels in Brazil, by Dr. von Martius.)—*For October*, 1846. Geyer's Notes on the Vegetation of Missouri and Oregon Territories, etc., (concluded.)—Notes on a continental tour in the summer and autumn of 1846, being extracted from letters addressed to the editor by a Botanical friend.—Notice of three new Fungi collected by Mr. Gardner, in Ceylon; *Rev. M. J. Berkeley.*—Notes on the Botany of the Pyrenees; *Richard Spruce*, (continued.)—Annotationes in Piperaceas Herb. Arnott præsertim Indicas; *F. A. G. Miquel.* Review of the family of the Simaroubeæ; *J. E. Planchon*, (commenced.)

November, 1846. Review of the family of the Simaroubeæ; *J. E. Planchon.*—On the genus Godoga et its analogues, with observations on the limits of the Ochraceæ; *J. E. Planchon.*—Memoir of the life of Dr. J. R. T. Vogel.

Transactions of the Geological Society; Vol. vii, part I. Mr. Hopkins on the Geological structure of the Wealden District. 4*s.* 6*d.*—Part ii. Mr. Bain on fossil remains in South Africa, and Prof. Owen on the Dicynodon. 4*s.*—Part iii. Mr. Kaye and Prof. E. Forbes on the Cretaceous fossils of South Eastern India, (nearly ready.)

Comptes Rendus Hebd. des Seances de L'Académie des Sciences, *August* 31. On the new Planet; *M. Le Verrier.*—Voyage of Exploration up the Amazon recommended by the Minister of the Marine. *September* 7. Structure of the liver of vertebrate animals; *N. Guillot.*—On the Œstridæ; *M. Joly.*—Reciprocal action of the metals and concentric sulphuric acid; *M. Maumené. September* 21. On the dilatation of liquids; *M. Is. Pierre.*—Experimental researches on electricity; *Marié Davy.*—Physiological and organographic memoir on the sensitive plant and others which are said to sleep; *M. Fée.*—On the presence of copper and arsenic in ferruginous waters; *M. Walchner. September* 28. Report on a memoir by M. Lewy, on the composition of the gas contained in seawater.—Solution of a problem on the fusion of alloys; *M. Person. October* 7. Fifth and last part, on the new Planet; *M. Le Verrier.*—On the skeleton of a Hippopotamus from the Province of Choa; *R. d'Hericourt.*—The title of officer of the Legion of Honor conferred on Le Verrier.

Annales des Sciences Naturelles, 8vo, 3me. Ser. Tome v.—*May.* On fossil Mammifera of the South of France; *P. Gervais.*—On the Dicynodon; *R. Owen.*—Nervous system of the invertebrata; *E. Blanchard.*—Fungi of the Museum of Paris; *J. H. Léveillé.*—Origin of the embryo in the grains of Phanerogamous plants; *G. Gasparrini.*—Remarks on the order Chariantheæ; *J. Decaisne.*—On the inflorescence of the Linden; *C. Brunner, Jr.*

June. Nervous system of the invertebrata; *E. Blanchard.*—On the blood of the Annelida; *A. de Quatrefages.*—On the inflorescence of the Linden; *C. Brunner, Jr.*—Microchemical researches on the nature and development of the walls of vegetable cellules; *P. Harting.*—Origin of roots; *A. Trécul.*—Various new plants from Botanical gardens in Europe, (Berlin, Turin, Genoa, Kœnigsberg, Dorpat,)—Botanical Criticisms.

THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

Art. XV.—*A general Review of the Geology of Russia;* by M. E. de Verneuil, delivered before the Geological Society of France on presenting in the name of Sir R. I. Murchison, Count A. von Keyserling, and de Verneuil, their joint work on the Geology of Russia.*

The first volume of the Report on the Geology of Russia consists of two parts. The first is devoted to the physical and structural geology of the extensive regions of Russia in Europe; the second gives a detailed description of the Ural chain. This natural division results from the character of the country itself. In a geological point of view, there is the most striking contrast between the nearly level and flat regions, which constitute Russia proper, and the mountains which separate it from Siberia. Throughout the vast plains of Russia, except in the Donetz country, the most ancient rocks occur in a tender and loosely aggregated condition, lying in horizontal beds with hardly a trace of upheaval or metamorphism. In the chain of the Ural, on the contrary, the palæozoic formations have been subject to the most violent dislocations, being variously tilted, folded, and even overturned. The limestones are indurated and lose that light color for which they are so remarkable in the plains. Argillaceous schist and graywacke replace the clays and friable sandstones, and it is only by the fossils, some of which are common to both regions, that the paralellism of the beds can be established.

---

* *Geology of Russia in Europe and the Ural Mountains,* 2 vols., 4to. London and Paris, 1845: the first volume in English, the second in French.

This analysis of the work, by M. de Verneuil, has been translated for this Journal from the Bulletin of the Geological Society of France, by D. D. Owen, Esq.

The first part of the work commences with an introduction, in which, after having adverted to the recent progress in the classification of the palæozoic deposits, the authors enter into some generalizations on its application to different parts of western Europe, and mention that they undertook the exploration of Russia in order to test the correctness of these views by observations over its extensive districts.

In accordance with their general plan, (which was to describe all the formations in the ascending order from the more ancient to the more recent,) the authors commence by a sketch of Scandinavia, where the fundamental rocks occur, on which the Silurian have been deposited. The most inferior beds of the latter system are characterized in Sweden, as in Russia, by *Asaphus expansus*, *A. Buchii*, *Illænus crassicauda*, and *Echinosphærites*, and, in the Scandinavian peninsula, they repose on gneiss or the more ancient schists, which the authors denominate *azoic* rocks. These last contain no traces of fossils, and it is probable that they were formed anterior to any trace of animated beings. They are completely unconformable with the inferior Silurian system, which is considered by its organic remains to be the equivalent of the most ancient fossiliferous beds known, i. e., those denominated by Sedgwick, in England, protozoic strata.

One of the most important results arrived at by the authors in their comparisons of the Silurian systems of Sweden and Russia, is, that, viewed on a great scale, they are divisible into two periods, each of which has its peculiar palæontological features. The inferior period comprehends all from the lowest fossiliferous rocks to the argillaceous and calcareous strata of the Island of Gothland. The superior epoch, but little developed in Russia, (except in the Ural,) embraces particularly the deposits of the Island of Gothland and Oesel, which represent the Wenlock and Ludlow limestones.

In the vicinity of St. Petersburg, the Devonian system succeeds immediately to the inferior division of the Silurian system, and is recognized at first sight by the great number of fishes which it affords. These fossil fishes, of which many are identical with species found in the old red sandstone of Scotland, are found associated with mollusca analogous to those of the calcareous beds of the Devonian system and those on the banks of the Rhine, and confirm the parallelism which the authors of the Devonian system have established between these beds.*

* M. de Verneuil has recently discovered in the Eifel, remains of the *Asterolepis* and *Coccosteus* and several other genera, associated with the well known shells of that country; one of these specimens sent to Prof. Agassiz has been described by him in his monograph of the fishes of the Devonian system, under the name of *Asterolepis Hœninghaasii.*

M. de Verneuil then called the attention of the Society to the immense development of the Devonian system in Russia. It appears, on one side, extending nearly to Voronez, and thus separates the carboniferous formation of Donetz from that of central Russia; on the other side it reaches towards the Teman Mountains, the basin of the Petchora and the Frozen Ocean. In these northern regions it presents nearly the same character which it has on the Baltic and the province of Valdai, and not the type which it exhibits in the Ural Mountains. It appears to be divisible into two epochs sufficiently distinct; viz., into the upper or fish-bearing red marls above, and the goneatite limestones and schists beneath, perfectly analogous to those of Nassau or Grund in the Hartz.

The carboniferous system is divisible in Russia into two natural regions. In the north and the centre of the country it is composed of horizontal beds of friable freestone, and black argillaceous beds, containing, here and there, a little coal surmounted by light colored limestone, sometimes magnesian. In the south, on the contrary, i. e., in the country of Donetz, it is much dislocated, and affords, as in the north of England, beds of good combustible coal, which alternate with gray, compact limestone, charged with marine fossils.

Above the carboniferous system is displayed a vast and powerful assemblage of deposits, (Permean system,) which occupy, in the government of Perm and the neighboring governments, an area greater than that of all France. They abut upon the flanks of the Ural but do not penetrate the interior of the chain, although elevated at certain points; their general bearing leads us to believe that the first upheaval of the Ural took place before their deposition and about the termination of the Carboniferous epoch. Their mineral composition varies along the line of observation. In every part of the Ural which forms a portion of the shore of the Permean sea, and one hundred and twenty-five to one hundred and fifty miles to the west of that chain, the predominating rock is the conglomerate of the red sandstone with minerals containing carbonate of copper disseminated. The copper is often concentrated in the beds charged with fossil wood. In the centre of the basin as well as towards its southern and western limit, the freestone is replaced by red marls. Beds of gypsum are intercalated at different levels in this immense system, as well as salt, along with calcareous, marly, and magnesian beds. In general the limestone and gypsum are at the base; the freestone conglomerate and marl at the upper part. These deposits appear, both from their stratigraphical position and organic contents, to fill up the interval between the coal formation and the triassic formation. It embraces those groups known in western Europe under the names of *Rothetodte liegende, Kupfer-*

schiefer, *zechstein*, and the *sandstones of the Vosges.* Since this formation is much more developed in Russia than elsewhere, and at the same time, since the beds do not present the same order as in Germany and England, the authors have thought proper to give it the name of the Permean system, upon the same principle that other palæozoic formations have been named from the country where they are most complete and best developed.

Passing to the secondary formations, M. de Verneuil pointed out the difficulties which are experienced in Russia in recognizing the true representative of the triassic formation. Judging from the few fossils which Count Keyserling found on Mount Bogdo, there is reason to believe that that formation exists in the Russian empire; and it is not impossible, that certain red sandstones or marls of the Government of Orenburg and Vologda represent the "*bunter sandstein.*"

If the trias has almost disappeared in Russia, the Jurassic formation, on the contrary, is easily recognized by its fossils. It occupies a considerable area, and the authors traced it through the Governments of Trer, Moscow, Valadimir, Simbirsk, Saratof, where it forms a vast basin of which the different parts are for the most part continuous. Another basin extends to the border of the Volga by Kastroma nearly to the eastern limit of the government of Vologda, towards the side of Ust-Sisolsk. Lastly, the same formation constitutes the surface of a great part of the "toundras" or marshy plains of the basin of the Petchora and of the Frozen Ocean. In central Russia the inferior part is composed of pisolite beds which enclose subordinate beds of blue argillaceous limestone. The superior part consists of a quartzose sandstone of considerable thickness and of a bluish grey color, generally non-fossiliferous, in which, nevertheless, some plants and mollusca have, recently, been discovered. It is remarkable that the *Ammonites cordatus* and several other fossils of the age of the Oxford clay are found in the lowest beds; so that the lias and the inferior oolite seem to be absent. A considerable portion, therefore, of the series is absent; this is the more important to be observed since it establishes the deficiency of strata which follow upon the trias, a formation, the existence of which in Russia is still problematical.

The cretaceous formation is found in Russia, only on the south of the Devonian axis which traverses the central part of the Empire. It is one of the most extensive formations of the southern governments, but it does not extend north of the government of Simbirsk. It occupies a considerable zone on the side of the Uralsk, and extends also into the Crimea. M. de Verneuil remarked particularly, that, in this immense country, the cretaceous series is always represented by white limestone with silex, grey limestone, siliceous argil and sandstone, possessing, therefore, all the characters of the cretaceous formation of the north of Europe. No part of it assumes the type which it possesses in Southern Europe, in Africa, Asia, and which is usually denominated the Mediterranean type.

The nummulite limestone, which in the Crimea reposes on the white chalk with *Belemnites mucronatus*, does not show itself in any other part of Russia.

Passing now to the tertiary formation, M. de Verneuil described the distribution of these different formations in proceeding from the north to the south. The great granitic axis which extends from Volhynia to Donetz appears to be the dividing line between the great eocene and miocene groups. It is, indeed, on the north side of this zone that the eocene deposits are found. The tertiary formation in the Volhynian-Podolian part of the plateaux described by M. Dubois of Montpereux, seems to be the continuation of the miocene deposites of Transylvania and Austria; it assumes, however, rather a different aspect as it advances easterly towards Kischenef, Marioupol and Taganroy. Lastly, a still more extensive and considerable deposit succeeds, viz. that which the authors have called "Aralo-Caspian," since it has been formed under the waters of a sea, the general area of which occupies the present basin of the Caspian and Aral seas. This immense sheet of water, of which these two seas are but the remains, extended even to the western shore of the North sea, and had no communication with the Mediterranean sea or the ocean. In consequence of its being an inland and isolated sea, it was peopled by a peculiar fauna, which reminds us of the present inhabitants of the Caspian sea. How has this great mass of waters in part flowed away so as to leave only the actual seas? Why are these limestones, which were deposited there, and which now form almost all the southern shore of the Black sea, now found at a height from 200 to 300 feet above the level of the existing waters? Anomalies like these can only be explained by supposing that there existed vertical movements of the surface, which disturbed but little the horizontality of the beds. The submersion of a great part of Russia at the termination of the tertiary and diluvial period appears to have been the result of these phenomena.

The communication of the waters of the Mediterranean with the basin occupied at present by the Black sea has had the effect to give to the fauna of this formation in that direction, a character more or less oceanic, but, certainly, very different from that of the Aralo-Caspian district. Indeed we find a very anomalous result; for, though the shores of the Black sea are formed of pliocene deposits, yet amongst the fossil shells of that region, there is not a single species identical with any inhabiting the present Black sea.

After the drainage of the waters from the great Aralo-Caspian basin, the depression which forms the Caspian sea of our day did not immediately take the configuration which we now behold. The water still covered for a long time the Kalmouck steppes to the north, extending even to beyond Simbirsk. These low plains where are found here and there shells which still live in the Caspian sea, resemble completely the bottom of an ocean recently dried up. Pallas knew well the characters of this depression and determined with considerable accuracy its ancient shores, defined on the northwest by the steep elevation of the right branch of the river Volga from Spash to Tzaritzin.

M. de Verneuil now took a rapid survey of the drift formation of Russia, and pointed out the limits of this formation as indicated on the chart. He showed that the extreme points to which the Scandinavian blocks have been transported is about six hundred miles distant from the place where they originated; that their course has been tortuous, conforming to the physical geography of the country and passing principally by the vallies of the Don and Desna, where the detritus extends farthest to the south. He mentioned particularly the fact, that all the erratic blocks of Russia have come from Scandinavia and Finland, diverging as they became scattered over Russia. The Ural, like other mountainous regions of great elevation, has only a local diluvium. The authors have arrived at the conclusion, that, after the Ural and the neighboring country had emerged from the ocean, a considerable part of Scandinavia and Russia in Europe, as well as the north of Germany, was still beneath its waters. M. de Verneuil considers these facts as proof that the glacial theory is not sufficient to account for the principal phenomena of the drift formation of Russia in Europe, inasmuch as the Ural chain, according to that theory, ought to have produced much more considerable glaciers than Finland, and also to have contributed more to the diluvial formation than that region. Moreover, the distance to which these deposits have extended across the country, but little disturbed, and far distant from the high mountains, requires movements of a different nature from that of terrestrial glaciers.

The second part of the work is devoted to the Ural Mountain district, which the authors traversed at eight different points, and of which they have given a special geological chart. This chain, though it attains but 5000 to 6000 feet, forms one of the principal elevated features of the globe, by reason of its continuity and its almost rectilinear direction. From the Straits of Vaigatz to the Orsk it comprehends nearly 18° of latitude, deviating but little from the meridian.

The axis of the chain is ordinarily composed of talcose schist or chlorite and quartzite, which the authors refer to the Silurian system from the fragments of fossils found there. These are the most ancient rocks of the Ural where there is nothing that is comparable to the gneiss and granite of Scandinavia. The granites of this chain are more recent and have burst through its eastern dislocations, but have not formed its principal summits. It is on the same side that most of the igneous rocks are found, as well as the rich metallic veins which accompany them, together with the alluvial gold. But, though the eastern slope has the greatest attraction for the miner, it is towards the west that it offers to the geologist the most complete and distinct stratigraphical succession. The carboniferous limestone and the associated freestones and schists are easily distinguished from the Devonian and Silurian systems.

The secondary formations do not penetrate into the Ural. Wherever the Jurassic formation approaches this chain, either on the north near the 64° of latitude, or on the south near Tanalyzk and Orenburg, it always preserves its horizontality. There is no doubt that the first elevation of the Ural, and that to which it owes its principal bearing, preceded the Jurassic epoch. Indeed there is reason to believe that it was even anterior to the Permian deposits. The subsequent movements have taken place, without doubt, after the accumulation of the cupreous freestones of the Permian system, and were of sufficient magnitude to modify the position of the axis, and to divide the lines of the previous water-shed; for the beds of copper, whence have been derived the cupreous waters that impregnated the Permian deposits lying to the west of the Ural, are situated on the eastern slope of that range of mountains.

The palæontology of Russia has been treated of as fully as the present state of that department of science will permit. The geological description of each grand system of beds has been accompanied by a general review of the principal fossils found in them; and, at the close of the Permian system, with which the authors consider the grand palæozoic period to terminate, they have endeavored to present a general idea of the whole assemblage of the animal kingdom of that epoch, as well as the different transformations which it underwent up to that time. Lonsdale, to whom the Polypifera were confided, has described the species with great judgment, in the appendix to the first volume.

The second volume is entirely devoted to Palæontology, and contains the description and figures of more than four hundred species. The description of the palæozoic fossils occupies nearly four-fifths of this volume. In order to arrive at conclusions with the greatest possible precision, the authors have availed themselves of all the light which the most competent men have been able to throw on each branch. Reserving that which concerned the palæozoic fossils to themselves, they submitted the examination of the Jurassic and cretaceous to M. d'Orbigny; the comparative anatomy of the fishes to M. Agassiz; those of the plants to MM. Ad. Brongniart and Morris. M. de Verneuil likewise cited as contributor to this work, M. Owen, to whom they were indebted for interesting observations on the structure of the teeth of the genus *Dendrodus*, and on the characters of certain mammifers; Lieut. M. Kokcharof, who accompanied the expedition, and who constructed a table of the minerals of the Ural, inserted at the end of the first volume; and, lastly, M. Viconte d'Archiac, of whose advice they frequently availed themselves in the course of the publication. In conclusion, M. de Verneuil congratulates himself in thus finding an opportunity to express to these gentlemen the obligations of the authors.

Art. XVI.—*On Zoöphytes*, No. IV; by James D. Dana.

Geographical Distribution of Zoophytes.*

Heat, light, pressure, and means of subsistence, influence more or less the distribution of all animals; and to these causes should be added, for water species, the nature or condition of the water, whether fresh or marine, pure or impure, still or agitated. Next to the character of the water, heat is the most prominent limiting agent for marine animals, especially as regards latitudinal extent, while light and hydraulic pressure have much influence in determining their limits in depth.

Although these causes fix bounds to species and families, they do not necessarily confine tribes of species to as small limits. This is sometimes the case, and it is nearly true of a large group of zoophytes; yet other tribes and orders include species whose united range comprises all the zones, from the equator to the polar ices, and every depth, to the lowest which man has explored affording traces of life.

Order Hydroidea.—The Hydroidea are met with in all seas and at great depths, as well as at the surface. The tropics, and the cold waters of the frigid zone, have their peculiar species, and a few are found in fresh waters. The rocks and common marine plants of the sea-coast, the dead or living shell, or the floating Fucus of the ocean, are often covered with these feathery corals; and, about reefs, they occasionally implant themselves upon the dead zoophyte, forming a mossy covering, taking the place of the faded coral blossom.

---

* Report on Zoophytes, p. 101.

The species are most abundant, however, in the waters of the temperate zone, and are common upon some portions of our own coast.

Order Actinoidea.—The Actinoidea are marine zoophytes. All oceans have their species, yet in the torrid zone they more especially abound, and display most variedly their colors and singular forms.

The soft Actinidæ and the Alcyonaria have the widest range, occurring both among the coral reefs of the equatorial regions, and, to the north and south, beyond the temperate zone. The Mediterranean affords species of Gorgonia, Corallium, and Alcyonium, besides numerous Actiniæ. The coasts of Britain have also their Alcyonia and Actinias, and from far in the northern seas, come the Umbellularia, and some other species of the Pennatula family.

Among the coral-making Actinaria, the Madrepore and Astræa tribes are almost exclusively confined to the coral-reef seas,—a region included mostly between the parallels of 28° north and south of the equator,—while the Caryophyllia family are spread as widely as the species of Actinia. Several species of Caryophyllidæ occur in the Mediterranean, and others in the high northern seas, and they are met with at depths of several hundred feet. They are also common among the coral-reefs of the tropics.

The Madreporacea and Astræacea, with the Gemmiporidæ, are the principal constituents of coral reefs. The temperature limiting their geographical range is 66° or 68° F., this being the winter temperature of the ocean on the outskirts of the reef-growing seas. The waters may sometimes sink to 64°, but this appears to be a temperature which they can endure, and not that in which they germinate. The extremes which they will survive prove only their powers of endurance, and do not affect the above statement; for their geographical distribution will be determined by the temperature which limits their powers of germination.

The temperature of the ocean in the warmest parts of the Pacific, varies from 80° to 85°, and here Astræas, Meandrinas, Madrepores, &c., are developed with peculiar luxuriance, along with thousands of other strange and beautiful forms of tropical life. A range from the above temperature to 72°, does not appear to be too great for the most fastidious species. At the Sandwich Islands, which are near the northern limits of the coral seas, Porites and Pocilloporæ prevail, and there are very few species of the genera Astræa, Mussa,* and Meandrina, which are common nearer the equator.

---

* *Lobophyllia* of Blainville, *Mussa* of Oken.

The range of these reef-forming corals in depth is singularly small. Twenty or perhaps *sixteen* fathoms will include very nearly all the species of the Madrepore and Astræa tribes.* Temperature has little or no influence in occasioning this limit, as 68° F. will not be found under the equator short of a depth of one hundred fathoms. Light and pressure, the latter affecting the amount of air for aëration, are probably the principal causes. The waves, moreover, seldom reaching to a greater depth than thirty fathoms, cannot aid in renewing the expended air below, as they do at the surface.

In recapitulation we state that the Astræacea, Madreporacea, and the Gemmiporidæ among the Caryophyllacea, are, with few exceptions, confined to the coral-reef seas,† and to within twenty fathoms of the surface. The Caryophyllidæ‡ extend from the equator to the frigid zone, and some species occur at a depth of two hundred fathoms or more. The Alcyonaria have an equally wide range with the Caryophyllidæ, and probably reach still farther towards the poles. The Hydroidea range from the equator to the polar regions, but are most abundant in the waters of the temperate zone.

Besides the above-mentioned limiting causes, there are others of importance, one of which may be alluded to in this place; the remaining, belonging more properly to the Geological Report on Coral Reefs and Islands, will be particularly considered in the forthcoming volume by the author. The cause referred to, is that proceeding from original sites or centres of distribution. There is sufficient evidence that such centres of distribution, as regards zoophytes, are to be recognized. The species of corals in the West Indies are, in many respects, peculiar, and not one can with certainty be identified with any of the East Indies. The central parts of the Pacific Ocean appear to be almost as peculiar in the corals they afford. But few from the Feejees have been found to be identical with those of the Indian Ocean. A more complete acquaintance with the corals of these different seas, will, undoubtedly, multiply the number of identical species; but observations, thus far made, seem sufficient to establish as a fact that a large part of zoophytes are confined to a small longitudinal range. This will be seen from the following table, exhibiting, in a general manner, as far as known, their geographical distribution. Each column gives the number *peculiar* to the region specified at top.

---

* The evidences on this point will be presented in the Report on Coral Islands.

† The exceptions belong mostly to the genus Euphyllia, which includes the genus Flabellum, some Turbinaliæ, and the Lobophyllia, having entire lamellæ.

‡ The *Caryophylliæ* of Blainville, with the *Dendrophylliæ*, *Oculinæ*, &c.

	East Indies, Indian Ocean, or Red Sea.	Pacific Ocean.	West Indies.	Pacific and the East Indies, or Indian Ocean.	Extra-tropical.	Doubtful.	Total.
TRIBE ASTRÆACEA.							
Fam. Astræidæ, ...	37	50	29	4	3	16	139
Fungidæ, ...	14	29	6	6	0	10	65
TRIBE CARYOPHYLLACEA.							
Fam. Caryophyllidæ, . . .	13	7	9	2	13	5	49
Gemmiporidæ, . . .	4	5	1?	2	0	2	14
TRIBE MADREPORACEA.							
Fam. Madreporidæ, . . .	30	42	4	8	1?	7	92
Favositidæ,*	14	15	5	3	0	4	41
Poritidæ,†	5	14	6	2	0	1	28
	117	162	60	27	17	45	428

From this table, it appears that only twenty-seven species out of three hundred and six are *known* to be common to the East Indies and Pacific Ocean. With regard to those common to the East and West Indies, for which no column is assigned, there are but two,—the Meandrina labyrinthica and Astrea galaxea,—about which much doubt remains.

We have no authority for accrediting to the West Indies any species of the genera Fungia, Pavonia, Herpetolithus, Merulina, Monticularia, Gemmipora, Anthophyllum,‡ Pocillopora, Sideropora, or Seriatopora, all of which are common in the opposite hemisphere. The Agariciæ, with the exception of two osculant species, are confined to the sub-genus Mycedia, exclusively West Indian, which contains very firm compact corals, often with an Astræa-like character. The Millepores are the only known Favositidæ, and but half a dozen Madrepores have yet been distinguished. The Manicinæ, Caryophylliæ, and Oculinæ, are more numerous in the West Indies than elsewhere, and the Ctenophylliæ (Meandrinæ, with stout entire lamellæ,) have been found only in the West Indies. The genus Porites contains several species, but they are uniformly more fragile and more porous species than those I have seen from the Pacific and Indian Oceans; and the polyps, as figured by Lesueur, are more exsertile, approaching, in this particular, the Goniopore.

* The Pocilloporæ, Sideroporæ, Milleporæ, Favosites, and other genera of Madreporacea, in which the cells are internally divided by horizontal septa.

† Part of the Porites of authors, the species having shallow cells closed at bottom, (Porites clavaria and the allied.) The other Porites, with a few exceptions, belong to the genus *Manopora* of the Author, and are true Madrepores in their cells, but with imperfect calicles or none: the *P. spumosa* of Lamarck, and the allied, are here included, besides the *Montipora* of Blainville.

‡ *Sarcinula* in part of Blainville, *Caryophyllia* in part of Lamarck; *Anthophyllum* of Schweigger, who introduces the name, but not of writers on fossil corals.

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

(Continued from p. 74, this volume.)

Genesee Slate. (Part of F. 8 of Pennsylvania and Virginia. Post-medial Newer Black Slate of Rogers.) Lithologically this upper black slate can hardly be distinguished from the Marcellus shale. It is a true "*mud*" rock, composed of exceedingly fine argillaceous particles charged with bitumen, which imparts to it a deep black color, and indurated so as to possess a slaty structure, yet not sufficiently hard to be useful as a roofing material, for, though when the edges above are exposed, it may resist the elements for a long time, still, when the surface is subjected to atmospheric vicissitudes, it soon splits, crumbles, and decays.

The Genesee slate attains a thickness of from one hundred to two hundred and fifty feet, retaining a remarkable uniformity of appearance and composition throughout its entire mass.

As usual in deposits of this nature, calcareous concretions are common; they are nearly spherical and vary in diameter from a few inches to three feet, and lie in two ranges wide apart. Iron pyrites and calcareous spar are the associated minerals; the latter always in the cavities of the concretions. In sheltered situations this formation produces saline efflorescences. Vanuxem gives the following account of a remarkable liquid discovered in one of the concretions:—"In one of the septaria from the ravine at Ogden's ferry on Cayuga lake, there was a liquid substance of the color of phosphate of iron or Prussian blue, and another substance resembling spermaceti before the oil is fully pressed out. It was composed of small scales, hard and yellowish-white, and was in small irregularly formed masses of the size of a pea, with an appearance of having been melted. The blue liquid was entirely lost; the white substance, though carefully packed in the cavity of the specimen, disappeared, for nothing of it was found when unpacked."

Owing to the destructibility of this slate formation, it occupies a superficial area too limited to be designated on the chart by a particular color. Its place lies at the junction of the purple and brown color, and ranges nearly east and west across the state, from Smyrna, in Chenango county, to Lake Erie. It borders the margins of Cayuga and Seneca lakes, and forms high cliffs in the ravines above the Tully limestone. Its greatest development is in the gorge of the Genesee river at Mount Morris; this locality has given name to the formation.

In the fissures of this slate, near the Tully limestone, Vanuxem mentions the occurrence of a semi-crystalline rock of a blackish-brown color, apparently a mixture of serpentine and limestone, having the appearance of trap rock.

The Genesee slate affords but few fossils, and these are found in its upper portion. The following species, figured in Vanuxem's Report, are tolerably abundant in its eastern extension near Lodi in Seneca county, and Bigstream point, ravine near Ogden's ferry and Cayuga lake.

Vanuxem's Report. (42.)

Fig. 1. *Orbicula lodensis.* 2. *O. quadricostata.* 3. *Lingula spatula.* 4. *L. concentrica.*

These occur in the upper twelve or fifteen feet of the mass, and are rare in the western part of the state.

Vanuxem found, also, a long linear smooth leaf of grass or sea-weed.

Vanuxem's Report. (94.)

Fig. 1. 2. *Avicula fragilis.* 3. *Strophomena setigera.* 4. *Tentaculites fissurella.*

In the fourth district the Aviculæ of this wood-cut are the most prevalent forms, especially on Lake Erie. It is remarkable that figs. 1, 2, 3, are the same species found in the Marcellus shale; recurring after a long interval in rocks widely separated from each other. The similarity of composition, without doubt, accounts for this analogy in organic remains.

Of the western equivalency of the Genesee slate we have elsewhere spoken.

Portage or Nunda Group. (Part of F. No. 8* of Pennsylvania and Virginia. Post-medidial Flags of Rogers.) In the Annual Reports the strata comprehended in this group were described

* In the New York Reports it is laid down as part of F. 9 of Pennsylvania and Virginia, but we believe this to be incorrect.

under the names of Sherburne flagstones and shale, but from its superior development on the banks of the Genesee river near the town of Portage, (formerly Nunda,) the name was changed to the one at the head of this paragraph. During the progress of the survey a diversity of opinion existed in the minds of the geologists, as to the most appropriate classification and subdivision of the rocks comprised in the upper part of the Erie division of the New York system; viz., of those members lying above the Genesee slate. The difficulties of reconciling the different views arose from the variations and modifications in lithological character, of the equivalent beds at distant localities, together with the scarcity of fossils in most of the rocks. For, though in certain situations, well defined lines of separation can be established, by the difference of mineral composition, yet these geological horizons become more and more obscure as the distance from the starting point increases. The final grouping was established mainly on palæontological evidence.

On the Genesee river the Portage group admits of a threefold subdivision: soft, green, argillaceous shale (Cashaqua shale) beneath, resting on the Genesee slate; green and black shale and sandy shale (Gardeau shale and flagstones) in the middle; thick bedded sandstone (Portage sandstone) above. Shales predominate therefore beneath, sandstones above, with but very few fossils. In going east the arenaceous strata increase in importance, and near Cayuga lake the whole series consists of shale and shaly sandstone passing almost imperceptibly into thick bedded sandstone not very different from those of the Chemung group, so that lithological divisions become unsatisfactory, not only between the subdivisions, but even between the Portage and Chemung groups. Going west the shaly matter augments and the sandstone constantly diminishes, so that along the shore of Lake Erie, there is a thick mass of black shale, succeeded by green and black shales for several hundred feet, with hardly any flagstone or sandstone, and this change is accompanied by an increase of the number of fossils.

"From its general similarity, and from the difficulty also of separating it from the higher rocks on its southern limit, it is colored the same tint on the map, being the northern part of the light umber tint." By consulting the geological map, it will be seen that nearly the whole of that part of the state south of the lakes is occupied by these two formations.

The scenery of that region is remarkable and highly picturesque, as may be gathered from the following extract from Hall's Report:—

"The higher sandstones of the group, and in many instances some of the intermediate ones, produce falls in the streams which pass over them, and some of the most beautiful cascades in the state are found amongst the rocks of this group. The highest perpendicular fall of water in the state is produced by the rocks of this group, and in none others do we meet with more grand and striking scenery. The pedestrian often finds his course impeded by a gorge several hundred feet in depth; and in the very bottom of this, and scarcely perceptible, is the winding stream, the only representative of the once powerful torrent that has excavated the deep channel. Farther on, above or below, he may see the little stream dashing over a precipice, and almost disappearing in spray before it reaches the bottom; here, however, it gathers itself in a deep pool from which it flows on quietly as before, or gurgling and dashing through the fragments of the fallen cliffs, it finds its way into the gently sloping valley of the softer shales."

The soils overlying the formations up to and as far south as the Tully limestone, are highly calcareous; that derived from the higher rocks, south of that geological zone of the state of New York, is deficient in calcareous matter, as might be anticipated from the absence of limestone beds. It is, therefore, not, on the whole, so fine a wheat growing country as the lower ground further north. However, where the lower argillaceous beds of the Portage group crop out, on the northern slopes of the group, it is stiff and clayey land and nearly as good for wheat as can be found. But as in ascending it becomes more and more siliceous, and the included gravel less rounded by attrition, the wheat crops are less abundant and more uncertain. These soils are better adapted for pasturage, and make good stock farms.

"Almost every ravine and stream," says Hall, "upon the elevation which rises to the south from the Hamilton group, exposes the rocks of the Portage group in greater or less perfection."

The thickness of the various members of this group, taken together, is estimated at 1000 feet.

A great variety of concretionary forms occur throughout the mass. In the black shales they are mostly spherical; in the green or greenish-black they are very flat or lenticular; the latter being less crystalline and more argillaceous than the former. Their regularity and the imitative forms which they occasionally assume are truly astonishing; it is not surprising that the uninitiated should often mistake them for petrified tortoises and turtles. On the Genesee river and Lake Erie a peculiar structure is observable, according to Hall, on the outer surface of some of these concretions, denominated "*cone in cone*;" a similar structure is observable in wedge formed layers in the same formation at the above-mentioned localities. From the remarks of this author respecting this appearance in layers of the Portage group, we infer that he supposes it due merely to the powers of segregation. This may be so, but we have been struck with the analogy which it bears to the figures of the so-called "*Cophinus dubius*" or "wicker basket" fossil, discovered in a vertical position in the Upper Ludlow rocks of England, and figured in Murchison's Silurian Researches.* The English fossil is believed to originate from some organic form, but to what order is not yet decided, as appears from the following extract from that work:—

"*Cophinus dubius.* (Pl. 26, fig. 12.) This is a nondescript fossil, concerning the origin of which no naturalist has yet given a decisive opinion. It has been referred with doubts to the family of soft *Zoophytes*, *Crinoidea*, and to *Mollusca*, so wide from each other are the guesses as to its place in the natural order. All that we can say with certainty is, that it has the shape of an inverted four-sided pyramid, with a column-like rounding off at each corner, and four intercolumniations or sides, transversely situated, producing the appearance of a basket-work; whence, whatever it may prove to be, the fossil is provisionally named, at the suggestion of Mr. König, *Cophinus*, (wicker basket.) This curious body has been adverted to in the text (p. 181) as occurring in positions more or less *vertical* in the uppermost strata of the Ludlow rock, from which I infer that the animal was attached by the end of the inverted cone, while the finely levigated muddy sediment accumulated around the columns or stems."

The chief difference observable between the figures of "cone in cone" and that of *Cophinus dubius*, is that the former is more or less conical, whilst the latter is pyramidal.

The surface of some of the layers of shaly sandstone of the Portage group exhibits an appearance likened to a rivulet of water frozen in the act of descending a declivity, or cooled cinder which has flowed from a furnace in a molten state. This phenomenon is attributed, by Hall, to a semi-fluid mud moving over a slightly descending surface, which has become consolidated.

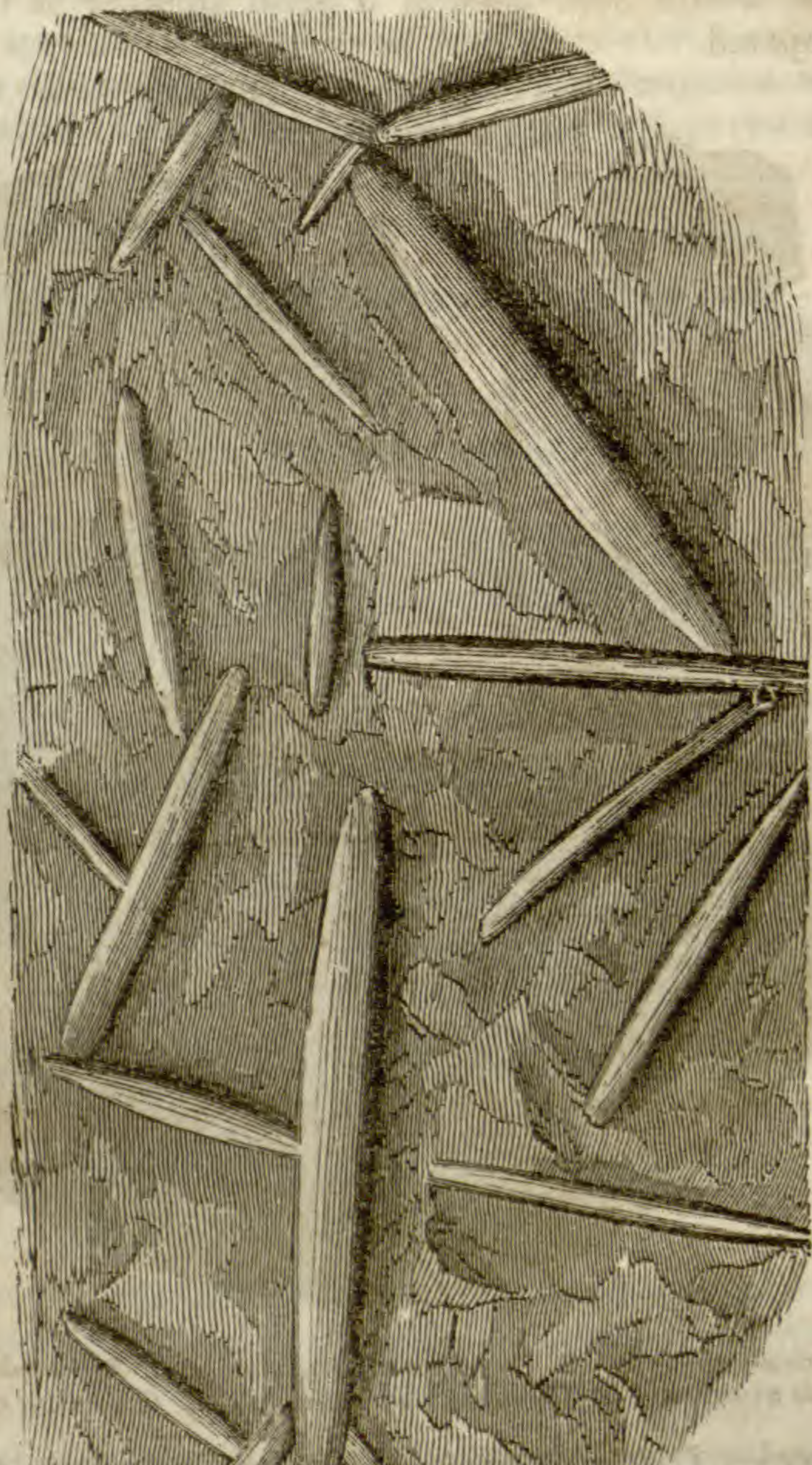
Casts of mud-furrows and striæ are likewise described as appearing on the under surface of the strata of flagstones.

No minerals of importance have been obtained from this group of rocks in the state of New York. Iron pyrites is disseminated through them, and the concretions yield some crystallized carbonate of lime and sulphate of barytes. Thin coatings of sulphate of lime invest some of the shales; and carbonaceous matter has collected in small quantities so as to produce thin and partial laminæ of coal, but not in sufficient quantity to answer any practical purpose.

Organic remains are, as already remarked, not abundant in the Portage group. The Fucoid figured in Vanuxem's and Hall's Reports, and here given, is the most characteristic. It occurs in

* See wood-cut, page 199, also fig. 12, pl. 26.

the flagstones of the middle part. As these have been extensively used for pavements in the towns and villages of the vicinity, fine specimens are often to be seen on the side-walks of the streets especially in Geneva and Pen-Yan.



Fucoides graphica.

Vanuxem's and Hall's Reports. (104.)

The most common fossil shells in the inferior members of the group are embraced in the wood-cuts on the following two pages.

Fig. 1. *Avicula speciosa* is abundant in and characteristic of the Cashaqua shales. Fig. 3. *B. expansus* is thought to resemble an Upper Ludlow fossil figured in Murchison's work, (fig. 32, pl. 5.) The figures are too imperfect to enable one to form an opinion. Fig. 7. *P. acutirostra* is considered by Hall a peculiar form

of this group. Supposing it to be a new species he has given it the name of *Pinnopsis*, from its resemblance to the recent genus *Pinna*. Fig. 8. *P. ornatus* is distinguished from the preceding by the number of ribs. It is a question, however, how far this distinction would hold good if a great number of individuals were compared.

Hall's Report, p. 24. (106.)

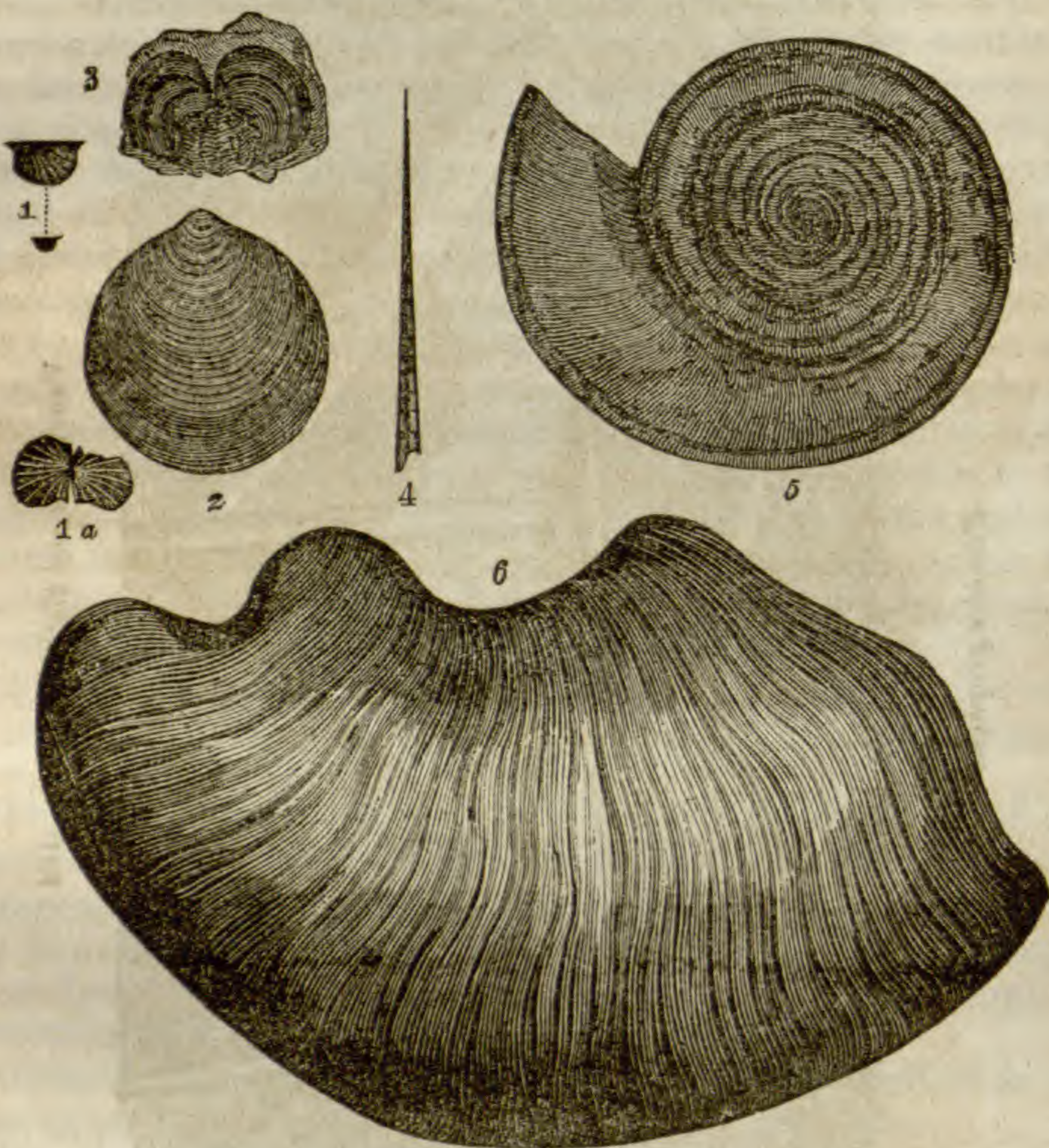


Fig. 1. *Avicula speciosa*. 2. *Ungulina suborbicularis*. 3. *Bellerophon expansus?* 4. *Orthoceras aciculum*. 5. *Clymenia? complanata*. 6. *Goniatites sinuosa*.

The species *Delthyris lævis*, *Cardium? vetustum*, *Orthis tenuistriata*, *Lucina? striata*, *Nucula lineolata*, *Astarte subtextilis*, *Bellerophon striatus*, *Goniatites bicostatus*, *G. sinuosus*, occur in the central and higher part of the group. *D. lævis* is found only in the vicinity of Cayuga and Seneca lakes. It is the only species of the genus *Delthyris* observed in the fourth district destitute of ribs. *C. vetustum* occurs in the soft green shales.

None of the above fossils have come under our observation in the western states. Indeed the shale and sandstone above the western black slate has as yet yielded but very few fossils.

The elegant Crinoidean, *Cyathocrinus ornatus*, figured in Hall's Report, p. 247, has been found in great numbers and in a very perfect state of preservation on the shores of Lake Erie in a stratum about six inches thick, thinning out in every direction within five feet of the centre. Mr. Carley, of Cincinnati, who received a specimen of this fossil, has succeeded, by great perseverance, in developing a most remarkable elongation of the visceral receptacle, several inches in length within the tentaculæ.

Hall's Report, p. 24. (106.)

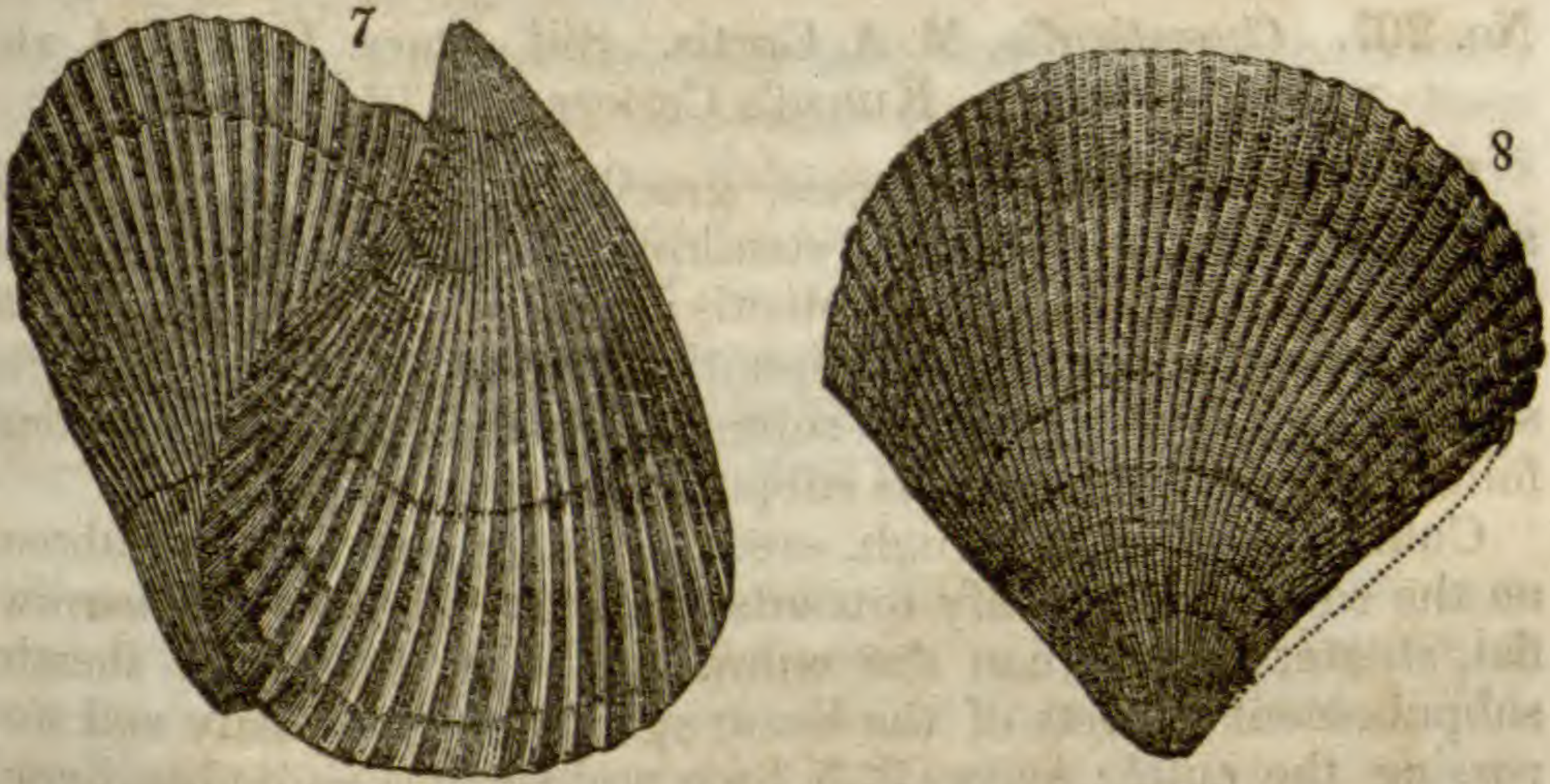


Fig. 7. *Pinnopsis acutirostra*. 8. *P ornatus.*

So extraordinary was this appendage that when the specimen was shown to Dr. Rœmer, when on a visit to Cincinnati, he could hardly believe that it belonged to the fossil. That it is not extraneous is demonstrated by its structure, its central position between the tentaculæ, and above all by the fact that when the fossil was first received there was no trace of the structure, and that Mr. Carley was induced to search for it by carefully trimming away between the fimbriated fingers of the fossil; because he had observed in the encrinites of his vicinity, curious projections proceeding from the plates surrounding the abdominal cavity.

(*To be continued.*)

Art. XVIII.—*Caricography;* by Prof. C. Dewey, M. D.

(Appendix, continued from Vol. ii, Second Series, p. 249.)

No. 206. *Carex cyperoides*, L. Schk. No. 40, Tab. A, fig. 5.

Spica composita terminali capitata; spiculis ovatis, densissimis, *distigmaticis*, supernè pistilliferis, folioso-bracteatis; fructibus ovatis elongato-lanceolatis, subulatis, teretibus, substipitatis, margine scabris, bidentatis, squama lanceolata cuspidata hyalina paulo longioribus.

Culm about a foot high, erect, leafy, triquetrous, smooth, striate, terminated by a head of dense and sessile ovate spikelets; leaves linear, flat and striate, longer than the culm; bracts long and leafy under the spikelets; stigmas two; spikelets staminate below; fruit ovate, long, slender, subtriquetrous, scabrous on the margin, and slightly stipitate; pistillate scale lanceolate, cuspidate, white, a little shorter than the fruit; whole plant pale green.

Found by Drs. Crawe and Wood in Jefferson Co., N. Y., the last summer; common on the continent of Europe, but not found before in our country.

No. 207. *C. æstivalis*, M. A. Curtis. Sill. Amer. Jour., Vol. xlii, p. 28; A. Gray. Kunze's Carices, p. 112, Tab. 28.

Spicis 3–5 longo-cylindraceis, gracilibus, suberectis, laxifloris, suprema androgyna, inferne staminifera, inferioribus exserto-pedunculatis, longo-foliaceo-bracteatis; fructibus *tristigmaticis*, ovatis, tereti-subtriquetris, substipitatis, vix rostratis, ore integris, squama ovata oblonga obtusa submucronata vix duplo longioribus; foliis vaginisque inferioribus subpubescentibus.

Culm 16–24 inches high, erect, triquetrous, slightly scabrous on the edges above, leafy towards the base; leaves long, narrow, flat, striate, shorter than the culm, and with the lower sheaths subpubescent; bracts of the lower spikes long and leafy and surpassing the culm; spikes 3–5, long and slender, cylindric, loose-flowered, suberect, lower ones pedicellate, upper nearly sessile, the highest androgynous and staminate below and with staminiferous scales ovate and acute; stigmas three; fruit ovate, tapering, subtriquetrous, slightly nerved, scarcely rostrate, smooth, at the orifice entire, sometimes slightly recurved at the apex; pistilliferous scale ovate, oblong, obtuse, slightly mucronate, nearly half as long as the fruit, white on the edge and green on the keel; color of the plant light green.

Mountains of North Carolina in tufts; Rev. M. A. Curtis. Named from its flowering long in July and August; A. Gray.

This species much resembles *C. gracillima*, Schw., but obvious characters separate them, as was early remarked by its discoverer, Mr. Curtis, an acute observer and successful botanist. It is a beautiful species.

No. 208. *C. lepidocarpa*, Tausch. Kunze's Carices, p. 52, Tab. 13, fig. 2.

Spica staminifera, erecta, triquetra, cylindracea, cum squamis oblongis obtusis; pistilliferis subbinis, 1–3, *tristigmaticis* rotundo-ovatis, sæpe aggregatis, nunc remotis, densifloris, foliaceo-bracteatis, infima interdum per-remota pedunculata ceterisque sessilibus; fructibus ovatis, triquetris, ellipsoideis, inflatis, nervosis, rostratis, demum recurvo-rostratis, bidentatis, divergentibus, squama ovata obtusa duplo-longioribus.

Culm 8–18 inches high, suberect, slender, triquetrous, slightly scabrous above, leafy towards the base, bracteate; leaves linear, obtusish, striate, shorter than the culm; staminate spike single, erect, cylindric, bearing oblong and obtuse scales; pistillate spikes 1–3, commonly 2–3, often approximate and the two upper nearly sessile, the lowest sometimes remote or very remote and pedicellate and the peduncle nearly inclosed in the sheath; stigmas three; fruit ovate, triquetrous, inflated, nerved, rostrate, the beak being straight or at length recurved, diverging or even turned backwards; pistillate scale ovate, obtusish, half as long as the fruit; whole plant yellowish-green.

Extended widely over New England, New York, Michigan, &c.

This plant, related to *C. flava* and *C. Oederi*, has long been the vexation of botanists in Europe and America. Though it resembles both, and often called a variety of the former, yet it has several times been described as distinct, and the new name is much needed. It is more slender than *C. flava*, and differs in its fruit and scale, and is still further removed from *C. Oederi*. The color is much more yellow than that of *C. flava*.

Note.—*C. Halei*, vol. ii, p. 248, Second Series, is *C. crus-corvi*, Shuttleworth in Kunze's Carices, p. 128, Tab. 32, 1844, and is also *C. sicæformis*, Boott, Boston Jour. Nat. Hist., 1845. I had not received Kunze's work till my paper had gone to press.

C. Steudelii and *C. Boottii* were found the last summer by Dr. Crawe, in Jefferson Co., N. Y.;—both are nearly related to *C. Willdenovia*.

Art. XIX.—*On Coracite, a new Ore of Uranium;* by John L. Le Conte, M. D.

This mineral forms part of a collection made by Mr. B. A. Stanard on the north shore of Lake Superior: the specimen in my possession, is from the surface of the vein, and one portion of it appears to be much weathered; the remainder is quite compact, and apparently unaffected by any exposure; it is, however, traversed in all directions by minute fissures filled with carbonate of lime, sulphuret of iron, and silica. Many of these are almost microscopic, and indeed, quite invisible, until they have been bleached by exposure to a high temperature. For this reason I have been induced to defer any quantitative analysis, until purer specimens shall be obtained. As will be seen, however, by the experiments detailed below, the composition of this mineral is such that it cannot be placed with any known species. On visiting the locality next summer, I hope to obtain specimens that will admit of a satisfactory quantitative analysis. The following are the characters on which this species is founded.

Massive and compact; cleavage, none.

H=4·5, G=4·378. Lustre resinous; fracture conchoidal, uneven: streak gray.

Before the blowpipe unalterable; after exposure to an intense heat, the mass assumes a grayish color; but on examination with a lens, it is found that this appearance is owing to a great number of threads of foreign substances by which the mass is penetrated. With borax it melts slowly into a glass yellow while hot, and pale yellow when cold: in the reducing flame, the bead affords indications of iron.

This mineral as I am informed by Mr Stanard, occurs on the north shore of Lake Superior, about seventy miles from the Sault St. Marie, at the junction of trap and sienite; the vein in which it is found is about two inches in width; but on account of its position, (on the face of an almost perpendicular cliff,) only a few specimens were obtained, and those with great difficulty. For the purpose of ascertaining its composition, the following experiments were made.

A small portion was pulverized: the powder was of a pale gray color.

A. This powder was treated with hydrochloric acid, it dissolved rapidly, with violent effervescence, and slight evolution of hydro-sulphuric acid. The solution was of a bright yellowish green color: it was evaporated to dryness, and left a dark green mass. Water was added and the solution filtered, a small quantity of silica was left on the filter. The solution was then boiled, when the color changed to a dark blackish-green, almost opake; on the ebullition being continued, a copious black-green precipitate was formed, and a colorless solution remained. This precipitate was collected on a filter and washed (*a*).

B. The remaining solution was very astringent; ammonia was added to it with the formation of a copious precipitate, slightly tinged with green, becoming yellow on exposure (*b*). The residual liquid was tested with sulphuric acid, and then with oxalate of ammonia, the latter caused a precipitate of oxalate of lime. The remaining solution, on being evaporated, left a residuum, volatilizable by heat, consisting only of the ammoniacal salts.

a. This precipitate dissolved with ease in dilute sulphuric acid; forming a pale green solution becoming yellow when heated with nitric acid, and on evaporation depositing small yellow crystals, and giving a copious red-brown precipitate with ferrocyanid of potassium. It was therefore protoxyd of uranium.

b. This precipitate was heated with a solution of potassa, a great portion was dissolved leaving a dark brown residuum (*c*). The portion dissolved appeared to be alumnia.

c. The brown substance was dissolved in dilute sulphuric acid, and the solution concentrated by heat; as the ebullition proceeded, a white precipitate was deposited, which was washed with a small quantity of water. When heated before the blowpipe it left a white earth, which gave a colorless assay with borax. The precipitate was therefore sulphate of thoria.

C. The solution left after separating the sulphate of thoria, was evaporated to dryness, and the crucible ignited, the residuum was gray.

d. This powder was boiled with hydrochloric acid almost to dryness; a fine yellow mass was left, which dissolved in water with the exception of a few flocks, (the last portions of the thoria.) The solution gave with ferrocyanuret of potassium a red-brown precipitate, it therefore contained uranium. An excess of solution of carbonate of soda was added to it; the yellow precipitate at first formed, was almost entirely redissolved, a few brown flocculi only remaining, which, when dissolved in hydrochloric acid, gave a deep blue precipitate with ferrocyanuret of potassium. They were sesquioxyd of iron.

The constituents of the mineral thus found, are:

(*a.* and *d.*) Protoxyd of uranium, (the peroxyd in (*d*) being formed by the decomposition of the protochlorid in (A).

b. Alumina.

c. Thoria.

d. Iron.

A. Carbonic acid, silica and sulphur.

B. Lime.

Now the carbonic acid could have been combined only with the lime, and the sulphur with the iron. The silica also was in very small quantity, These were probably the components of the small veins which became apparent on heating the mass. Rejecting these we have left protoxide of uranium, alumina and thoria, as the essential ingredients. The pitchblende from Joachimstahl in Bohemia., was found by Rammelsberg to be a compound denoted by $\dot{U}\dddot{\mathbf{U}}$. So that this mineral may be regarded as a corresponding compound in which the sesquioxyd of uranium is replaced by alumina.

The physical characters of this mineral approach very closely to those of pitchblende; from which however it may be distinguished by its lustre, and its less specific gravity. The presence of the thoria gives this mineral rather an anomalous composition; but as it is contained in a very small proportion, I apprehend that it will be found adventitious, or that the same vein will eventually furnish specimens of thorite, which being very similar in its physical properties, would not be obvious if mingled with the coracite.

Art. XX.—*Geological Results of the Earth's Contraction in consequence of Cooling*; by James D. Dana.

There are few geological writers at the present day who do not admit the former igneous fluidity of our globe.* In this belief they recognize the fact that the earth has undergone contraction as a consequence of cooling, and acknowledge a readiness to receive as geological truth, whatever may be shown to be the natural effects of such contraction. Yet why, after attributing to this cause, in a general way, much of the unevenness of the earth's surface, should the subject then be dropped, as if no such cause had operated? It is certainly of the highest importance that an agency so universal and so fundamental in its nature, should be followed out in all its bearings to the very limits of its possible effects.

---

* As matter of history, and on the principle also of "honor to whom honor," we cite here the following passages from the Protogæa of Leibnitz, written in 1691, giving his views respecting the origin of the saltness of the sea, and the formation of mountains and of rock strata.† On the first point he offers the true explanation; and although his views on the other points require some modification, they exhibit the wonderful depth and penetration of his mind. Alluding in the outset to an original state of igneous fluidity, he says (§ iv):—

"Ex hac *genesi rerum* jam observata hactenus procedet *salsi maris origo*. Nam ut perusta, ubi refriguere, humorem attrahunt, unde olea per deliquium Chemicis nascuntur in cella; ita pronum erit credere, sub rerum initiis, nondum separato a luce opaco, *cum globus noster adhuc arderet*, pulsum ab igne humorem abiisse in auras, deinde vero destillationum exemplo renatum, mox remittente æstu in aquosos vapores iterum fuisse densatum, et cùm a congelascente terrestris superficiei massa resorberetur, in aquam denique rediisse, quæ terræ faciem abluens vasta recentis empyreumatis vestigia, salemque fixum in se recepit. Unde natum est *lixivii genus*, quod deinde in mare confluxit."—"Postremò credibile est, contrahentem se refrigeratione crustam, ut in metallis, et aliis, quæ fusione porosiora fiunt, *bullas* reliquisse, ingentes pro rei magnitudine, id est, sub vastis fornicibus *cavitates*, quibus inclusus fuit aër humorve; tum etiam in folia quædam discessisse, et varietate materiæ calorisque *inæqualiter subsedisse massas*, quin et *dissiluisse* passim, fragminibus in *declivia vallium* inclinatis, cùm partes firmiores, et velut columnæ, supremum locum tuerentur: unde jam tum *montes* superfuere. Accessit pondus aquarum, ad alveum sibi parandum in molli adhuc fundo. Denique vel pondere materiæ, vel erumpente spiritu, fracti fornices, maximæque, humore cavitatibus per ruinas expulso, aut sponte montibus effluente, secutæ inundationes, quæ cùm deinde rursus sedimenta per intervalla deponerent, atque his indurescentibus, redeunte mox simili causa, strata subinde diversa alia aliis imponerentur, facies teneri adhuc orbis sæpius novata est. Donec quiescentibus causis atque æquilibratis, *consistentior* emergeret *status rerum*. Unde jam *duplex origo* intelligitur firmorum corporum; una, cùm ab ignis fusione refrigescerent, altera cùm reconcrescerent ex solutione aquarum. Neque igitur putandum est *lapides ex sola esse fusione*. Id enim potissimum de prima tantùm massa ac terræ basi accipio; nec dubito, postea materiam liquidam in superficie telluris procurrentem, quiete mox reddita, ex ramentis subactis ingentem materiæ vim deposuisse, quorum alia varias terræ species formarunt, alia in saxa induruere, e quibus strata diversa sibi super imposita diversas præcipitationum vices atque intervalla testantur." Here we have in general terms the just mean between Wernerism and Huttonism attained long before either Werner or Hutton lived.

Again, he remarks as follows, after some explanations, on the elevation of mountains, § xxii:—"Ego ut facilè admittam, initio cùm liquida esset massa globi terræ,

† An abstract of this passage is given by Lyell in his Principles of Geology, and with illustrative remarks by Conybeare, in the Rep. Brit. Assoc., 1832, p. 366; also a brief abstract of the Protogæa by Prof. E. Mitchell, may be found in this Journal, xx, 56, 1831.

Among English geologists, the subject has received little attention except in the writings of De la Beche; and in the Treatises on Geology in our own language the absolute rising and sinking of the continental lands and the stability of the waters are usually set down as established truths.* In this country, Prof. W. W. Mather† has made the theory of "secular refrigeration" a subject of special consideration: and an account of its supposed bearing on the magnetic variation of our globe and on the tides, has been published by Prof. J. H. Lathrop.‡ In the Geological Society of France, this theory of a cooling globe has been a frequent subject of discussion, owing perhaps, in a great degree, to the attention called to the subject by the elaborate mathematical essay of Cordier.§ M. Elie de Beaumont, the great champion of "soulèvement" theories, appeals to contraction to explain the direction and

---

luctante Spiritu superficiem variè intumuisse, unde illi mox indurescenti primæva inæqualitas; neque etiam diffitear, firmatis licèt rebus, terræ motu aliquando vel ignivomâ eructatione, monticulum factum. Sed ut vastissimæ Alpes ex solida jam terra, eruptione surrexerint, minus consentaneum puto. Scimus tamen et in illis deprehendi reliquias maris. Cùm ergo alterutrum factum oporteat, credibilius multo arbitror, defluxisse aquas spontaneo nisu, quàm ingentem terrarum partem incredibili violentiâ tam altè ascendisse." In § vi, he explains the oscillation of the water and land by supposing the existence of great arched cavities ("fornices," obviously considered as a result of contraction on cooling,) which were afterwards broken. He says: "Ita priore rupto aqua in montes ascenderit, mox, posteriore fracto in abyssum ulteriorem penetrarit, terrestribusque habitatoribus iterum indulserit in sicco locum verisimile est." There is certainly some approach to the views we advocate, in his rejecting the idea of a bodily lifting of mountains by force beneath, and also in the suggestion that oscillations were produced in the water level by subsidences, though we know nothing of his "fornices."

* De la Beche, one of the profoundest geologists of the age, appeals to contraction for the production of fissures, depressions, and elevations by lateral action; he also considers fractures and elevations to form from matter struggling to free itself, from earthquakes of great intensity or from elastic forces acting beneath. Lateral pressure is attributed to contraction, but in the case of the Alps and other cases mentioned, to the extrusion of material from below.

We observe in the memoir by Prof. Sedgwick, on the Cambrian Mountains, (Geol. Trans., ii Ser., iv, 47, 1833,) the following remark: "As the earth has apparently diminished in temperature, we have a right to look for some indication of a contraction in its dimensions. May not some of the great parallel corrugations of the older systems of strata have been produced by such a partial contraction?"

† See this Journal, xlix, 284, 1845. Prof. Mather, in his valuable paper, attributes changes of level to contraction causing depressions and elevations and lateral displacements, to "a subterranean force tending to elevate parts of the earth's surface," to waters gaining access to opened fissures, and to paroxysmal variations in the angular velocity of the earth, the latter causing paroxysmally a westward motion in the internal fluids, and through them, the same motion in certain parts of the crust of the globe, which are consequently dislocated and folded.

‡ This Journal, xxxviii, 68, and xxxix, 90. Prof. Lathrop, (now President Lathrop, of the University of Missouri,) besides recognizing the general effect of contraction in causing a change of water level, endeavors to prove that the fluids of the interior have a slow westward movement, correspondent with the change of magnetic variation, and also a tidal motion, which acting on the crust is a cause of the marine tides.

§ Essai sur la Temperature de la Terre, 4to, pp. 84. Read before the Academy of Sciences, June 4, and July 9 and 23, 1827. Also, the same, translated by the Junior class in Amherst College, 1 vol., 12mo, 94 pp.: Amherst, 1828. See also an abstract in this Journal, xv, 109.

origin of mountain chains, and the same view is adopted by M. Omalius d'Halloy and others, who appear to consider no farther the results that may flow from this cause. MM. Leblanc,* Angelot,† Roys, and Rozet,‡ reason more freely upon the subject, and derive from the theory explanations of volcanic and other phenomena. Prevost§ has the credit of priority in many principles adduced, and of greater precision and comprehensiveness in his deductions. Cordier alluded only in general terms to dislocations from contraction. Prevost shows not only that the cause should produce displacements, but points out ways in which these displacements should take place; and he concludes that the

---

* Leblanc (Bull. de la Soc. Geol. de France, xii, 137, 1841) endeavors to show by calculation, what are the effects of this contraction in depressing certain parts of the crust and swelling others, the swelling producing, as he argues, void places below and fractures of the crust; he remarks that the largest depressions thus formed are the oceans, while the folds are the mountains, and the plains are the parts "qui correspondent aux exhaussements lents qui ont dû precéder des rides."

† M. Angelot reasoning upon similar grounds, accounts for volcanic action by supposing that the void spaces produced by contraction become filled by water, which water feeds the fires, and may be at times a source of earthquakes and of much metamorphic action, as for instance the production of serpentine. (Bull. Soc. Geol. de France, xi, 178, 245, 1840; xiii, 377, 400, 1842; xiv, 43, Nov. 1842.) The hypothesis of the existence of such void spaces is opposed by M. Roys, and others. (Ibid, xiii, 238, 249.) M. Angelot quotes Bischof's investigations, in Leonhard und Bronn's N. Jahrbuch, 1841, pp. 565, 566, which show that granite *contracts a fourth* of its volume on cooling from a liquid state, trachyte *a fifth*, and basalt *a tenth*, or respectively in decimals, 0·7481, 0·8187, 0·8960. The *lineal* contraction of granite is hence *one-tenth*.

‡ Bull. de la Soc. Geol. de France, xii, 176, xiii, 175, 1841, 1842. Rozet agrees with Cordier with regard to volcanic eruptions; but he attributes some of the great geological changes to a change in the earth's axis of rotation.

§ Prevost's views have been presented in various discussions before the Geological Society of France during the twenty years past, but are most fully detailed in volume xi, of the Bulletin, pages 183 to 203, March, 1840, from which we cited his general deductions in the last volume of this Journal, page 355. The "*Elevation*" theory of craters, which constitutes a part of the views opposed to his theory, is also discussed in the same place, and in the volumes preceding, and following. To give a more just exhibition of his views, and that he may not be charged with any modifications of them, or peculiar deductions, for which the writer alone is responsible, we give here a translation of several paragraphs from his memoir.

"If a cause analogous to that which, according to the theory of *Elevation*, (soulèvement,) is supposed to have raised the Alps or Andes, should elevate the bottom of the South Seas and cause a continent to appear above the waters, what effect would this event have upon the land? It is evident that a quantity of water equal to the volume of the submerged part of the new continent would be thrown over the shores of America, Asia and Europe, and after the oscillations had ceased, parts now dry would remain submerged.

"But passing from these suppositions and reasonings to actual geological facts, do we not observe over all lands, continents as well as islands, ancient marine beaches and thick deposits of marine origin, which have been left dry and still preserve their normal position? The general level of the waters has then been lowered; and in order to this effect, either the waters have diminished, (which few will suppose,) or else in consequence of displacements in the earth's crust, the depressions formed are much more considerable than the elevations.

"If upon all shores, from New Holland to England and Iceland, both of islands and continents, and on the banks of rivers, we recognize undeniable marks of a previous water level at different heights, all nearly parallel, it is very difficult to attribute the successive elevations of such extent, to an absolute elevation of the surface, the different parts of which surface retain the same relative positions as agency of contraction alone, without the causes of "soulèvement"* usually appealed to, will account for the various changes of level which the continental areas have undergone. He rejects the idea of an *elevating* force which can raise mountains or continents, except such as is incidental to contraction. The principal points in Prevost's theory have already been presented in the preceding volume of this Journal, on page 355; and below we have given in a note a part of his explanations.

The reader will perceive that although the main principles of Prevost are sustained by the writer in this and his former paper, the manner in which these principles are carried out, is in some respects a little different, especially in the idea that the *oceanic areas* have been the more igneous parts of the globe, and for this reason have contracted most;† that certain orographic changes over the continents are due to contraction beneath the oceanic regions, and that the fissurings and mountain elevations have for this reason taken place in some instances near the margin of a continent, or near the limit between the great contracting and the non-contracting (comparatively non-contracting) areas. The efficiency of the cause of contraction has appeared to the writer to be wider and more evident, as the subject has received closer attention; and the study of it has naturally led to modifications of former views.

The theory if true does away with the most incredible of geological dogmas,—the idea of a force acting beneath the continents which can raise them bodily with their load of mountains. The mind unprejudiced naturally asks, where does this force reside? and how does it act? What fills the void left by the raised continent? Why, after an earthquake has passed, should not a mass of rock as large as the Andes and half of South America, sink back again to its place?

---

before the change of level. If, on the other side, we view as submerged all the parts of existing continents and the islands on which marine deposits occur in horizontal position; if we place beneath the water the great part of the points of the surface now existing as mountains, whatever is supposed to have *risen* since the formation of these marine deposits, we cannot but see that there would be no place for vegetation or terrestrial animal life, none for the great lakes with their freshwater animals and plants, and none for the rivers, the remains of whose numerous organic productions are met with in ancient deltas.

"Are we not then forced to admit that while the bottom of the sea has been raised above the level of the sea and made dry land, by a series of displacements, still larger terrestrial areas have disappeared from submergence; and in such a way that the depressions formed were greater than the elevations, a condition without which, I repeat it, the low parts of our existing continents could not have been emerged, a condition requiring for its fulfillment, no aid from the supposed agent of "soulèvement," since this would produce a contrary effect."

* The word "*soulèvement*" in French has a force which does not belong to our English word elevation, as it implies an upheaval from force applied *beneath*.

† Lyell translates and cites the following from Strabo: "We must therefore ascribe the cause [of changes of level] to the ground,—either to *that* ground which is under the sea, or to that which becomes flooded by it, but rather to that which lies beneath the sea, for this is more movable, and on account of its humidity, can be altered with greater celerity." (Principles of Geology, vol. i; Strabo, Geog., lib. 1.)

It is said that waters gain access below, and by a sudden expansion to a state of vapor, the land is thrown up: but, again, why should not the vast weight cause it to sink back as the vapors are condensed? Surely an injection of liquid lavas into any cavities or opened fissures—a material that cools with such extreme slowness—would be a poor support for a chain of mountains. Is the water to gain access through opened fissures? but it would meet molten material rising from below to fill the fissure, and how then could the water thus intercepted make its way, in any large body, *under* the crust, so as to *lift* the surface into mountains? How can such an elevating force get beneath when there is no "beneath" to the fluid column short of the antipodal crust?* The expansive force of contained vaporizable substances pent up in the liquid interior, can be a no more effectual cause; for it does not appear that such a force can act against the incumbent pressure, except by making the lavas somewhat lighter and causing them to swell up into an opening; it can give no eruptive force to the igneous fluid.†

It is urged again that the crust below may possibly be acquiring heat from the internal fires, so as to become elevated by expansion. But there is little to satisfy the mind in this assumed *possibility*, especially when it is considered that through past times the elevation of the land has been on the whole increasing, and yet facts and reason evince that there has also been a gradual cooling below and a thickening of the crust. With such a theory we should have, therefore, the incongruity of an average *increase* of heat through past ages to the present time, and a cooling of the crust going on, that is, a *diminution* of heat, at the same time.

If after all, we can account for facts without calling upon any special force for lifting continents;—if this effect may be a simple result of contraction, we are relieved of many improbable assumptions. We can well conceive that fractures should take

---

* We have not alluded here to the reservoirs of water, which, according to M. Angelot, have been so important a means of elevations and metamorphism, because we see no evidence that such cavities exist. The slow cooling and consolidation within produce a gradual thickening inward of the crust; and no cavities of much size would form till the crust was too thick to yield to the tension by fracturing; and this is a condition which, possibly, is yet hardly attained, for the crust, even if a hundred miles thick, is relatively less than a fourth the thickness of the skin of an orange.

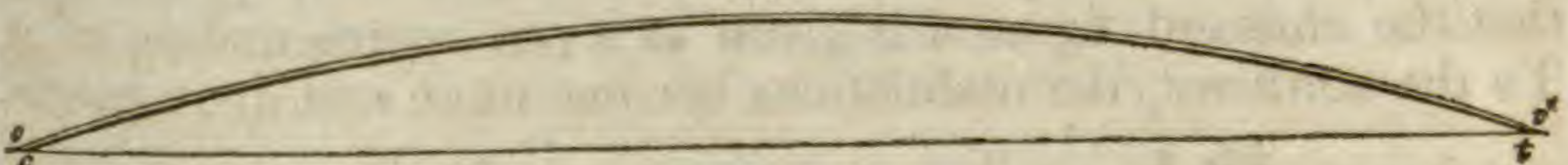
† Speaking of lava in a crater, Prevost says significantly, (loc. cit. p. 188,) "La lave n'est donc pas plus *soulevée* par une force qui serait placée sous l'extrémité inférieure de la coulonne qui s'élève, que la mousse de la bière n'est soulevée par le fond de la bouteille." Again, speaking of volcanic mountains, he says with some humor and with truth, "Il ne faudra pas dire que ces masses sont soulevées, pas plus qu'on ne dit que la *pâte de froment*, qui a été pétrie avec du levain, et qui *lève*, est *sous-levée*." In a note to page 96 of this volume it was incorrectly implied that Prevost attributed all ordinary volcanic eruptions to the collapsing of the earth, consequent on contraction; on the contrary, he recognizes the influence of the process of tumefaction ("boursouflement") in volcanic operations.

place as a consequence of contraction below a stiffened crust; we know them to be a necessary effect. We see also that depressions would somewhere follow a fracture, and the lateral pressure exerted would be likely to dislocate, often raising and necessarily propping or supporting as it raised. We understand that such fissurings, whether internal or external, would cause shakings of the earth (*earthquakes*) of great violence, and in all periods of the earth's history, and it might be over a hemisphere at once. We comprehend too how the continued contraction of vast areas like the oceans would draw off the waters from the land; and by the several combined effects of the cause under consideration, oscillations in the water level would take place. These effects have been briefly stated in the preceding number of this Journal.* The theory appears to us to be more worthy

---

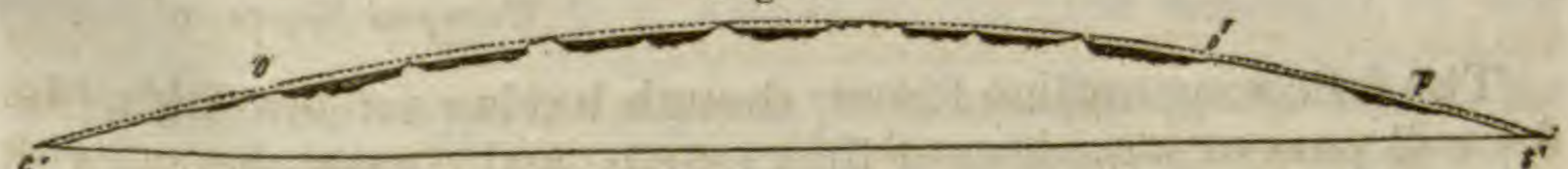
* See page 95.—The principles may perhaps be rendered more clear by means of the following figures. In fig. 1, the crust (*c t*) is represented covered with wa-

Fig. 1.



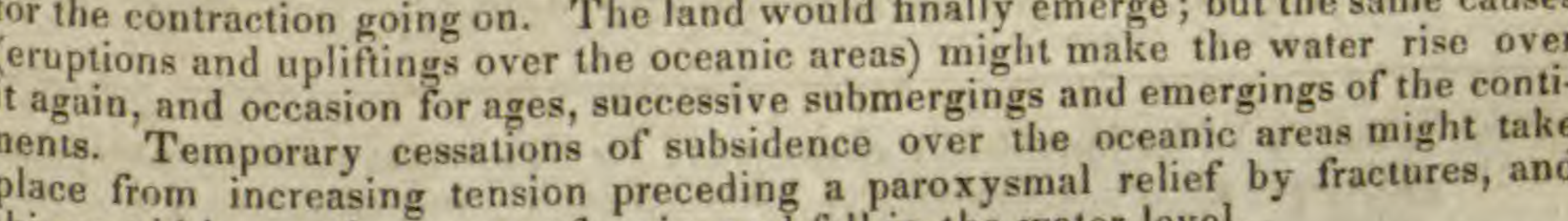
ter (*o o'*). In fig. 2, the globe has contracted from the dotted line to *c't'*; *c'o*, *o't'*, are the portions free from volcanic action, (as was the case almost entirely with the parts corresponding to the continents in the Silurian period;) *p* is an area of wa-

Fig. 2.



ter upon *o't'*. *oo'* represents the incipient oceanic depression, over which, owing to its igneous character and thinner crust, (this Journal, ii, 352,) contraction went on the most rapidly, and where, at the same time, igneous ejections and displacements (which result from contraction beneath the crust, causing a drawing down of the crust upon a diminishing nucleus) were frequent. It is evident that the depression would at first be too shallow to contain all the water; but as subsidence proceeded, and most rapidly over the oceanic areas, the capacity of the cavity would increase and tend to drain the forming continent. This result might, however, be long delayed by the eruptions and upliftings throughout the area *oo'*, an effect which would diminish the capacity of the oceanic basin, and so compensate for the contraction going on. The land would finally emerge; but the same causes (eruptions and upliftings over the oceanic areas) might make the water rise over it again, and occasion for ages, successive submergings and emergings of the continents. Temporary cessations of subsidence over the oceanic areas might take place from increasing tension preceding a paroxysmal relief by fractures, and this would be another cause of a rise and fall in the water level.

Fig. 3.



As the crust below the oceanic depression becomes thicker by cooling, the contraction, not now causing fractures and upliftings over its own area alone, would produce a tension laterally against the non-contracting area and occasion pressure, fissures, and upheavals; and thus the elevations *m*, *n*, *r*, *s*, fig. 3, would result. From this figure, the fact will be appreciated that the amount of effect, claimed for of favor the more closely it is applied, and we would fain believe that the following explanations will be found to secure it some additional attention.

I. *Folding of Strata.*—In our last article on this subject, allusion was made to the foldings of the Appalachian strata, and from the fact that the plications were more abrupt, and the effects of heat more decided, towards the ocean, and also in view of the correspondence observed with analogous facts on the Pacific side of the continent, it was urged that the foldings resulted principally from a subsidence of what is now the oceanic part of the earth's surface. But the peculiar features of the folds present points for consideration which the theory, if true, should explain. We refer again to the admirable paper of the Professors W. B. and H. D. Rogers on the Appalachian chain for the details of the structure there presented.† These geologists have shown that the folds or plications are many and vast. Towards the southeast they are as closely compacted as is in any way possible, so that the annexed figure 4 is given as a just representation of it. To the northeast, the undulations become more and more gentle.

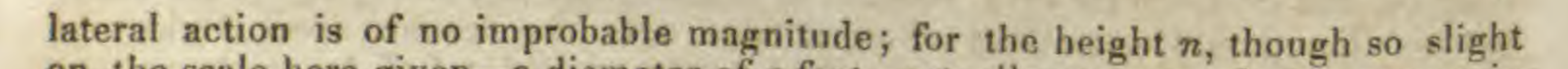
Fig. 4.

Fig. 5.

Cacapon Mountain.

The following outline figure, though having too few folds, (fig. 6,) will present some idea of their extent, and (in connection with figs. 4 and 5,) shows the characteristic forms of the plications, as ascertained by these able geologists.

Fig. 6.



S.E. N.W.

From the Southeast across the Appalachians to the Northwest.

Though the regularity is somewhat exaggerated, the general facts are not so. The surface of the country has since been

---

lateral action is of no improbable magnitude; for the height *n*, though so slight on the scale here given—a diameter of a foot—actually corresponds to a mountain twelve miles in altitude above the sea. It could not well have been made less on the scale adopted. The reader can judge how small an elevation would represent the average height of the continents above the sea; for this height, according to Humboldt, is somewhat less than a thousand feet, or, on the scale in the above figures, about a seventieth part of the elevation *n*.

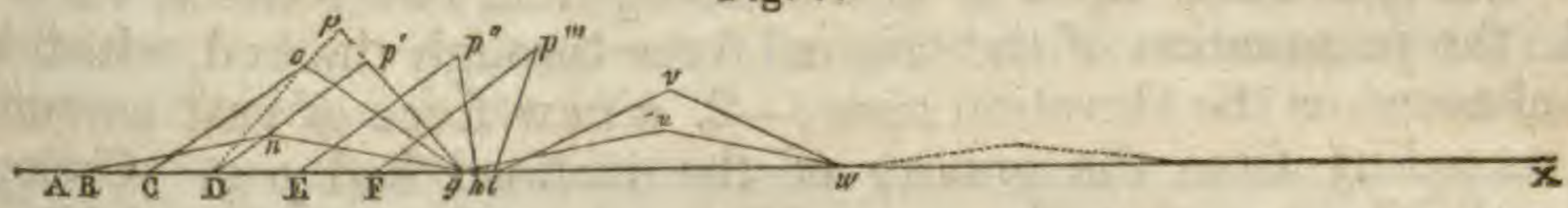
† Trans. American Geol. and Nat., p. 474.—We owe to these geologists, in addition to their exposition of the system of curves in the Appalachian strata, the fine generalization that the *southeasterly* dip in the metamorphic rocks through the regions east of these mountains, has arisen from a close plication of the strata as illustrated in fig. 6. It is apparent from this figure that the strata of both slopes of the fold dip alike to the southeast, as shown also in figure 4.—See this Journal, xliii, 177; xliv, 359; xlv, 341, 346; xlvii, 276.

greatly denuded, and has almost wholly lost the wave-like features, which are so distinct in the stratified beds of rock.

The principal peculiarity of these plications to which we would now ask attention, is the following;—*the greater abruptness of the northwestern slope of each fold, in connection with the diminution of the undulations to the northwestward:* and it will be our endeavor to show that *this peculiarity, and the irregularities which exist, are necessary results of the action of a force laterally exerted.**

This point may hardly require a formal demonstration; yet as other explanations have been offered, we propose to present it in brief detail. In the following figure the folds are represented for convenience of illustration, angular at summit.

Fig. 7.



Let AX represent a bed of stratified clay and sand, in alternating layers, say a thousand feet thick and many miles long; the material either not at all indurated or imperfectly so.

Suppose the *force* to be exerted from the left against A, in a direction varying very little from horizontality.

Resistance to this force will proceed *from gravity*, each vertical square yard pressing with a weight in the case supposed, of *one*

* The Professors Rogers in accounting for the facts they have so skilfully developed, admit a degree of lateral action; but they argue that this action proceeded from the propelling force or thrust of moving waves of molten material beneath the earth's crust, the material of the interior being supposed to be in a state of free liquidity and subject to undulations. With regard to the northwest slopes being steepest, they say (loc. cit., p. 512), "This forward thrust operating upon the flexures formed by the waves, would steepen the advanced side of each wave precisely as the wind, acting on the billows of the ocean, forces forward their crests and imparts a steeper slope to their leeward sides;" and alluding to the position of the operating force, as determined by the greater dislocations to the southeast, they say (p. 517), "the progressive rise of the whole belt towards the side which anciently lay near the shore of the Appalachian ocean, accords entirely with the belief that under the now rent and dislocated margin of the chain there was a vast accumulation of fluid rock charged with compressed gaseous matter, which exerted on the crust an enormous disrupting tension."

Prof. W. W. Mather, in his remarks on the secular refrigeration of the earth, (this Journal, xlix, 284,) accounts for the foldings and for the steeper northwest slopes on the ground of "a paroxysmal elevation and the action of inertia," this paroxysmal elevation, as he urges, arising from a change in the rapidity of the earth's rotation consequent on an abrupt change of dimensions from cooling, (see note, p. 177.) He says, p. 299, "If the earth has at any time become more oblate in consequence of increased angular velocity, inertia would tend to make the solid matter of the exterior of the globe press to the westward." And again, with reference to the steeper northwest slopes, (p. 292,) "Suppose the *sudden* elevation of a mountain mass one mile in height; it would still retain the linear velocity it had when a mile nearer the axis of rotation, while the *proper* linear velocity at this increased distance would be 3·1415÷24 miles, or 694 feet greater per hour than that which it had before its elevation. Inertia therefore would cause the mass at the top to press to the westward with a force proportioned to its mass and the above mentioned velocity."

and a half millions of pounds, or 750 *tons*;—also *from cohesion* within the bed, and below.

The force will travel slowly from A towards X, on account of the gravity, cohesion and partial compressibility of the mass: the first dislocation will hence take place towards A, and it will therefore produce a bulging, as B *n g*, A at the same time advancing to B. (The distance A *g*, for a specific direction of the force, will depend on the thickness, gravity and cohesion of the bed.)

The force continuing in action, *part* of it will be transmitted towards *g* and X, owing to the difficult flexibility of the bed arising from cohesion and gravity: *another part* will cause B to advance towards C, and tend to raise B *n g* to C *o g*. In the same manner, C *o g* will tend to change to D *p g*.

But the action upon *g* is increasing from two sources, viz:— 1. the propagation of the original force through the bed, which is enhanced as the elevation rises;—2. a new force of vast amount proceeding from the gravity of the inclined bed *p g*. Owing to the last mentioned cause, in connection with the yielding nature of the material, *p g* sinks to $p' g$, and D $p' g$ becomes the actual position of the bed instead of D *p g*. The sinking of *p g*, and the primal force together, (if the latter were not before sufficient,) would cause *g w* to rise to *h u w*.

The force continuing, the position D $p' g$ is changed successively to E $p'' h$, F $p''' i$. The greatest propelling power is exerted by the gravitation of the inclined bed *p g*, when its angle of inclination is between 45 and 60 degrees. Beyond 60° the action is increasingly downward, and the propelling part of the action becomes small. At 90° and beyond, the action is wholly downward, so that in this position, *p g* shortens only from the compressibility of the mass. Now, the action on *g w* is simply the primal force, nearly or quite the whole of which acts upon *g* X. Thus *h u w* rises to *i v w*; and this again, continuing to rise, changes in form in the manner just illustrated.

By this process, therefore, a *series of folds would be produced each with the inclination steepest on the side farthest from* A; *and moreover, these folds would be necessarily most abrupt the nearer they are to* A.

In the above, the lateral force has been supposed to act directly upon the borders of an oceanic depression. When the contraction in progress produces *fractures over the interior of a continent*, the continued contraction and increasing lateral pressure, still operating upon the same yielding area, might *produce plications parallel with the line of fracture, which would be most abrupt near it, and diminish in the distance*, a fact illustrated in the Urals.* The plications would differ in extent on the two sides of the line, provided the force or the material were different.

* Geology of Russia and the Urals, R. I. Murchison, i, 462.

II. *Reasons why this action should not produce perfectly regular and uniform folds.*—Irregularities would proceed—

1. *From a variation in the thickness of the bed*, in consequence of which there would be a difference in the gravity of the mass in different parts.

2. *From a want of uniformity in the material* or its state of induration, causing the cohesion to vary, and hence also the flexibility or frangibility of the bed.

3. *From an inequality in the action of the force upon the different parts of the line against which it operates.* If the main cause of this force is contraction beneath the oceanic parts of the earth, such inequalities must have existed. For we know that igneous vents have been localized to a great extent over these oceanic areas, and generally they occur in lines, as groups of islands evince. Consequently the effects of contraction could not be equal along a given line.

4. From any irregularity which there might be in the contraction going on (for there should be some such contraction) beneath the area which is subjected to the lateral pressure.

A *fifth* reason might be added, but it is of a general nature and will form the subject of another communication. The four specified are sufficient to set aside any objections to the view urged on the score of the irregularities which exist.

III. *Effects of gravity on the inclined strata.*—When the beds become very much inclined, or dip at a large angle, the more sandy layers if not too much indurated, would settle bodily downward; the clayey layers would also settle, but owing to their cohesion when moist, they would become flexed or crimpled. *Thus plications would be produced*, from gravity alone; a fact abundantly illustrated in the metamorphic rocks of New England and other countries; and it might happen that small plications should in the same manner be produced between non-plicated beds.

IV. *Effect of lateral action where there is no plication, or but a limited amount of it.*—If the material subjected to lateral pressure be not capable of folding, or *only partially so*, the region operated upon instead of rising into a series of elevations, would be raised into one or more ridges of much greater height. Has not this last been the case on the Pacific side of the continent? or, is the elevation owing to a less nearly horizontal direction of the lateral force? or to a greater amount of oceanic depression?

V. *Intruded igneous rocks occurring with plicated beds.*—The occurrence of dikes or intruded masses of igneous rock in a plicated region, is no certain evidence that the intrusion was the cause of the plication, as the two effects, on the principles explained, might be concomitant results of the same general operation.

VI. *The folding of strata by subsidence of the plicated region can be only of small extent.*—This subsidence may or may not be attended by a *general contraction* of the earth's crust below the plicated bed. If not, then the bed, before straight, must be lengthened by the action to fit the curve of depression: a curve of a semicircle would require an extension of one half, in the bed, and a more abrupt plication, a greater extension. It is well known that clays and sand layers would not bear such a stretching, and the result could be accomplished only by fractures and openings. The material moreover would be drawn off from the summits of the convexities, or very much thinned out in those parts; a supposition not warranted by facts to the extent required in the explanation. The hypothesis moreover would not account for the greater steepness of the northwest slope.

But if the material beneath may be supposed to have contracted correspondingly with the amount of plication, then folds might have been produced by the process. The hypothesis however has many weighty objections. It is at variance with the fact that this same region remained unplicated, at least in the parts occupied by the coal formation, till after the coal epoch, although the contraction must have been more rapid during the preceding epochs of the earth's cooling.* The non-plication of the Silurian rocks of the centre of our country, adds force to this objection. Why this long delay in the action of those violent forces supposed to be imprisoned beneath the earth's crust?

Farther, a stiffened crust cannot be much folded by mere *shrinkage*, where the material is like that of the earth's crust. The fact that the Silurian rocks of the interior are not plicated by contraction below them, is evidence of this. Instead of becoming plicated, they have probably aided by lateral action in producing the elevations on the east or west, or the Ozark Mountains or other heights intermediate.

Moreover, the very *close compacted* folding illustrated in figs. 4 and 6, a result which only lateral pressure could effect.

VII. *Position of volcanoes.*—The occurrence of volcanoes mostly in the neighborhood of the sea, is a necessary result of these principles. For we have already stated that fractures of the earth would be likely to take place near the limits between the contracting and non-contracting areas:† *here* they would have that depth and extent which is necessary in order that they should remain open as the seat of perpetual eruptions; for there is necessarily a wide difference as regards extent between those fissures

* The writer has offered as an explanation of this non-plication till after the coal epoch, the suggestion that the crust over the oceanic (or igneous) portions, had so far cooled by that time, that the pressure or strain arising from contraction was no longer relieved to the same extent as before by rents and upliftings over the igneous region. This lateral action was exerted long previously, but its greatest effects on the earth's features date subsequently to the carboniferous epoch.

† This volume, page 96.

that only allow the material to escape and form dikes, and those great fractures from which an Etna, or a range of Chimborazos, has originated. We have remarked in another place,* and the fact is sufficiently important to be again repeated, that the absence of the sea is no reason for the absence of volcanoes from the interior of our continents; since this same freedom from volcanoes existed in the Silurian epoch, when these very continents were mostly under salt-water.

VIII. *Geological epochs.*—This subject suggests a cause for the transitions marking geological epochs. The formation of the Appalachians was attended by rendings and emissions of heat on a vast scale, and the baking and crystallizing of the metamorphic rocks of the region, as well as the debituminizing of the mineral coal rendering it anthracite, are attributed by the Professors Rogers to this action. It is not a matter of surprise that there should have been an abrupt cessation with this event, of preëxisting forms of marine life. The period when the effects of dislocation began to be transferred from the oceanic areas to the continents, appears to have been the era of this catastrophe; and it was an era of similar changes in various parts of the globe. The previous epoch no doubt had its violent convulsions, but still there was *comparative* quiet favoring the continuance of Silurian life.

This era was probably followed after a while by another of similar quiet to that which preceded it, along the eastern portions of our country; and during this elapsing time, tension (from the progressive contraction,) may have been slowly increasing. The opening of the trap fissures, and their injection with the molten rock, may mark the termination of this period of quiet—the extensive fractures being a result of the increased tension. The parallelism of the dikes to the Appalachians, alike in Nova Scotia, the Connecticut valley, and New Jersey, and farther south, renders it probable that the same grand cause which produced the elevation of those mountains, produced also this result. These igneous eruptions and the vibrations which the ocean must at times have experienced, are adequate to explain the occurrence of a second era in the geological history of this country.

We know not how widely the last catastrophe extended over the globe, or whether it belonged to this continent alone, for we may not say with certainty whether displacements and fissure-ejections of the same general era in Europe, belonged to this particular period in the era. The above facts are brought forward to illustrate the general principle, already admitted by some writers, that such grand crises,—by causing wide emissions of heat, a change of level in the sea, and violent shakings of the globe with its mobile waters,—were in early times a necessary result of the

* This Journal, ii Ser., ii, 353.

contraction in progress. Facts on record prove farther, that these grand catastrophes had their widest influence after the coal era, and became less and less general as succeeding ages rolled on.

IX. These principles give us some *data for comparing the energy of forces in past times in the earth's history, with those now in action.*—In admitting them as a basis of geological reasoning, we may be considered as proceeding on an hypothetical basis. Yet in reasoning without reference to them, is the ground assumed any the less hypothetical? With those who believe in the former igneous fluidity of our globe, contraction is the grand and fundamental agency to be first considered after the general principles of solidification.

X. *Tides and paroxysmal movements beneath the crust of the globe.*—In the course of this article we have not alluded to the effects of tidal and other motions in the heated interior of the globe, leaving it for those who can prove their occurrence to modify thereby the explanations here offered. Several difficulties have appeared to the writer to strengthen the opinion advocated by Lyell and Poisson, that the globe, before its crust had consolidated, had become so stiffly viscid as not to admit of tides, a condition believed to be essential to the formation of a permanent crust. If there were *daily tides*, or a *westerly movement*, or if *undulations* were possible, sufficient to throw up the Appalachians, why, as we have asked before, were these mighty and resistless agents nearly dormant in this part of the globe till after the coal era? Why did they not act violently upon the Silurian rocks of the west, before the period that originated the Appalachians? and why not also more decidedly at the time of this great catastrophe? These questions are, perhaps, in part answered by Prof. Mather, by the argument that there would be grand paroxysmal effects attending contraction, causing at long intervals, a violent westerly movement beneath the crust. But, again, why if the cause of the mountain elevations is a westerly movement (that is a movement from the *east*) beneath the crust, why should we have mountains on the *west* side of the continent, while the wide interior is nearly flat? And why should these western mountains have attained such an altitude? Why should the areas of greatest igneous action be to the west of the summit on the Rocky Mountains, and to the east over the Appalachian region; that is, on the *oceanic* side in each case? These are among the objections to the hypothesis, that internal tides or undulations have been a prominent agent in geological dynamics since the beginning of the Silurian epoch; and if the explanations of phenomena, offered in this article, are at all satisfactory, they contain a still weightier argument against the view.

ART. XXI.—*Notes on the Herbaria, Gardens and Botanists of Upsal, St. Petersburg, &c.*, gathered from the letters of a distinguished botanist during a continental tour.*

AT Upsal, I was fortunate enough to find both Prof. Wahlenberg, who has the care of the Museum of Natural History and Botanic Garden, and Professor Fries, at home. Both received me with every civility and attention, and I spent as much time with one or the other as my short stay would admit of my devoting to botany. The Museum was founded after the younger Linnæus's death, when the loss to the country of Linnæus's herbarium, made the government feel the want of a public establishment for the reception of national collections. The herbarium, placed in two spacious and well lighted rooms, consists chiefly of Thunberg's herbarium, Afzelius' African herbarium, and Wahlenberg's private herbarium. Of these, Thunberg's is by far the most valuable; it is glued down on white paper, after the model of our English collections, but on smaller paper than the Banksian, the species, in like manner, gathered in generic covers: the genera have been arranged by Wahlenberg, according to Sprengel. Besides the plants collected by Thunberg himself at the Cape, Japan, Ceylon, and in North Europe, it contains a considerable number of authentic specimens from Swartz, Lamarck, and other botanists of his day. * * * * * I soon found that the ascertaining of the identity of the specimens described in his *Flora Capensis*, would be a work of much more labor and time than I could bestow. His plants are indeed all named; but in many cases he had discovered the mistakes he had made, erased his original names so as to render them quite illegible, and substituted others; so that unless some botanist of correct judgment, and well acquainted with Cape plants, were to come and bestow some months on going through his herbarium, the puzzles of the *Flora Capensis* must remain uncleared. The specimens are generally small, but with a few exceptions tolerably satisfactory and well preserved. Afzelius's Sierra Leone collection is a very fine one;

---

* Extracted from the London Journal of Botany for October, 1846.

We are informed by the writer of these notes, that Dr. Lehman at Hamburg, has found time to finish the *Plantæ Preissianæ:* at Copenhagen, Prof. Schouw, so well known for his labors on geographical botany, has been ill for the last year and a half. Dr. Liebmann, the adjunct professor, has lately returned from Mexico, with a collection of plants which he estimates at 10,000 species. The herbarium and copious manuscripts of Vahl are still in the possession of his son, Dr. Vahl, (who lived many years in Greenland,) the present librarian at the Botanic Garden. At Gottenburg, Areschoug, who lectures at the High School, is a zealous investigator of *Algæ.*

At Stockholm the writer met Prof. Wikström, and examined the herbarium of Swartz, which belongs to the Academy of Sciences. It appears to be extensive and in good preservation.

one set is glued down, after the pattern of Thunberg's, and the remainder, often many duplicates, are loose in sheets of a larger size. The specimens are generally good, and many of them accompanied by fruits in a separate collection, but with references to the specimens.

The living collection in the Botanical Garden, though not kept in such good order as could be wished, is tolerably rich. The Russian species, received through the Petersburg garden, flourish well here; other exotics are such as could be obtained through Booth, of Flottbeck, and some interesting plants are the descendants of those cultivated by Linnæus, and thus constitute the only authentic specimens of such as he did not dry for his herbarium. We went with Prof. Fries to see the house in which Linnæus lived, and the garden where he cultivated his 'Hort. Upsal.' plants, now no longer belonging to the family, but in which the buildings used by this great father of modern botany as green-houses and lecture-room, still exist; and a poplar tree, known to have been planted by his own hands, is shown with great reverence. Proud though we may be in England of possessing his collections, it is impossible to be at Upsala, where so much is associated with his name, to see the respect paid to his memory, and the value attached to the few manuscripts or other remembrances of him which they have been able to amass, without feeling that this is the place where his library and herbarium ought to be, and that if they had been here the botanical world would long since have known what information can or cannot be derived from the specimens preserved; and as a tribute to his extraordinary genius, such of his manuscripts as are really interesting or curious, (and they are not a few,) would have been given to the public, instead of lying unknown in the attics of our Linnæan Society.

Prof. Fries is devoting himself, with his usual zeal, to the investigation of the Scandinavian Flora, (that of the Scandinavian Peninsula from Petersburg to the North sea,) and has been specially studying *Hieracium*, *Salix*, and *Carex*. The general result of his observations has lately appeared under the title of "*Summa Plantarum Scandinaviæ*," being an enumeration of the flora of the country, with geographical indications of each species, and detailed characters for such as are not in Koch's Synopsis, or are differently characterized by Fries. It appears to be a useful work, more especially as a kind of resumé of the conclusions drawn by Fries from a long and careful study of many difficult species.—(pp. 528–530.)

St. Petersburg contains two great botanical collections, that of the Academy of Sciences, and that of the Botanical Garden. The herbarium of the Academy of Sciences is under the direction of Dr. Carl Anton Meyer, and under him, Dr. Ruprecht, but without at present any assistance for the mechanical part of the business. It is contained in two large rooms and a small one, around which are arranged the cabinets with mahogany glazed doors—useful in enabling you to see where the genera are, without opening the doors; but a luxury, the cost of which might have been better applied in the purchase of specimens, for which the Academy is very short of funds. The specimens are loose, in double sheets of paper of a large size, and arranged in natural orders, the genera separated by thin sheets of pasteboard, the species under each genus being placed alphabetically; the whole loose on the shelves, not tied in bundles, a great advantage over the usual continental custom of having from one to a dozen strings to untie every time you would look at a specimen; but still, if the herbarium were to be frequently consulted, having the disadvantage of not preserving the specimens so well as we do by glueing them down. The collection is rich in Russian and in Brazilian plants, it contains all Chamisso's and a very complete set of Sieber's plants, and besides some of the usual Cape collections, a very good one made by Hesse, with a miscellaneous collection from other parts of the world, the whole in very good consulting order, the undetermined and doubtful plants being at the end of each natural order. Besides this general herbarium, there is Marschall von Bieberstein's Tauro-Caucasian herbarium, nearly complete with good specimens, and Trinius's *Gramineæ*, a most extensive series, remarkably rich in authentic specimens. Dr. Meyer, who lives at the Botanic Garden, and is intimate with Dr. Fischer, has not published any thing since the Monograph of *Ephedra*, which appeared two or three months ago; he is now investigating the Roses allied to *R. cinnamomea*. Dr. Ruprecht has been at work on the Flora of Russia, and has completed the three last parts of the "*Contributions to the Flora of Russia*," containing a critical enumeration of the plants of the Samoied territory, with several new species, some of them figured; of the Russian *Ferns*, of which some are new; and of the plants of the neighborhood of St. Petersburg, with geographical and historical notes to each. His worldly position at the Academy is not satisfactory for a man of so much ability, and he appears anxious to go out on an expedition round the world. The herbarium of the Botanic Garden, under the general direction of Dr. Fischer and his assistants, Dr. Meyer and Avé-Lallemant, is under the especial care of Mr. Meinshausen, a young man who accompanied Schrenk into Soongaria; there appeared to be also one or two young men at work as assistants. The space allotted to it is small; the different collections it consists of are, as yet, separate, and all tied up in bundles, so that it is difficult to judge of its extent; but it must be considerable. It contains the herbarium of the late

Dr. Mertens, of Bremen, left by him in very good order, containing about twenty-five thousand species, and especially rich in European plants; that of Schrader, of Göttingen, bulky, but of less value; that of Schumacher, of Copenhagen, containing, like other Danish herbaria, a great many of Rohr's Cayenne plants, Thonning's African ones, &c.; very rich sets of Turczaninow's, Sowitz's, and Schrenk's plants, and those of other Russian collectors, besides miscellaneous collections. The library is also very good. What both herbaria are chiefly deficient in, appear to be East Indian, South American, (except Brazil and Guiana,) and Antarctic plants. Dr. Fischer himself has been at work at *Astragali*, and has prepared for the press a detailed monograph of the section of the *Tragacantheæ;* and with Dr. Meyer, he is now publishing the first part of a folio work, under the title of "Jardin de Saint Pétersbourg," to contain colored drawings and descriptions of interesting plants which have flowered here. This first part has a short account and drawing of the new Palm house, in the state it had attained last season, and figures and descriptions of ten species, amongst which is a very handsome Brazilian *Almeidea*. Dr. Fischer possesses a private herbarium, arranged in large double sheets like that of the Academy of Sciences, and apparently containing a very considerable miscellaneous collection in good order. I met here Prof. Trautvetter, of Kieff, who is at work on the plants brought by Middendorf from Northern and Arctic Russia; and as there are but few aids at Kieff, he came here to consult books and herbaria. The Flora gathered by Middendorf, is, in many respects, that of Melville Island, but more numerous in species.—(pp. 531–533.)

Art. XXII.—*Observations on the Rocky Mountains and Oregon;* from the Reports of the Exploring Expeditions of Capt. J. C. Frémont.*

Few travellers have encountered greater hardships, and none have exhibited more indomitable courage, or untiring zeal, than Captain Frémont in his explorations about the Rocky Mountains, and among the heights, lakes and deserts of Oregon and California. The *first* of the two Expeditions of which we have an account in the volume above referred to, terminated at the summit of the Rocky Mountains, after an examination of the south pass

---

* Report of the Exploring Expedition to the Rocky Mountains in the year 1842, and to Oregon and North California in the years 1843, '44, by Brevet Captain J. C. Frémont, of the Topographical Engineers, under the orders of Col. J. J. Abert, Chief of the Topographical Bureau. 694 pp. 8vo, with plates and a map. Washington, 1845.

—the lowest depression of the mountains and the present route to Oregon—and an ascent to the summit of Frémont's peak in the Wind river chain, believed to be the highest elevation in the Rocky Mountain range. In the *second*, by a different route, he reached the same pass, and thence proceeded to the Great Salt lake and Fort Vancouver; he next went south just to the east of the Cascade range, over an unexplored region, to latitude 38° 44′, where he crossed the snowy heights, and finally after severe trials, arrived at San Francisco. From this place he went south, ascending the fine valley of the Joachim, and in latitude 34½° turned northeast across the California semi-desert, to Utah lake. A complete circuit was thus made in eight months, which cost them 3500 miles of travelling; and during this time they were never out of sight of snow.

Captain Frémont's Journal is written in a graphic style, bearing evidence of literal accuracy in all its statements, and yet in many parts reading like a romance. With deep interest we follow the adventurous traveller threading his pathless way over lofty ridges, through dense forests, and up the icy heights, till at last he stands perched on a pinnacle of the Wind river mountains. Our readers may have often perused the account, yet will find renewed interest in the following description of the last day of this perilous adventure.

"When we had secured strength for the day by a hearty breakfast, we covered what remained, which was enough for one meal, with rocks, in order that it might be safe from any marauding bird; and, saddling our mules, turned our faces once more towards the peaks. This time we determined to proceed quietly and cautiously, deliberately resolved to accomplish our object if it were within the compass of human means. We were of opinion that a long defile which lay to the left of yesterday's route would lead us to the foot of the main peak. Our mules had been refreshed by the fine grass in the little ravine at the Island camp, and we intended to ride up the defile as far as possible, in order to husband our strength for the main ascent. Though this was a fine passage, still it was a defile of the most rugged mountains known, and we had many a rough and steep slippery place to cross before reaching the end. In this place the sun rarely shone; snow lay along the border of the small stream which flowed through it, and occasional icy passages made the footing of the mules very insecure, and the rocks and ground were moist with the trickling waters in this spring of mighty rivers. We soon had the satisfaction to find ourselves riding along the huge wall which forms the central summits of the chain. There at last it rose by our sides, a nearly perpendicular wall of granite, terminating 2,000 to 3,000 feet above our heads in a serrated line of broken, jagged cones. We rode on until we came almost immediately below the main peak, which I denominated the Snow peak, as it exhibited more snow to the eye than any of the neighboring summits. Here were three small lakes of a green color, each perhaps a thousand yards in diameter, and apparently very deep. These lay in a kind of chasm; and, according to the barometer, we had attained but a few hundred feet above the Island lake. The barometer here stood at 20·450, attached thermometer 70°.

"We managed to get our mules up to a little bench about a hundred feet above the lakes, where there was a patch of good grass, and turned them loose to graze. During our rough ride to this place, they had exhibited wonderful surefootedness. Parts of the defile were filled with angular, sharp fragments of rock, three or four and eight or ten feet cube; and among these they had worked their way, leaping from one narrow point to another, rarely making a false step, and giving us no occasion to dismount. Having divested ourselves of every unnecessary encumbrance, we commenced the ascent. This time, like experienced travellers, we did not press ourselves, but climbed leisurely, sitting down so soon as we found breath beginning to fail. At intervals we reached places where a number of springs gushed from the rocks, and about 1,800 feet above the lakes came the snow line. From this point our progress was uninterrupted climbing. Hitherto I had worn a pair of thick moccasins, with soles of *parflêche;* but here I put on a light thin pair, which I had brought for the purpose, as now the use of our toes became necessary to a further advance. I availed myself of a sort of comb of the mountain, which stood against the wall like a buttress, and which the wind and the solar radiation, joined to the steepness of the smooth rock, had kept almost entirely free from snow. Up this I made my way rapidly. Our cautious method of advancing in the outset had spared my strength; and, with the exception of a slight disposition to headache, I felt no remains of yesterday's illness. In a few minutes we reached a point where the buttress was overhanging, and there was no other way of surmounting the difficulty than by passing around one side of it, which was the face of a vertical precipice of several hundred feet.

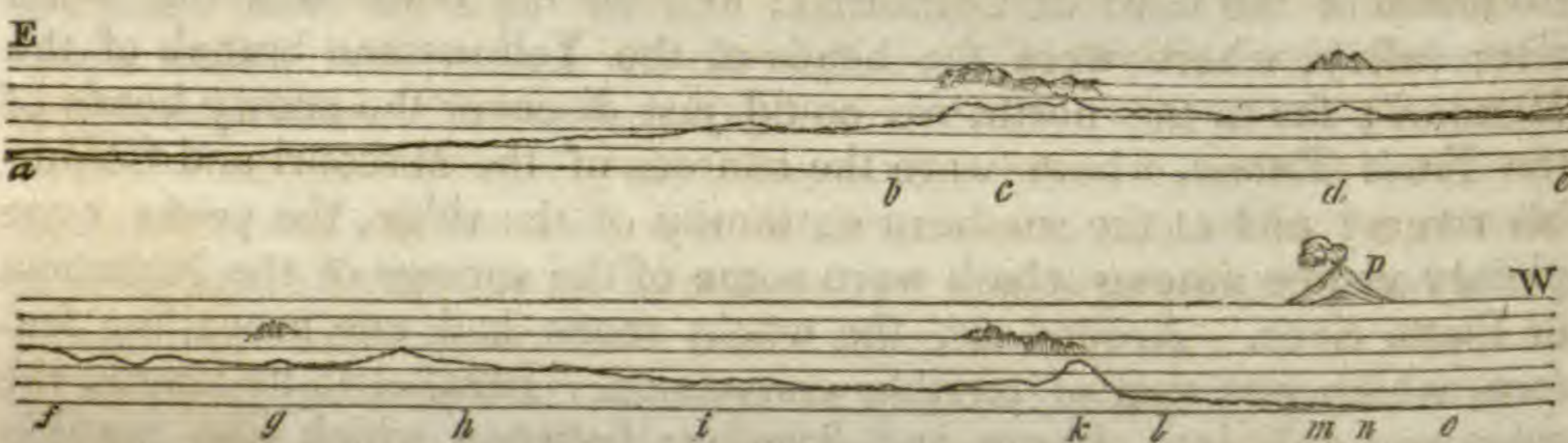
"Putting hands and feet in the crevices between the blocks, I succeeded in getting over it, and, when I reached the top, found my companions in a small valley below. Descending to them, we continued climbing, and in a short time reached the crest. I sprang upon the summit, and another step would have precipitated me into an immense snow field five hundred feet below. To the edge of this field was a sheer icy precipice; and then, with a gradual fall, the field sloped off for about a mile, until it struck the foot of another lower ridge. I stood on a narrow crest, about three feet in width, with an inclination of about 20°, N. 51° E. As soon as I had gratified the first feelings of curiosity, I descended, and each man ascended in his turn; for I would only allow one at a time to mount the unstable and precarious slab, which it seemed a breath would hurl into the abyss below. We mounted the barometer in the snow of the summit, and, fixing a ramrod in a crevice, unfurled the national flag to wave in the breeze where never flag waved before. During our morning's ascent, we had met no sign of animal life, except the small sparrow-like bird already mentioned. A stillness the most profound and a terrible solitude forced themselves constantly on the mind as the great features of the place. Here, on the summit, where the stillness was absolute, unbroken by any sound, and the solitude complete, we thought ourselves beyond the region of animated life; but while we were sitting on the rock, a solitary bee (*bromus, the humble bee*) came winging his flight from the eastern valley, and lit on the knee of one of the men.

"It was a strange place, the icy rock and the highest peak of the Rocky Mountains, for a lover of warm sunshine and flowers; and we pleased ourselves with the idea that he was the first of his species to cross the mountain barrier—a solitary pioneer to foretell the advance of civilization. I believe that a moment's thought would have made us let him continue his way unharmed; but we carried out the law of this country, where all animated nature seems at war; and, seizing him immediately, put him in at least a fit place—in the leaves of a large book, among the flowers we had collected on our way. The barometer stood at 18·293, the attached thermometer at 44°; giving for the elevation of this summit 13,570 feet above the Gulf of Mexico, which may be called the highest flight of the bee. It is certainly the highest known flight of that insect. From the description given by Mackenzie of the mountains where he crossed them, with that of a French officer still farther to the north, and Colonel Long's measurements to the south, joined to the opinion of the oldest traders of the country, it is presumed that this is the highest peak of the Rocky Mountains. The day was sunny and bright, but a slight shining mist hung over the lower plains, which interfered with our view of the surrounding country. On one side we overlooked innumerable lakes and streams, the source of the Colorado of the Gulf of California; and on the other was the Wind river valley, where were the heads of the Yellowstone branch of the Missouri; far to the north, we could just discover the snowy heads of the *Trois Tetons*, where were the sources of the Missouri and Columbia rivers; and at the southern extremity of the ridge, the peaks were plainly visible among which were some of the springs of the Nebraska or Platte river. Around us, the whole scene had one prevailing feature, which was that of terrible convulsion. Parallel to its length, the ridge was split into chasms and fissures; between which rose the thin lofty walls, terminated with slender minarets and columns, which is correctly represented in the view from the camp on Island lake. According to the barometer, the little crest of the wall on which we stood was three thousand five hundred and seventy feet above that place, and two thousand seven hundred and eighty above the little lakes at the bottom, immediately at our feet. Our camp at the Two Hills (an astronomical station) bore south 3° east, which, with a bearing afterward obtained from a fixed position, enabled us to locate the peak. The bearing of the *Trois Tetons* was north 50° west, and the direction of the central ridge of the Wind river mountains south 39° east. The summit rock was gneiss, succeeded by syenitic gneiss. Syenite and feldspar succeeded in our descent to the snow line, where we found a feldspathic granite. I had remarked that the noise produced by the explosion of our pistols had the usual degree of loudness, but was not in the least prolonged, expiring almost instantaneously. Having now made what observations our means afforded, we proceeded to descend. We had accomplished an object of laudable ambition, and beyond the strict order of our instructions. We had climbed the loftiest peak of the Rocky Mountains, and looked down upon the snow a thousand feet below, and, standing where never human foot had stood before, felt the exultation of first explorers. It was about two o'clock when we left the summit; and when we reached the bottom, the sun had already sunk behind the wall, and the day was drawing to a close. It would have been pleasant to have lingered here and on the summit longer; but we hurried away as rapidly as the ground would permit, for it was an object to regain our party as soon as possible, not knowing what accident the next hour might bring forth.

"We reached our deposite of provisions at nightfall. Here was not the inn which awaits the tired traveller on his return from Mont Blanc, or the orange groves of South America, with their refreshing juices and soft fragrant air; but we found our little *cache* of dried meat and coffee undisturbed. Though the moon was bright, the road was full of precipices, and the fatigue of the day had been great. We therefore abandoned the idea of rejoining our friends, and lay down on the rock, and, in spite of the cold, slept soundly."—pp. 68, 69, 70 and 71.

Other pages of general interest might be cited, but we pass to some points of geological importance, in the regions examined.

It was before known that the slopes of the Rocky Mountains were very gradual in inclination; but the fact is brought out with greater definiteness and more distinctly to the eye, in the section presented by Lieut. Frémont, of which the following is a reduced copy.



Profile of the route from the mouth of the Kansas to the Pacific, by J. C. Frémont, in 1843. Vertical scale to horizontal as 1 to 30. The intervals between the horizontal lines are each 2,000 feet; and an inch in the horizontal scale corresponds to 284 miles. *a*. Mouth of Kansas River. *b*. St. Vrain's Fort. *c*. Laramie River. *d*. South Pass. *e*. Dividing range. *f*. Beer Springs. *g*. Great Salt Lake. *h*. Fort Hall. *i*. Crossing of Snake River. *k*. Blue Mountains. *l*. Fort Wallawalla. *m*. Dalles. *n*. Cascades. *o*. Fort Vancouver. *p*. Mount St. Helen's.

It corrects at once a common impression that these mountains are a narrow line of heights, showing that they stretch over a breadth of twelve or fifteen hundred miles, and that the ridges at summit like those on some parts of the declivities, are properly ranges of heights upon the great Rocky Mountain elevation. To be fully apprehended, it should be observed that, although the inclination in the above view is so gradual, the height as related to the breadth is actually on the scale adopted, exaggerated *thirty times*. The pass which was followed by Captain Frémont, called the South Pass and situated in latitude 42° 24′ 32″, longitude 109° 26′, was found to be 7,490 feet above the sea.

In the journey of Capt. Frémont south from Fort Vancouver into California, the party crossed the Cascade range (or, as it is called in that part, the Sierra Nevada) at a height of 9,338 feet, which is nearly 2,000 feet above the Rocky Mountain pass, and "several peaks in view rose several thousand feet higher." Thus within 150 miles of the coast, and 500 from the summits of the Rocky Mountains, there is a range of heights even exceeding this chain in elevation. This Cascade range extends north and south through Oregon into California, and contains several lofty volcanic cones, from 10 to 15,000 feet in altitude; two of them, St. Helen's and Mount Regnier, are stated by Captain Frémont to have been in action at the time of his visit; and he adds that "on the 23d of the preceding November, St. Helen's had scattered its ashes like a light fall of snow over the Dalles of the Columbia."

On the ascent of the Rocky Mountains, specimens of the rocks and several interesting fossils were collected. As observed by Major Long, sandstones are most abundant; but in many places the rock is calcareous and passes into an earthy whitish or yellowish limestone, often porous or appearing sandy; and this again is occasionally finely laminated. Sand and gravel cover the larger part of the surface between the Missouri and the Mississippi. From an examination of the fossils, Mr. James Hall concludes that the cretaceous formation to which the limestone belongs, extends at least to a height of 5,000 feet above the sea. On Smoky Hill river, in latitude 39° and longitude 98°, the rock was an impure limestone and abounded in shells of a species of Inoceramus. The height of the place was about 1,500 feet above the sea. Near Fort St. Vrain in latitude 105°, and at an altitude of 5,500 feet, a similar rock was observed, upon which Mr. Hall remarks that "two fragments of fossils still indicate the cretaceous period; but the absence of any perfect specimens must deter a positive opinion upon the precise age of the formation; yet one specimen from its form, markings and fibrous structure, I have referred to the genus Inoceramus." "The whole formation," as Mr. Hall adds respecting the seven degrees of longitude travelled over to the place just mentioned, "is probably, with some variations, an extension of that which prevails through Louisiana, Arkansas and Missouri." Beyond St. Vrain's Fort, the region towards the Wind river mountains changes to granitic. Yet sandstones and shales prevailed farther north, near Frémont's pass and beyond, with some thin beds of coal, which Mr. Hall suggests may possibly belong to the oolitic period. In longitude 111° and latitude 41½°, on Muddy river, the rock was a "yellowish gray oolitic limestone, containing turbo and cerithium," and not far distant fossil ferns were obtained, among which was one species resembling the *Glossopteris Phillipsii*, an oolitic fossil. Mr. Hall remarks, "this species alone, with the general characters of the other species, and the absence of the large stems so common in the coal period, had led me to refer them to the oolitic period: I conceive however, that we have scarcely sufficient evidence to justify this reference."

At the Cascades on the Columbia, tertiary beds and fossils were met with, and the same rock occurs towards the mouth of the river.

The Great Salt lake, called also Lake Timpanogos, and Lake Youta, was examined in September, 1843, and this party was the first which had visited one of its islands. The elevation of the surface was ascertained to be 4,200 feet above the sea. The rock here observed was a talcose rock or steatite. Standing on the summit of the island 800 feet high, to which they had passed in an India rubber boat, they had "an extended view of the lake, enclosed in a basin of rugged mountains, which sometimes left marshy flats and extensive bottoms between them and the shore, and in other places came directly down to the water, with bold and precipitous bluffs. To the southward, several peninsular mountains, 3000 or 4000 feet high entered the lake, appearing, so far as the distance and our position enabled us to determine, to be connected by flats and low ridges with the mountains in the rear." The cliffs around were much incrusted with salt from evaporation, and saline flats and plants in many places bordered the lake. The area of the lake as laid down on the map, is about 2000 square miles, and its highest northern point is in latitude 41° 48′. A portion of the salt obtained by evaporation was afterwards analyzed, and found to consist of common salt 97·80, chlorid of calcium 0·61, chlorid of magnesium 0·24, sulphate of soda 0·23, sulphate of lime 1·12.

The lateness of the season hurried our explorers from this region before it could be thoroughly surveyed. There is a smaller lake to the south (Lake Utah) connected with the Great Salt Lake like Lake George with Champlain, which Captain Frémont visited on his return and found to consist of fresh water.

Various thermal and mineral springs were met with on the different journeys, and efflorescent salts often abounded over the dry soil. One region of carbonated springs was met with on the *Fontaine-qui-bouit* river, in longitude 105° 23′. Another, the Beer springs, on Bear river, not far above the Great Salt Lake, is noticed as follows.

"Although somewhat disappointed in the expectations which various descriptions had led me to form of unusual beauty of situation and scenery, I found it altogether a place of very great interest; and a traveller for the first time in a volcanic region remains in a constant excitement, and at every step is arrested by something remarkable and new. There is a confusion of interesting objects gathered together in a small space. Around the place of encampment the Beer springs were numerous; but, as far as we could ascertain, were entirely confined to that locality in the bottom. In the bed of the river, in front, for a space of several hundred yards, they were very abundant; the effervescing gas rising up and agitating the water in countless bubbling columns. In the vicinity around were numerous springs of an entirely different and equally marked mineral character. In a rather picturesque spot, about 1,300 yards below our encampment, and immediately on the river bank, is the most remarkable spring of the place. From an opening on the rock, a white column of scattered water is thrown up, in form like a *jet-d'eau*, to a variable height of about three feet, and, though it is maintained in a constant supply, its greatest height is attained only at regular intervals, according to the action of the force below. It is accompanied by a subterranean noise, which, together with the motion of the water, makes very much the impression of a steamboat in motion; and, without knowing that it had been already previously so called, we gave to it the name of the *Steamboat spring.* The rock through which it is forced is slightly raised in a convex manner, and gathered at the opening into an urn-mouthed form, and is evidently formed by continued deposition from the water, and colored bright red by oxide of iron. An analysis of this deposited rock, which I subjoin, will give you some idea of the properties of the water, which, with the exception of the Beer springs, is the mineral water of the place.* It is a hot spring, and the water has a pungent and disagreeable metallic taste, leaving a burning effect on the tongue. Within perhaps two yards of the *jet-d'eau* is a small hole of about an inch in diameter, through which, at regular intervals, escapes a blast of hot air with a light wreath of smoke, accompanied by a regular noise. This hole had been noticed bv Doctor Wislizenus, a gentleman who several years since passed by this place, and who remarked, with very nice observation, that smelling the gas which issued from the orifice produced a sensation of giddiness and nausea. Mr. Preuss and myself repeated the observation, and were so well satisfied with its correctness, that we did not find it pleasant to continue the experiment, as the sensation of giddiness which it produced was certainly strong and decided. A huge emigrant wagon, with a large and diversified family, had overtaken us and halted at noon at our encampment; and, while we were sitting at the spring, a band of boys and girls, with two or three young men, came up, one of whom I asked to stoop down and smell the gas, desirous to satisfy myself further of its effects. But his natural caution had been awakened by the singular and suspicious features of the place, and he declined my proposal decidedly, and with a few indistinct remarks about the devil, whom he seemed to consider the *genius loci.* The ceaseless motion and the play of the fountain, the red rock, and the green trees near, make this a picturesque spot.

"A short distance above the spring, and near the foot of the same spur, is a very remarkable yellow-colored rock, soft and friable, consisting principally of carbonate of lime and oxide of iron, of regular structure, which is probably a fossil coral. The rocky bank along the

---

* Carbonate of lime 92·55, carbonate of magnesia 0·42, oxyd of iron 1·05, silica, alumina, water and loss, 5·98 = 100·00.

shore between the Steamboat spring and our encampment, along which is dispersed the water from the hills, is composed entirely of strata of a calcareous *tufa* containing the remains of moss and reed-like grasses, which is probably the formation of springs. The *Beer* or *Soda springs*, which have given name to this locality, are agreeable, but less highly flavored than the *Boiling springs* at the foot of Pike's peak, which are of the same character. They are very numerous, and half hidden by tufts of grass, which we amused ourselves in removing and searching about for more highly impregnated springs. They are some of them deep, and of various sizes—sometimes several yards in diameter, and kept in constant motion by columns of escaping gas. By analysis, one quart of the water contains as follows:

	Grains.
Sulphate of magnesia, ...	12·10
Sulphate of lime, ...	2·12
Carbonate of lime, ...	3·86
Carbonate of magnesia, ...	3·22
Chloride of calcium, ...	1·33
Chloride of magnesium, ...	1·12
Chloride of sodium, ...	2·24
Vegetable extractive matter, &c. . . .	0·85
	26·84"

pp. 136, 137.

Travelling along, east of the Cascade range, many fine lakes were met with, and in latitude 40° 40′, another remarkable locality of hot springs.

"This is the most extraordinary locality of hot springs we had met during the journey. The basin of the largest one has a circumference of several hundred feet; but there is at one extremity a circular space of about fifteen feet in diameter, entirely occupied by the boiling water. It boils up at irregular intervals, and with much noise. The water is clear, and the spring deep; a pole about sixteen feet long was easily immersed in the centre, but we had no means of forming a good idea of the depth. It was surrounded on the margin with a border of *green* grass, and near the shore the temperature of the water was 206°. We had no means of ascertaining that of the centre, where the heat was greatest; but, by dispersing the water with a pole, the temperature at the margin was increased to 208°, and in the centre it was doubtless higher. By driving the pole towards the bottom, the water was made to boil up with increased force and noise. There are several other interesting places, where water and smoke or gas escape, but they would require a long description. The water is impregnated with common salt, but not so much so as to render it unfit for general cooking; and a mixture of snow made it pleasant to drink.

"In the immediate neighborhood, the valley bottom is covered almost exclusively with chenopodiaceous shrubs, of greater luxuriance, and larger growth, than we had seen in any preceding part of the journey."—p. 215.

The lakes passed among the ridges of the Cascade range, were remarkable for their beauty and the singularity of their situation. We close this notice with Captain Frémont's remarks on *Pyramid Lake*, a short distance only from the Boiling springs just noticed. Ascending the mountain by a broad pass they reached the summit, beyond which—

"A defile between the mountains descended rapidly about two thousand feet; and, filling up all the lower space, was a sheet of green water some twenty miles broad. It broke upon our eyes like the ocean. The neighboring peaks rose high above us, and we ascended one of them to obtain a better view. The waves were curling in the breeze, and their dark-green color showed it to be a body of deep water. For a long time we sat enjoying the view, for we had become fatigued with mountains, and the free expanse of moving waves was very grateful. It was set like a gem in the mountains, which, from our position, seemed to enclose it almost entirely. At the western end it communicated with the line of basins we had left a few days since; and on the opposite side it swept a ridge of snowy mountains, the foot of the great Sierra. Its position at first inclined us to believe it Mary's lake, but the rugged mountains were so entirely discordant with descriptions of its low rushy shores and open country, that we concluded it some unknown body of water; which it afterwards proved to be.

"On our road down, the next day, we saw herds of mountain sheep, and encamped on a little stream at the mouth of the defile, about a mile from the margin of the water, to which we hurried down immediately. The water is so slightly salt, that, at first, we thought it fresh, and would be pleasant to drink when no other could be had. The shore was rocky—a handsome beach, which reminded us of the sea. On some large *granite* boulders that were scattered about the shore, I remarked a coating of a calcareous substance, in some places a few inches and in others a foot in thickness. Near our camp, the hills, which were of primitive rock, were also covered with this substance, which was in too great quantity on the mountains along the shore of the lake to have been deposited by water, and has the appearance of having been spread over the rocks in mass.*

"The next day, we followed again a broad Indian trail along the shore of the lake to the southward. For a short space we had room enough in the bottom; but, after travelling a short distance, the water swept the foot of precipitous mountains, the peaks of which are about 3,000 feet above the lake. The trail wound along the base of these precipices, against which the water dashed below, by a way nearly impracticable for the howitzer. During a greater part of the morning the lake was nearly hid by a snow storm, and the waves broke on the

* The label attached to a specimen of this rock was lost; but I append an analysis of that which, from memory, I judge to be the specimen.

Carbonate of lime,	77·31
Carbonate of magnesia,	5·25
Oxide of iron,	1·60
Alumina,	1·05
Silica,	8·55
Organic matter, water, and loss,	6·24
	100·00

narrow beach in a long line of foaming surf, five or six feet high. The day was unpleasantly cold, the wind driving the snow sharp against our faces; and, having advanced only about twelve miles, we encamped in a bottom formed by a ravine, covered with good grass, which was fresh and green.

"We did not get the howitzer into camp, but were obliged to leave it on the rocks until morning. We saw several flocks of sheep, but did not succeed in killing any. Ducks were riding on the waves, and several large fish were seen. The mountain sides were crusted with the calcareous cement previously mentioned. There were chenopodiaceous and other shrubs along the beach; and, at the foot of the rocks, an abundance of *Ephedra occidentalis*, whose dark-green color makes them appear like evergreens among the shrubby growth of the lake. Towards evening the snow began to fall heavily, and the country had a wintry appearance.

"The next morning the snow was rapidly melting under a warm sun. Part of the morning was occupied in bringing up the gun; and, making only nine miles, we encamped on the shore, opposite a very remarkable rock in the lake, which had attracted our attention for many miles. It rose, according to our estimate, 600 feet above the water; and, from the point we viewed it, presented a pretty exact outline of the great pyramid of Cheops. The accompanying drawing presents it as we saw it. Like other rocks along the shore, it seemed to be incrusted with calcareous cement. This striking feature suggested the name for the lake.

"The elevation of this lake above the sea is 4,890 feet, being nearly 700 feet higher than the Great Salt lake, from which it lies nearly west, and distant about eight degrees of longitude. The position and elevation of this lake make it an object of geographical interest. It is the nearest lake to the western rim, as the Great Salt lake is to the eastern rim, of the Great Basin which lies between the base of the Rocky Mountains and the Sierra Nevada."—pp. 216, 217, 218.

The work is illustrated by many fine views of scenery, besides five plates of fossils, and four of recent plants. There was no retinue of science attached to the expedition, yet by personal exertion, in connection with his other arduous duties, Captain Frémont made valuable geological and botanical collections. Unfortunately, a considerable portion of them were lost by accidents from which our travellers barely escaped with their lives. Part of the specimens preserved are described in the volume by Prof. J. Torrey. We observe one genus dedicated to Captain Frémont, (Fremontia.) It is right that this bold explorer of the mountains should have his name inscribed among the flowers of the region, and about its loftiest heights, as well as upon the honored page of history.

ART. XXIII.—*Hybridity in Animals, considered in reference to the question of the Unity of the Human Species;* by SAMUEL GEORGE MORTON, M. D.

(Continued from p. 50, this volume.)

PART II.—BIRDS.

Gallinaceous Hybrids.—The variation of size, form and plumage, so remarkable among the different breeds of domestic fowls, has been usually attributed to the action of physical agents on a single, original species. This supposition however, is now found to be untenable; for the best ornithologists, and those, too, who have no view to collateral generalization, have succeeded in tracing this family of birds to, at least, ten different species. Without appealing to unnecessary details it is sufficient to observe, that independently of certain admitted changes as the result of domestication, these birds are in far greater degree modified by the power possessed by their several species, (so far, at least, as the experiment has been extended,) of mingling with each other and producing a fertile hybrid progeny. Hence, in a great measure, those interminable varieties of exterior form, size and color now everywhere familiar.*

The *Gallus ecaudatus* (tail-less fowl) has been triumphantly quoted as an evidence of the power of climate and locality to produce changes, not only of plumage, but of anatomical conformation. This bird is deficient in the last dorsal vertebræ, and consequently has no tail. But it was asserted, even by some naturalists, that this fowl was originally possessed of a tail, but lost it on being sent from England to Virginia, and domesticated in the latter country. More recent investigations, however, have proved, that this is a wild, native species of Ceylon.†

The fowl with rumpled or inverted feathers, which was long regarded as a mere accidental variety, is now believed to be a distinct species, and a native of Guiana. It breeds with all the other domestic fowls, and the offspring is prolific without end.

Fortunately for the further elucidation of this question, the continent of America produces a family of gallinaceous birds,—the *Alectors* of ornithologists,—among which the very same in-

* We have been at some pains to ascertain the specific names of the several *original* gallinaceous birds; yet without presuming that ornithologists have described all that exist, we append a list of such as are already known: *Gallus bankiva; G. æneus; G. Anstrutheri; G. furcatus; G. Sonneratii; G. Lafayettii; G. giganteus; G. morio; G. lanatus; G. ecaudatus*, and *G. crispus*. I omit several supposed species which may, for the present, be regarded as apocryphal. I have had the pleasure of examining *five* of these original species, contained in the magnificent *Wilson Collection of Birds*, now deposited, by its liberal proprietor, in the Academy of Natural Sciences of Philadelphia.

† Griffith's Cuvier, viii, pp. 19, 21, 173.—Temminck, as quoted in the same work.

termixture of species takes place, and consequent fertile offspring, as we have remarked in the several species of domestic fowls. All the *Hoccos* or Currasows (Crax) for example, which are derived from their native forests of Guiana, readily unite with each other, giving rise to a progeny that is reproductive without end. "It is probable," observes a judicious ornithologist, "that if the intercourse were repeated in a variety of ways, it would be possible to cultivate, by suitable care, many different races of these birds, whose descendants might be susceptible of multiplying, *ad infinitum*, and branching out into a number of singular varieties, under the superintendance of man."*

In fact, the Dutch menageries have already obtained the prolific hybrids of three species† of this genus; and it has been observed that these mixed birds have their plumage more varied, and far more agreeable to the eye, than the uniform livery of the adult individuals of the pure race.‡

Here, then, we have a family of wild birds, recently reclaimed from their native forests, so as to leave no possible question of their origin and specific diversity; and by intermixing these species in a state of domestication, we have passing under our eyes, as it were, the identical series of phenomena, those very same changes, which are so remarkable and so familiar in the common fowl.

Since I commenced writing this essay, I have met with two hybrid gallinaceous birds, between the common fowl and the Guinea fowl (Numida meleagris). They were bred in the state of Delaware, and possess, in a remarkable and unequivocal manner, the exterior characters and the habits of both parents. One of them looks more like the common fowl; the other, on the contrary, has a much stronger resemblance to the Guinea fowl. The sounds which they utter are intermediate, often analogous to those of the Guinea fowl, but occasionally having the *cluck* of the other parent. These birds are yet living, and their sex has not been positively determined, but the male characters appear to predominate.

Since they came under my notice, I have heard of three other examples of similar hybrids occurring in different parts of the United States; but no progeny has resulted from them.§

Bechstein states that the cock of the wood (*Tetrao urogallus*) will breed with the black grouse (*T. tetrix*) and even with the domestic fowl and turkey. White of Selborne‖ gives a plate

---

* Griffith's Cuvier, viii, p. 100.

† *Crax alector*, *C. rubra* and *C. globicera*.

‡ Griffith's Cuvier, viii, p. 113.

§ See Proceedings of the Academy of Natural Sciences of Philadelphia, for September, 1846.

‖ Naturalist's Calendar, for 1795.

and description of a wild hybrid, between the pheasant and domestic fowl; and a bird of the same kind was preserved in the Leverian museum at Oxford. A similar example is again recorded by Mr. Eyton, in his History of the rarer British Birds, in which five individuals were produced.*

Further, the common ring-pheasant of England, is now ascertained to be a hybrid between the *Phasianus colchicus* and *P. torquatus* of China. This cross is very prolific, and is said to be spreading faster than the ordinary breed.† In fine, we are informed on the best authority that "many of the birds which compose the gallinaceous order, appear to be less difficult to be brought to unite with strange species, than those of any other order. From the great majority of the pheasants, mongrels may be thus produced. All the *hoccos* (Crax) will couple in a state of domestication; the pheasant will ally with the cock; the last with the turkey, with which, also, the hoccos, born in the domestic state, will also unite. It appears, in fact, very possible to produce mongrels from the major part of those Gallinæ which are susceptible of cultivation."‡

Hybrids of the Fringillidæ.—The Finch family furnishes another example of an extensive amalgamation of species, and a remarkable series of prolific hybrids. Thus, according to Bechstein, the Redpole (Fringilla linaria) will breed with the goldfinch, linnet and canary; while the cross between the latter and the goldfinch is capable of reproduction.

The Citril finch (F. citrinella) also, readily pairs with the canary, and gives rise to a fertile offspring; and, indeed, so remarkable is the fecundity of these hybrids, and the ease with which they reproduce with the goldfinch, bullfinch and greenfinch, that M. Veilliot, in order to account for a phenomenon that conflicted with the prevalent opinion of the sterility of all hybrids, assumed that the *F. citrinella* and *F. canaria* were not distinct species, but only two races that had sprung from the same stock; and that one having colonized in Europe and the other in the Canary islands, their different characteristics were owing to a mere difference of locality.§

On the other hand, those persons, who, for pastime, have given great attention to this subject, are of the opinion that the cage-canary is not derived only from the *Fringilla canaria;* but that it is, itself, a fertile hybrid, of which there now exist upwards of thirty various breeds.

Syme, who has written on the British song-birds, says that the wild canaries of the islands that bear that name, have less resem-

---

* Proceedings of the Zoolog. Society of London, 1835.
† Rennie, in Montagu's Ornithological Dict., p. 424.
‡ Griffith's Cuvier, viii, pp. 173, 175, 176.—Prichard. Researches, &c., i, p. 140.
§ Griffith's Cuvier, vii, p. 271.

blance in song and plumage, to the domestic canary, than to the *Siskin* of Germany, the *Venturon* of Italy, or the *Serin* of France.

The celebrated ornithologist Bechstein, adds the following remarks: "We might almost conclude that the *Venturon* (F. citrinella), the *Serin* (F. serinus) and the *Siskin* (Carduelis spinus), are the wild originals of the cage-canary. I have seen a bird produced between the *Siskin* and *Serin* which perfectly resembled the variety called the green canary;—I have, also, seen a mule from a grey female canary, whose true parentage could not be distinguished." The Siskin, it will be observed, belongs to a different genus from the wild canary.

The canary is now known to breed, not only with the three species just mentioned, but also, with the goldfinch, linnet, sparrow, chaffinch, bunting, greenfinch and bullfinch; and with several of them, it produces a fertile offspring.

M. Veilliot once caught a mule bird, which he supposed to be the produce of a male greenfinch (F. chloris) and a female goldfinch; for it mingled the size, color and song of both these species. This bird did not appear to have resulted from the domestication of the parents, for it remained extremely wild, yet was brought to couple with a female canary.*

A yet more remote alliance, that between a canary and a nightingale, produced an egg that could not be hatched. This fact conjoined with others to which we have adverted, illustrates the remark of Prof. Temminck, that the occurence of prolific offspring between different species of birds, is an evidence of the near affinity between them; and that when the reverse takes place (infertile mules) it proves the disparity between the species thus brought together.

Hybrids of the Anatidæ.—The cross between the *Anser cygnoides* and the common tame goose of Europe, is proverbially frequent, and the offspring has proved prolific.† Mr. Eyton and Mr. Blyth have recorded examples of this kind, and M. Chevreul has seen the progeny extended through seven generations.‡

The *Anser canadensis* is often taken in the United States and reduced to the domestic state, in which it crosses with our common goose, producing a hybrid offspring, which, however, appears to be sterile.

The swan (Cygnus olor) has crossed with the common European goose, but I am not aware that the hybridity has been noticed beyond the first offspring. This fact is quoted by Dr. Prichard, from M. Frederick Cuvier.

---

* Griffith's Cuvier, vii, p. 259.

† Loudon's Magazine, ix, p. 511. Temminck, Manuel d'Ornithologie, i, p. 109. —Eyton, Monograph of Anatidæ.

‡ Journal des Savans, June, 1846.

Mr. Charles Waterton, the celebrated traveller, has published a very interesting account of a hybrid between the female Canada goose, and the wild Bernacle gander (Anser bernicla).* This fact occured at Mr. Waterton's seat at Walton Hall, England. "These hybrids," he observes, "are elegantly shaped, but are not so large as the mother, nor so small as the father, their plumage partaking in color with that of both parents. The white on their front is only half as much as is seen on the front of the gander, while their necks are brown in lieu of the coal-black color which appears on the neck of the goose. Their breasts, too, are of a dusky color, while the breast of the bernacle is black, and that of the Canadian, white; and throughout the whole of the remaining plumage there may be seen an altered and modified coloring, not to be traced in that of the parent birds."†

It remains to notice some instances of hybridity among different species of ducks; thus a cross has been obtained between the *Anas fuligula* of Europe, and the European teal (Anas querqucdula).‡ "Selby mentions a male wigeon (Mareca penelope) breeding with a female pintail (Anas acuta), notwithstanding the fact of females of his own species being kept on the same piece of water." Other crosses have taken place between the pintail and the common mallard (Anas boschas);§ and in the wild state, between the latter and the dusky duck (A. obscura), of which my friend Mr. William Gambel, has seen a specimen in the possession of Mr. J. G. Bell, of New York, near which city it was shot. A much more frequent hybrid occurs between the mallard and muscovy duck (A. moschata).

Mr. William R. Clapp informs me that he saw, at Rye Pond, in the state of New York, a female wild duck that had been taken when young and placed in company with the common tame species, and that a fertile hybrid progeny was obtained from them. From the description of this wild bird, I suppose it to have been the *Anas rurfitorques.*

Other Hybrid Birds.—Among bird-hybrids it only remains to notice those of *Motacilla lugubris* and *M. alba*, as recorded by Temminck, and which possessed color and markings intermediate between both parents.|| A mixed breed has been repeatedly observed in Scotland between the common crow (Corvus corone), and the hooded crow (C. cornix), and another mixed species between the latter bird and the carrion crow. Finally, a hybrid has been obtained between the throstle (Turdus musicus) and the black-bird (Merula vulgaris) of Great Britain.¶

---

* Bernicla brenta.

† Essays on Nat. History, p. 118, 2d edition.

‡ Prichard. Researches, &c., i, p. 140, from M. Geoffroy St. Hilaire.

§ Loudon's Magazine, ix, p. 615.

|| Manuel d'Ornithologie, i, p. 254.

¶ Loudon's Magazine, ix, p. 615.

Hybrid Reptiles, Fishes, Mollusca and Insects.

Among reptiles, I have found but a single authenticated example, that of a cross between the European frog and toad, which are generically distinct. (Bufo and Rana.)*

Among fishes, specific hybrids have been obtained by means of artificial impregnation between *Cyprinus carpio*, and *C. carassias*, and between the former species and *C. gibellio.*† "Defay mentions a hybrid between the *barbus* and *carpio*, and Bloch a similar production intermediate between *Cyprinus blicco* and *C. brama*."‡

My friend Mr. S. S. Haldeman, well known for his many and accurate contributions to various branches of natural science, has kindly furnished me with the following note in relation to some American freshwater Mollusca, in connexion with the present inquiry.

"Whilst I deem *Unio radiatus* and *U. siliquoideus* distinct species, there is a certain variety, apparently of the latter, although almost precisely intermediate, which induces me to believe it may possibly be a hybrid. I have never, however, seen any thing like a hybrid between the other species inhabiting the eastern waters of the United States, although I have had many opportunities for observation.

"In their proper localities no species can be more readily separated than *Paludina decisa* and *P. ponderosa;* yet intermediate individuals occur which it is extremely difficult if not impossible to give an undoubted place with either. This difficulty has sometimes almost induced me to regard the two as one species; but when I found that the best developed specimens of *P. decisa* never take the form of *P. ponderosa* where the latter is not found, as in the waters east of the Alleghanies, I could not safely unite them. Perhaps hybridity may be the cause of the difficulty where the two species occur in the same locality."

In Entomology, Mr. Haworth has published some highly interesting facts relating to hybrid productions, and particularly in respect to the genus *Coccinella.* Fabricius had noticed and published some of these facts; but Dr. Prichard remarks, that they "do not afford an unequivocal example of the union of different species, since, according to the opinion of Illiger, accidental varieties of the Coccinella have been frequently mistaken for distinct kinds."§ Yet on the other hand, Mr. Haworth asserts that he has often seen, *in coitû,* several different species of this genus; and he adds the following observations:

"That they mix sexually with each other, when their proper mates cannot be found, is well known; and I have even had

* Brande's Dict. of Science, &c., Art. Hybrid. † Ibid.
‡ Prichard. Researches, &c., i, p. 140. § *Ut supra.*

larvæ produced from the union of *C. tripunctata*, and *C. quadripustulata*, which, but for an accident, would have been reared. Yet such junctions cannot destroy the distinctions of the primitive species, although it may give birth occasionally to hybrid broods; not barren, but capable of generating, for a while, others like themselves. Such, in all probability, are *Coccinella annulata* and *C. fasciata*. If these two had never existed, no Entomologist would have conceived that all the insects of this section and *C. bipunctata*, were of the same species! Wherefore it follows that they are not."

"Practical entomologists well know that similar unions happen in other genera, but more especially in *Cicada;* and from them arise occasionally a set of hybrid varieties, which still do not overturn the primitive distinctions of the original species whence they sprung; however difficult they may sometimes render the task of discriminating amongst such a set of mongrel productions.

"It is even probable that two species of distinct sections may occasionally generate a race very different from both parents, yet resembling both, and not barren, as is usually the case with mules, but capable of procreating. And such a brood some hold to be a new and distinct species in the scale of nature—brought to light by her own operations, and in the very same way that she has occasionally multiplied, and still continues to increase, the stupendous members of the vegetable kingdom."*

Hybrid Plants.

Dr. Prichard, as the result of extensive inquiry, informs us that the number of hybrid plants in the wild or uncultivated state, is about forty; that a few of these have reproduced, but that the greater part of them are sterile.† On the other hand, it is asserted by Shiek, that a multitude of plants produce specifical hybrids in a state of nature.‡

There are innumerable instances, as every one knows, of crosses obtained from plants of different species of the same genera, even when brought from the most distant parts of the world, as the experiments of Kolrenter, Sagaret and Herbert abundantly testify. Not only are these hybrids fertile, but in some instances their reproductiveness exceeds that of the parent plants, by multiplying not only from the seed, but from roots, shoots and suckers. The intermixture is not confined to particular species, but even the most dissimilar can be crossed. We think it unnecessary to give examples when the facts are available to every one; and therefore in respect to the blending of *species* among plants, the reader

* Trans. of the Entomological Soc. of London, i, pp. 267, 291.
† Researches, &c., i, p. 139.
‡ Brande's Dict. of Science, Art. Hybrid.

is particularly referred to the admirable essays of the Rev. Mr. Herbert, and M. Sagaret.*

We may remark, however, that so abundant are these hybrids, that Mr. Herbert, in order to avoid the difficulty they present to a favorite theory, declares it as his opinion, that botanical species are only a higher and more permanent class of varieties, which should be discarded from the systems, leaving the *genera* to define the individuality of kind; or, in other words, to designate those permanent characteristics, which have hitherto, in his opinion, been erroneously attributed to species.†

But in the treatise of M. Sagaret, various instances are given of hybrid plants derived from the mixture of different genera; thus realizing, in this department of nature, the same facts that we have seen to occur in the several sections of the zoological series. We will offer a single example,—the cross between the horse-radish (Cochlearia raphanus) and the cabbage; the former bearing a short pod, or *silicula*, the latter a long pod or *siliqua*.

Remarks.

While we admit that hybrids, as a general law, are contrary to nature, we are also compelled to concede that this law has very many exceptions. "It is manifest," says Dr. Prichard, "that there is some principle in nature which prevents the intermixture of species, and maintains the order and variety of the animal creation. If different species mixed their breed, and hybrid races were often propagated, the animal world would present a scene of confusion. By what method is this confusion prevented? The fact seems to be, that the tribes of wild animals are preserved distinct, not only by the sterility of mules, but that such animals are never, in the state of nature, brought into existence. The separation of distinct species is sufficiently provided for by the *natural repugnance* between individuals of different kinds. This is, indeed, overcome *in the state of domestication*, in which the natural propensities cease, in a great measure, to direct their actions."‡

But we have seen that mules are not always sterile, and also that hybrids are really produced in a state of nature, wholly independent of the influence of cultivation; facts which, indeed, are admitted and illustrated by Dr. Prichard in his later writings. That domestication evolves the faculty of hybridity there can be no question; and we would apply the principle to various classes of animals. It will materially assist in explaining so great a variety in some animals, by pointing, as De Azara and Hamilton Smith

* Herbert. Amaryllidaceæ. *Introd.*—Sagaret. Annales des Sciences Nat., T. viii. † Amaryllidaceæ, p. 19.

‡ Researches into the Physical History of Mankind, i, p. 97. *Second Edition.*

have suggested, to certain primitive species, which were endowed with the capacity for reproducing among themselves, especially under the influence of domestic culture. We have shown that this fact is unquestionable among some quadrupeds and some birds, of which the hybrid varieties have been cultivated for the uses of man.

Could we trace back the origin and history of various other species, we should, in all probability, arrive at the very same result; for it appears to be a law of nature, that the faculty possessed by different species of animals of producing fertile hybrid offspring, is in proportion to their aptitude for domesticity.

Now, since man possesses this aptitude in the highest degree, being as Blumenbach expresses it, the most domestic of animals, it would be nothing singular if he possessed the power of fertile hybridity, even if the human family should prove to embrace several distinct species; because, as we have fully shown, this phenomenon is not unfrequent among animals, whose specific, and even generic diversities, are unquestionable. If, therefore, domestication, or as we have termed it, the aptitude for domesticity, explains the fact in one instance, it certainly does so in the other; more especially since fertile reproduction has ceased to be evidence of identity of species.

A word with respect to the theory of *repugnance*. The same phenomena, moral as well as physical, take place, to a certain extent, among men as among animals; for the repugnance of some human races to mix with others, has only been partially overcome by centuries of proximity, and, above all other means, by the moral degradation consequent to the state of slavery. Not only is this repugnance proverbial among all nations of the European stock among whom negroes have been introduced, but it appears to be almost equally natural to the Africans in their own country, towards such Europeans as have been thrown among them; for with the former a white skin is not more admired than a black one is with us.*

* See the travels of Hawkins, Browne, Burkhardt, Caillet, &c., for abundant evidence of this fact.

I must here be permitted to offer a single additional remark. It is obvious that while cultivation produces obvious changes in some animals, its influence has had little or no effect on others; for example, the ass, the rat, and the mouse, among quadrupeds, and the peacock and guinea fowl among birds. These species have been domesticated from immemorial time, in all latitudes, under every conceivable variety of circumstances. Among wild birds and quadrupeds, on the other hand, some undergo very remarkable changes in a state of nature, as some species of squirrel, fox, wolf, &c., while other species of the very same genera undergo no change whatever. Hence the fallacy of drawing inferential conclusions from those that *do* change, in order to explain the phenomena of diversity among men.

The diversities of animals are in some cases owing to exterior causes alone; in other intances they arise solely from amalgamation of species; while in a third class we can trace the operation of both these agents.

Conclusion.

1. A latent power of hybridity exists in many animals in the wild state, in which state, also, hybrids are sometimes produced.

2. Hybridity occurs not only among different species, but among different genera; and the cross-breeds have been prolific in both cases.

3. Domestication does not cause this faculty, but merely evolves it.

4. The capacity for fertile hybridity, *cæteribus paribus*, exists in animals in proportion to their aptitude for domesticity and cultivation.

5. Since various different species of animals are capable of producing together a prolific hybrid offspring, hybridity ceases to be a test of specific affiliation.

6. Consequently, the mere fact that the several races of mankind produce with each other, a more or less fertile progeny, constitutes, in itself, no proof of the unity of the human species.

ART. XXIV.—*Abstract of a Meteorological Journal, for the year* 1846, *kept at Marietta, Ohio,* Lat. 39° 25′ N., and Long. 4° 28′ W. of Washington City; by S. P. HILDRETH, M. D.

MONTHS.	THERMOMETER. Mean temperature.	Maximum.	Minimum.	Fair days.	Cloudy days.	Rain and melted snow. Inches.	100ths.	Prevailing winds.	BAROMETER. Maximum.	Minimum.	Range.
January, - -	33·00	55	3	13	18	3	25	S. W. & N. & W.	29·95	29·05	0·90
February, -	31·33	57	6	14	14	2	33	W., N. & S. W.	29·90	28·95	0·95
March, - -	43·33	70	13	17	14	2	37	W., N. & S. E.	29·70	29·00	0·70
April, - -	51·00	89	24	19	11	2	04	S. W., W. & E.	29·85	29·18	0·67
May, - -	65·33	86	37	18	13	1	37	S. S. W. & N.	29·58	29·10	0·48
June, - -	67·00	84	44	16	14	7	04	S. S. W. & E.	29·62	29·25	0·37
July, - -	72·00	92	49	21	10	6	20	S. W., N. & S. E.	29·65	29·25	0·40
August, - -	74·16	91	56	22	9	6	00	S. & S. E.	29·55	29·28	0·27
September, -	69·83	90	43	22	8	1	68	S. & S. W.	29·60	29·20	0·40
October, - -	52·66	79	24	18	13	4	00	S. W. & N.	29·75	29·10	0·65
November, -	46·33	67	10	10	20	3	55	N. N. W. & E. S. E.	29·80	29·12	0·68
December, -	37·77	65	14	11	20	6	44	W. N. W. & E. N. E.	29·95	29·10	0·85
Mean for year,	53·64					46	27				

Remarks on the year 1846.—The mean temperature for the year is 53·64°, which is greater by about one degree than that of 1845, and considerably above the mean temperature for this place. The mean of the winter months is 29·91°—spring 53·22°—summer 71·05°—autumn 56·27°.

The year which has just closed, has been one of unusual fertility, having been remarkable for that regular distribution of heat and moisture, that would naturally produce a favorable result. Crops of all kinds have been good and abundant, especially that of fruit. Apples ripened much earlier than usual, owing to the warmth and moisture of the summer months, so that many of our winter varieties were changed into those of autumn, being mature a month earlier than usual, and causing a rapid decay of the fruit intended for winter use. Several of the winter kinds, especially greenings, ripened and fell to the ground in August, being a total loss except where they were cut and dried. Peaches also, suffered from the excessive rains of August, much of the fruit cracking open and decaying upon the trees. Grapes were greatly injured from the same cause. The warmth and moisture of June and July, caused a mildew to appear on the leaves and fruit, which could not be checked by the usual remedies, and the grapes perished in great quantities. On some vines a small insect destroyed the vitality of the leaves, and the crop could not ripen from a lack of the usual juices elaborated by them. The "potato rot," so ruinous to this vegetable in some parts of the world, did but little damage in this portion of Ohio—much less than in 1845; and it is to be hoped it may disappear altogether. No effectual remedy has been found; and as it came without any known cause, it may perhaps cease in the same manner.

The amount of rain and melted snow, is 46·27 inches; which is more than in 1845, by twelve or thirteen inches. The three summer months furnished nearly twenty inches, and the month of December six and a half inches, chiefly of rain. The Ohio river has been navigable for boats of a large size all the season. The mean temperature for the winter months, is about seven degrees colder than the winter preceding; severe weather commenced early, and the navigation of the Ohio was much obstructed with ice nearly all the winter. An abundance of this valuable article was formed to lay up for summer use, while the winter previous there was none frozen of sufficient thickness.

The mean temperature of the spring months, was 53·22°, which is a little below that of 1845, but was much more uniform and regular in temperature. That of March was nearly the same, while April was seven degrees colder, and May six degrees warmer, making the average temperature of the two springs nearly alike, while they varied considerably in the distribution; producing that beautiful variety so common to all the operations of nature, while the grand results of each year are nearly similar. No two springs could be more unlike; that of 1845 having been remarkable for the excessive, untimely frosts, and cold, drying winds; while that of 1846 was uniformly mild and pleasant, with no frost to injure the fruit blossoms, or blight the hopes of the florist.

The severe cold, however, of December previous, destroyed the blossoms and buds of that rich and showy flower, the Chinese tree Peony, so that not one in twenty ever expanded; showing that this plant needs some protection against the severe cold of our winters. This spring was remarkable for the appearance of the Cicada septendecim, or seventeen year locust, which was so abundant in this part of Ohio in 1829. (See beyond, page 216.)

Floral calendar for 1846, *migration of birds, &c.*—March 7th, the wild goose seen in flocks, flying towards the north, notes of the robin heard; 10th, garden Crocus in bloom; 15th, blue bird appears; 17th, martin seen; 22d, Hepatica triloba in blossom; 29th, black bird, in flocks.

April 4th, apricot tree in bloom, early hyacinth; 6th, Sanguinaria canadensis; 9th, wood Anemone, Juneberry or service tree, Pyrus japonicus; 10th, peach in bloom in warm exposures on side hills; 11th, dwarf iris, white maple in blossom, Corydalis cucullaria; 12th, crown imperial in blossom, and two and a half feet high, peach generally in bloom; 13th, red cherry; 17th, imperial gage; 18th, pear tree; 19th, Circas ohioensis, or Judas tree; 20th, harebell; 21st, peach tree shedding its blossoms, from the great heat of the weather; 22d, apple in blossom, Uvularia; 23d, Chickasaw plum, Ranunculus; 24th, tulip in full bloom, quince tree; 25th, Trillium thalictroides, Cornus florida; 27th, lilac, the whippowil heard; 28th, black hawthorn and hickory tree in bloom; 29th, purple mulberry; 30th, common or garden currant full size and fit for cooking, but not ripe. The hill sides are green with the foliage of forest trees, which have attained a size quite unusual at this season of the year.

May 1st, the fruit of the apricot is as large as a robin's egg; 2d, Tartarian honeysuckle in blossom; 5th, buck eye; 8th, double yellow rose; 9th, locust tree in blossom in warm exposures, which is ten days earlier than usual; 12th, rye in head; 13th, wild cherry, or Prunus virginiana; 16th, blackberry; 18th, white peony; 20th, wild grape in bloom; 23d, Peony fragrans, Juneberry and strawberry ripe; 24th, hardy roses generally in bloom; 25th, Syringa philadelphica, Osage orange, May dulce cherry ripe; 27th, wheat heading out; 29th, wheat in blossom, privet.

June 4th, white and orange lily in bloom; 6th, cucumbers, planted in the open ground, but germinated under boxes, fit for the table—apples dropping very much, from the punctures of the Curculio, which insect is becoming a serious annoyance to nearly all our fruits. The New England canker-worm has also appeared for the first time, in some of the apple orchards of Belprie; and on an island in the Ohio river, three miles below Marietta, they have destroyed the foliage of a large orchard. This destructive insect was probably introduced to the valley of the Ohio by means of its eggs on one or more fruit trees, brought from the nurseries near Boston, as it first appeared near Cincinnati three or four years since. It will doubtless prove to be the greatest scourge to western fruit growers ever seen in the valley of the Ohio. 8th, purple mulberry ripe; 12th, Catalpa in blossom; 13th, Sambucus; 15th, common raspberry ripe; 16th, red Antwerp, wheat fields on warm sandy lands fit for harvesting; 17th, red cherry ripe; 20th, bass-wood tree in bloom; 29th, golden drop apple ripe; 30th, whortleberry and dewberry.

July 1st, early Chandler apple ripe; 3d, apricot ripe; 26th, water melon ripe.

August 31st, Indian corn ripe, and the farmers on the Ohio river cutting it up for harvest. The pastures on the hill sides, which usually at this season are dried up, are now as green as in April or May, owing to the abundant rains of this month; and they continued so through September.

Summer.—The mean temperature of the summer months is 71·05°, which is a little below that of 1845. There was a long continuation of heat, so that by most people it was considered the hottest summer they had ever known; but the thermometer, not so variable in its sensibilities as man, declares the heat not to be greater than that of ordinary years. The mercury at no time rose much above 92°, and only on a few days was as high as 90°. In September the heat was as great for the first fourteen days as in August, and there were seventeen days in which the temperature at 2 P. M. was at and above 80°, while in Sept., 1845, there were only seven days—so that this month was the hottest known for many years. This unusual heat ripened the fruit rapidly, and was the cause of its premature decay in the autumnal months, no year having been equal to this for the rotting of apples. The summer months were remarkable for the amount of rain, there falling nearly twenty inches in June, July and August, while in the year preceding there was less than twelve inches. The harvesting of grain began earlier than usual, while the crops were very abundant and fine, free from the destructive mildew which falls upon it in certain conditions of the atmosphere while the grain is in the milk. Indian corn was never better, and was ripe the last of August, or early in September. Potatoes, especially the early planted, were nearly free from the disease called "the rot," and the yield was as large as in any preceding year; while in 1845, many fields of the early planted yielded to the cultivator but little more than the seed planted, being destroyed by the frosts and drought of the spring months.

Autumn.—The mean of the autumnal months was 56·27°, being four degrees above that of the preceding year, which may be accounted for by the unusual heat of September. October and the fore part of November were very pleasant, but terminated rather unexpectedly by a fall of snow from the northwest, of four or five inches on the 25th. On the 26th at sunrise the temperature was at 14°, and on the 27th at 10°. The cold continued only two days, and by the last of the month the snow had disappeared. This sudden severe weather injured much of the young tender wood of the grape vine and some other fruit trees. The first floating ice in the Ohio, was on the 22d of December. It remained only a few days, and the river has been navigable to the fore part of January, 1847, and twice since the winter commenced there were nearly full banks, from the great rains.

Cicada septendecim in 1846.—It is now seventeen years since, in 1829, this curious insect appeared in this portion of Ohio. Its exit from the earth, where it had remained excluded from the light of day for so long a time, was looked for with considerable interest. They were first seen to come out of the ground on the 14th of May, ascend some bush, fence, or tree, cast off their exuviæ, and become a flying insect. They had been observed, near the surface, since the beginning of April, and were turned up by the plough, and dug out of the earth by hogs, which were very fond of them, as were also birds, domestic fowls and cats. At a brick yard in Marietta, where the clay was dug from the side of a hill, under the remains of an old orchard of apple trees, the workmen observed the cells of this insect in 1838, in the large masses of earth, broken off from the side of the bank. In 1840, I visited the spot, collected several of the Cicadæ and preserved them in spirit. Their cells, at that time, were measured and found to be a third less than in the seventeenth year. The cells are oval and very smooth within, they are two and a quarter inches long and three fourths of an inch in diameter, being sufficiently large for the single Cicada, which inhabits it, to move and turn round. Thus they dwell for sixteen years and ten months secluded in a grotto of their own construction.

After the eggs of the female are deposited in the tender branches of trees, they remain two months or sixty days in the pith of the wood before they are hatched and ready to seek their home in the earth; and as they invariably ascend in May, soon after which the eggs are deposited, it makes their actual residence in the earth two months short of seventeen years. The perfect insect lives about thirty days, and then perishes. In 1840, the cells were found to be from two and a half to four feet below the surface; and without any tube communicating with the top of the ground. The cells are probably water proof, as the flood of 1832 covered the surface to the depth of six or eight feet in my garden. In 1846 a large number of these insects emerged from the earth under an apple tree, in the branches of which the parent Cicada had deposited her eggs in 1829. If the water at that time, when only in their third year, had had access to their cells, they must have perished, for it remained over them five or six days. In their cells no appearance of excrementitious matter was noticed. When their period of entombment is completed, in the seventeenth year, or perhaps earlier, they commence working out a smooth cylindrical tube, towards the surface, taking care not to approach within reach of frosts, and where examined for the purpose, the tubes have been found to be usually about four feet in length. For constructing their cells and excavating these tubes, their fore feet are admirably adapted, being much larger and stronger than those for locomotion, and formed with stout claws like the craw fish, as here represented enlarged.

Fig. 1.

Each pupa is armed with a stout proboscis, one fourth of an inch long, which usually lies between the fore legs on a line with the body. A remarkable example of instinct was observed in some which came to the surface under a pile of boards, raised by timbers five or six inches above the earth. The ground was wet, and to enable themselves to reach the dry boards they continued their cylinders up to them, forming thus towers of damp clay in the centre of which they were concealed. These towers were five or six inches high and about an inch in diameter; they were constructed of lumps of wet earth compacted together in a firm but rough manner. A diminished drawing of one of these is given in the annexed figure.

Fig. 2.

A large number of these towers was found when the boards were removed; some had the top closed, and from these the Cicada had not departed. When they had reached the boards, they crawled along on the under side, and came to the open air, where, fixing on a spot favorable to their purpose, they remained attached, until a rupture was made in the cuticle on the back of the thorax, and the perfect insects then with great effort extricated themselves from the armour that had so long protected them in the earth. As there was no further use for the stout claws of the fore legs after they became denizens of the air, these legs were replaced by two that were small and delicate like the other four. In a few days after leaving the earth they had chosen their mates, and the female soon commenced depositing her eggs in the under sides of the tender branches of trees, by means of an ovi-positor, resembling an awl or punch, and continued at this for several days. The preceding year's growth of the branches of apple trees is a favorite wood with them;—but in the forest, the tender branches of almost any variety of wood is used for this purpose. In a few days the leaves on the twig dry up, and the punctured part, in many instances, break with the wind and fall to the ground.

By the 21st of May they had increased rapidly, and the woods on the side hills were vocal with their music. The male is the songster and has vibrating air cells, back of and under the wings, as figured and described in Vol. xviii, p. 47, of this Journal. Where they are abundant their noise is deafening in the sunny and hot portion of the day, but they are nearly silent at night. About the sixth and seventh of June the weather was quite cold, which retarded their progress very much, and during a long and continued rain many of them died. They delight in heat and sunshine; moving about with great briskness. By the last of June they had nearly all perished; and as in 1829, numbers were seen flying short distances, after the abdomen had wasted away, and separated from the wings and thorax. By the middle of August, or about sixty days after the eggs are deposited, they are hatched, and the young Cicadas are ready to enter into the earth. They prevailed over the woody region on the north of the Ohio river, from the Alleghany mountains to the Mississippi; and were full as numerous as in 1829, but will probably diminish as the forests are cut away.*

Marietta, January 5th, 1847.

In continuation of this subject, which is one of general interest, we cite the following paragraphs from the very valuable work of T. W. Harris, M. D., on the Insects of Massachusetts injurious to Vegetation, (pp. 171–175,) referring to the work itself for a more complete history of the Cicada.†—*Eds.*

In those parts of Massachusetts which are subject to the visitation of this Cicada, it may be seen in forests of oak about the middle of June. Here such immense numbers are sometimes congregated, as to bend and even break down the limbs of the trees by their weight, and the woods resound with the din of their discordant drums from morning to evening. After pairing, the females proceed to prepare a nest for the reception of their eggs. They select, for this purpose, branches of a moderate size, which they clasp on both sides with their legs, and then bending down the piercer at an angle of about forty-five degrees, they repeatedly thrust it obliquely into the bark and wood in the direction of the fibres, at the same time putting in motion the lateral saws; in this way they detach little splinters of the wood at one end, so as to form a kind of fibrous lid or cover to the perforation.

* For figures of the perfect Cicada, see Vol. xviii, p. 47.

† Report on the Insects of Massachusetts, injurious to Vegetation; by Thaddeus William Harris, M. D. 460 pp., 8vo. Cambridge, 1841.

The hole is bored obliquely to the pith, and is gradually enlarged by a repetition of the same operation, till a longitudinal fissure is formed of sufficient extent to receive from ten to twenty eggs. The side-pieces of the piercer serve as a groove to convey the eggs into the nest, where they are deposited in pairs, side by side, but separated from each other by a portion of woody fibre, and they are implanted into the limb somewhat obliquely, so that one end points upwards. When two eggs have been thus placed, the insect withdraws the piercer for a moment, and then inserts it again and drops two more eggs in a line with the first, and repeats the operation till she has filled the fissure from one end to the other, upon which, she removes to a little distance, and begins to make another nest to contain two more rows of eggs. She is about fifteen minutes in preparing a single nest and filling it with eggs; but it is not unusual for her to make fifteen or twenty fissures in the same limb; and one observer counted fifty nests extending along in a line, each containing fifteen or twenty eggs in two rows, and all of them apparently the work of one insect. After one limb is thus sufficiently stocked, the Cicada goes to another, and passes from limb to limb and from tree to tree, till her store, which consists of four or five hundred eggs, is exhausted. At length she becomes so weak by her incessant labors to provide for a succession of her kind, as to falter and fall in attempting to fly, and soon dies.

Although the Cicadas abound most upon the oak, they resort occasionally to other forest trees and even to shrubs, when impelled by the necessity for depositing their eggs, and not unfrequently commit them to fruit trees, when the latter are in their vicinity. Indeed there seem to be no trees or shrubs that are exempted from their attacks, except those of the pine and fir tribes, and of these even the white cedar is sometimes invaded by them. The punctured limbs languish and die soon after the eggs which were placed in them are hatched; they are broken by the winds or by their own weight, and either remain hanging by the bark alone, or fall with their withered foliage to the ground. In this way orchards have suffered severely in consequence of the injurious punctures of these insects.

The eggs are one twelfth of an inch long, and one sixteenth of an inch through the middle, but taper at each end to an obtuse point, and are of a pearl-white color. The shell is so thin and delicate that the form of the included insect can be seen before the egg is hatched, which occurs, according to Dr. Potter, in fifty-two days after it is laid, but other persons say in fourteen days.

The young insect when it bursts the shell is one sixteenth of an inch long, and is of a yellowish white color, except the eyes and the claws of the fore-legs, which are reddish; and it is covered with little hairs. In form it is somewhat grub-like, being longer in proportion than the parent insect, and is furnished with six legs, the first pair of which are very large, shaped almost like lobster-claws, and armed with strong spines beneath. On the shoulders are little prominences in the place of wings; and under the breast is a long beak for suction. These little creatures when liberated from the shell are very lively, and their movements are nearly as quick as those of ants. After a few moments their instincts prompt them to get to the ground, but in order to reach it they do not descend the body of the tree, neither do they cast off themselves precipitately; but running to the side of the limb, they deliberately loosen their hold, and fall to the earth. It seems, then, that they are not borne to the ground in the egg state by the limbs in which their nests are contained, but spontaneously make the perilous descent, immediately after they are hatched, without any clue, like that of the canker-worm, to carry them in safety through the air and break the force of their fall. The instinct which impels them thus fearlessly to precipitate themselves from the trees, from heights of which they can have formed no conception, without any experience or knowledge of the result of their adventurous leap, is still more remarkable than that which carries the gosling to the water as soon as it is hatched. In those actions that are the result of foresight, of memory, or of experience, animals are controlled by their own reason, as in those to which they are led by the use of their ordinary senses or by the indulgence of their common appetites they may be said to be governed by the laws of their organization; but in such as arise from special and extraordinary instincts, we see the most striking proofs of that creative wisdom which has implanted in them an unerring guide, where reason, the senses and the appetites would fail to direct them. The manner of the young Cicadas' descent, so different from that of other insects, and seeming to require a special instinct to this end, would be considered incredible perhaps, if it had not been ascertained and repeatedly confirmed by persons who have witnessed the proceeding. On reaching the ground the insects immediately bury themselves in the soil, burrowing by means of their broad and strong fore-feet, which, like those of the mole, are admirably adapted for digging. In their descent into the earth they seem to follow the roots of plants, and are subsequently found attached to those which are most tender and succulent, perforating them with their beaks, and thus imbibing the vegetable juices which constitute their sole nourishment.

They do not appear ordinarily to descend very deeply into the ground, but remain where roots are most abundant; and it is probable that the accounts of their having been discovered ten or twelve feet from the top of the ground have been founded on some mistake, or the occurrence of the insects at such a depth may have been the result of accident. The only alteration to which the insects are subject, during the long period of their subterranean confinement, is an increase of size, and the more complete development of the four small scale-like prominences on their backs, which represent and actually contain their future wings.

As the time of their transformation approaches, they gradually ascend towards the surface, making in their progress cylindrical passages, oftentimes very circuitous, and seldom exactly perpendicular, the sides of which, according to Dr. Potter, are firmly cemented and varnished so as to be water-proof. These burrows are about five-eighths of an inch in diameter, are filled below with earthy matter removed by the insect in its progress, and can be traced by the color and compactness of their contents to the depth of from one to two feet, according to the nature of the soil; but the upper portion to the extent of six or eight inches is empty, and serves as a habitation for the insect till the period for its exit arrives. Here it remains during several days, ascending to the top of the hole in fine weather for the benefit of the warmth and the air, and occasionally peeping forth apparently to reconnoitre, but descending again on the occurrence of cold or wet weather.

During their temporary residence in these burrows near the surface, the Cicada grubs, or more properly pupæ, (for such they are to be considered at this period, though they still retain something of a grub-like form,) acquire strength for further efforts by exposure to the light and air, and seem then to wait for only a favorable moment to issue from their subterranean retreats. When at length this arrives, they issue from the ground in great numbers in the night, crawl up the trunks of trees, or upon any other object in their vicinity to which they can fasten themselves securely by their claws. After having rested awhile they prepare to cast off their skins, which, in the mean time, have become dry and of an amber color. By repeated exertions a longitudinal rent is made in the skin of the back, and through this the included Cicada pushes its head and body, and withdraws its wings and limbs from their separate cases, and, crawling to a little distance, it leaves its empty pupa-skin, apparently entire, still fastened to the tree. At first the wing-covers and wings are very small and opake, but, being perfectly soft and flexible, they soon stretch out to their full dimensions, and in the course of a few hours the superfluous moisture of the body evaporates, and the insect becomes strong enough to fly.

During several successive nights the pupæ continue to issue from the earth; above fifteen hundred have been found to arise beneath a single apple tree, and in some places the whole surface of the soil, by their successive operations, has appeared as full of holes as a honeycomb. In Alabama the species under consideration leaves the ground in February and March, in Maryland and Pennsylvania in May, but in Massachusetts it does not come forth till near the middle of June. Within about a fortnight after their final transformation they begin to lay their eggs, and in the space of six weeks the whole generation becomes extinct.

Fortunately these insects are appointed to return only at periods so distant that vegetation often has time to recover from the injury they inflict; were they to appear at shorter intervals, our forest and fruit trees would soon be entirely destroyed by their ravages. They are moreover subject to many accidents, and have many enemies, which contribute to diminish their numbers. Their eggs are eaten by birds; the young, when they first issue from the shell, are preyed upon by ants, which mount the trees to feed upon them, or destroy them when they are about to enter the ground. Blackbirds eat them when turned up by the plough in fields. Hogs are also excessively fond of them, and, when suffered to go at large in the woods, root them up, and devour immense numbers just before the arrival of the period of their final transformation, when they are lodged immediately under the surface of the soil. It is stated that many perish in the egg state, by the rapid growth of the bark and wood, which closes the perforations and buries the eggs before they have hatched; and many, without doubt, are killed by their perilous descent from the trees.

Art. XXV.—*On the Analysis of the Oat;* by Prof. John Pitkin Norton,* of Yale College.

A chemical inquiry into the nature of the oat would be of importance in almost any part of Europe, but it becomes a kind of national object in a country where, as in Scotland, oatmeal forms almost the sole food of a large portion of the population. But though Scotchmen have long fed and thriven upon it, and have carried their estimation of its virtues to every quarter of the globe where their adventurous footsteps have penetrated, the true properties of the oat, its chemical constituents, and the physiology of its growth, have been almost unnoticed. The few investigations hitherto published have been of a partial character. Hermbstädt and Sprengel were among the first who made experiments on the subject at all worthy of confidence. More lately Boussingault has published a single analysis; but no researches of an extended nature have hitherto been published.

To the Highland and Agricultural Society belongs the honor of first encouraging an extended inquiry for the purpose of increasing our knowledge as to the general value of the oat, as food for man and beast, and as to other points, physiological and

* This memoir, here reprinted, was presented by its author to the Highland Agricultural Society of Scotland, and received the premium of fifty sovereigns. The investigations were made in 1845.

practical, connected with its growth and cultivation. The encouragement of such researches is well calculated to retain for the Society its high position, and if possible, to increase the estimation in which it is held, as the parent of the Agricultural Societies in the British Islands.

In the laboratory of the Agricultural Chemistry Association, I have enjoyed great advantages for the prosecution of such an investigation. The kindness of Professor Johnston afforded me every facility, while his great experience pointed out the proper method for the prosecution of my inquiries.

In the detail of my results I have endeavored so to arrange them as to present a distinct connected view of the whole investigation, such as is necessary for its full appreciation. I have commenced with that which naturally comes first, the young plant, and have followed it through its successive stages of growth and development to maturity. This part of the subject completed, I proceed to the consideration of the full-grown plant.

I. Of the Unripe Plant.

Through the kindness of my friend Mr. J. Girdwood of Featherhall, Corstorphine, I was enabled to obtain during the past season, at intervals of a week, specimens of the young corn, cut always from the same spot in the field, and forwarded so as to reach me in a perfectly fresh condition.

I must here express my very great obligations to Mr. Fromberg, first assistant in the Laboratory of the Agricultural Chemistry Association, to whom I am indebted for nearly all the results connected with the unripe plant. Early last spring, he undertook this part of the investigation, at the request of Professor Johnston, and has devoted much of his time to it during the past season. I am thus enabled to render my paper far more complete than it could otherwise have been.

A. *Of the Quantity of Ash yielded by the several parts of the Unripe Plant.*

As soon as the plants were received, portions of the several parts were weighed for the purpose of determining the water, and dried at a temperature not exceeding 212° Fahrenheit, until their weight became constant. At least three separate portions of each part were taken to provide for accidents, and to secure at least two concurring determinations.

While the above were drying, others were weighed from which to determine the ash. The burning was always effected in platinum vessels over argand gas-burners, and at a dull red heat.

The first specimens of the young plant arrived on the 4th of June, and the succession at weekly intervals was uninterrupted until the cutting of the crop on the 3d of September. The oats were of the potato variety, and though retarded by the unusually wet season, were uniformly strong and healthy, the sample proving one of uncommon excellence. The plants on the 4th of June were from four to six inches in height, consisting merely of one leaf, and the commencement of the stalk. These two parts, therefore, are first to be considered, as to the quantity of ash which they yield.

1. *Of the Leaf.*—The following Table exhibits the proportions in the leaf at successive stages of its growth—1. Of Water. 2. Of Ash. 3. Of Ash calculated dry.

TABLE I.

	June				July					August				Sept.
	4.	11.	18.	25.	2.	9.	16.	23.	30.	6.	13.	20.	27.	3.
Per cent. of Water,	80·51	82·76	82·02	78·53	80·26	76·97	76·53	77·61	77·00	76·63	74·06	79·93	70·68	24·60
Per cent. of Ash,	2·16	1·86	1·63	2·35	2·24	2·81	3·06	3·85	3·78	3·75	6·14	4·25	6·49	15·78
Do. calculated dry,	10·83	10·79	9·07	10·95	11·35	12·20	12·61	16·45	16·44	16·05	20·47	21·14	22·13	20·90

During the whole growth of the plant the diminution in the quantity of water in the leaf was not great, being only about 10 per cent. from the 4th of June to the 27th of August. So late as the 20th of August it was nearly as high as at first. When the plant becomes ripe, however, the leaf at once withers, and this accounts for the great decrease of water between the 27th of August and the 3d of September. This decrease in the water gives a great apparent increase of ash in the undried leaf. When calculated dry, in the third line, there appears an actual decrease from the two preceding weeks. There may have been some change in the circulation at the last, by which a portion of the inorganic materials was carried back into the stalk.

2. *Of the Stalk.*—The per-centages of water, of ash, and of ash calculated dry, were determined as in the leaf.

TABLE II.

	June				July					August				Sept.
	4.	11.	18.	25.	2.	9.	16.	23.	30.	6.	13.	20.	27.	3.
Per cent. of Water.	87·04	87·05	87·13	84·74	83·66	82·05	80·85	79·60	76·64	75·66	69·80	76·27	71·57	71·70
Per cent. of Ash,	1·36	1·28	1·28	1·40	1·28	1·40	1·52	1·63	1·74	2·01	2·00	1·58	2·19	2·36
Do. calculated dry,	10·49	9·88	9·32	9·17	7·83	7·80	7·94	7·99	7·45	7·63	6·62	6·66	7·71	8·35

The decrease of water during the growth of this part is considerably more than in the leaf. The quantity of ash in the undried straw (second line) increases toward the end, as in the undried leaf. This, in both cases, is owing to the gradual disappearance of the water; for we see, in the third line, that the actual per-centage of ash in the *dried* stalk is less on the 3d of September than it was on the 4th of June. In the earlier growth of the stalk, the dried stem or solid part, though less in quantity, actually contains a larger per-centage of ash than is afterwards necessary to its perfect maturity. As the stalk is the stem of the plant, through it must pass the inorganic materials necessary for the building up of all the other parts. How wise the provision, which enables it to furnish an abundance of these materials at the time when they are most needed! Between the 6th and the 27th of August, the demand upon the straw was very great; at this period the grain was most rapidly attaining its full size; the leaf also between the 13th and the 20th of August, increased its per-centage of ash from 16 to 21. When these parts have attained their full size, and approach maturity, the ash in the stalk begins to accumulate again, as is seen in the last two weeks. This is at the same time that the decrease in the leaf, mentioned above, takes place.

From the very large per-centage of water in the stalk on the 3d of September, when the oats were cut, it is evident that there must be an immense diminution during the drying of harvest, as I have seldom found more than 13 or 14 per cent. of water in straw taken from a well-made stack. This will appear in a subsequent table.

3. *Of the Quantity of Ash in the Knots.*—It was not until the 23d of July that determinations of ash and water in the knots were commenced. Professor Johnston has stated in his Elements of Agricultural Chemistry, some curious facts respecting the knots in the stalks of wheat, rye, bamboo, &c. He says, that the ash of this part is larger in quantity, and contains a greater proportion of silica, which, in the bamboo, is sometimes found in solid masses. To ascertain if the quantity of ash in the knots of oats varied greatly from that in the whole straw, these trials were made.

TABLE III.

	July 23.	July 30.	Aug. 6.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.
Per cent. of Water, . .	76·05	75·54	74·82	75·29	75·38	73·55	70·65
Per cent. of Ash, . . .	2·40	2·54	2·63	2·80	2·90	2·98	3·14
Do. calculated dry, . . .	10·02	9·60	10·44	10·48	11·79	11·27	10·7

The variation in the per-centage of water in this table is not large. The ash is, in accordance with Professor Johnston's results, larger in quantity than in the straw, taken as a whole. The difference in the ripe plant amounts to 2 per cent. But in Table II, the ash is given for the *whole straw*, including the knots; the difference therefore between the knots and the straw, taken separately, would be at least 4 per cent. The variations in the per-centage of ash, shown by the above table, are not very striking.

4. *Of the Quantity of Ash in the Chaff.*—The determinations of ash and water in this part of the plant commenced on the 16th of July. I must here mention, that by the chaff I mean the outer covering which envelopes the oat during its growth, becoming looser as it ripens, and finally falling off during thrashing.

Per-centage of ash and water exhibited as before.

TABLE IV.

	July 16.	July 23.	July 30.	Aug. 6.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.
Per cent. of Water,	55·01	56·95	50·49	45·04	40·86	47·08	40·44	21·96
Per cent. of Ash,	2·72	3·92	6·08	7·83	11·05	11·20	13·38	21·43
Do. calculated dry,	6·00	9·11	12·28	13·75	18·68	21·07	22·46	27·47

The quantity of water given by the above table is much less, while that of ash is much greater, than in any other part of the unripe plant. The extraordinary quantity of 27 per cent., as given in the third line, is very remarkable. It is to be observed, however, that in no other specimen of chaff have I found so high a per-centage. The crop, as I have before stated, was unusually vigorous, and grown on a deep rich loam, where every thing it required seems to have been in abundance, and the per-centage of ash in every part is uncommonly large. It will be noticed that the increase of ash is more steadily progressive than in any of the other parts.

5. *Of the Quantity of Ash in the Oat.*—It is necessary for me here to explain, that, in speaking of the *Oat*, I always mean the seed and husk together. By the *Grain*, I mean the seed divested of its husk. This distinction will prevent confusion. The oats did not become sufficiently developed for separation from the stalk until the 2d of July. The same treatment was pursued as with the other parts, and the following table exhibits the results.

TABLE V.

	July 2.	July 9.	July 16.	July 23.	July 30.	Aug. 6.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.
Per cent. of Water, . .	80·84	75·56	69·83	63·22	62·06	62·44	55·11	49·76	45·92	30·74
Per cent. of Ash, . . .	0·94	1·02	1·17	1·33	1·60	1·62	1·87	1·83	1·90	2·53
Do. calculated dry, . .	4·91	4·36	3·38	3·62	4·22	4·31	4·07	3·64	3·51	3·65

During the growth of this part of the plant, the per-centage of water steadily decreased to considerably less than one-half of the original quantity. As in the stalk, this has caused an apparent increase of ash (second line), but when calculated dry (third line), there is an actual decrease. This diminution of ash occurs only in these two parts of the plant. I have already given a probable explanation of the cause in the stalk, and think that one equally simple may be given as to the oat itself. Every one who has noticed its growth, knows that the husk, being necessary for the protection of the grain, is formed first, and attains nearly its full size while the grain is yet scarcely visible. A subsequent table will show that the husk contains about three times as much ash as the grain. During the first growth of the oat, this husk, requiring an abundance of inorganic materials, is to be formed, and we accordingly find such a proportion of these materials present, as are not found at any subsequent period. When the husk is formed the grain enlarges, and as it gradually becomes three-fourths of the oat, the per-centage of ash, taking the two together, of course diminishes. By reference to Table II, it will be seen, that on the 2d of July, just when the oat began to show itself, a sudden decrease took place in the ash of the stalk. The per-centage of water in the oats when the crop was cut, on the 3d of September, was more than twice as much as I have found in those taken from the granary or stack-yard.

Heretofore I have only spoken of the quantity of ash yielded by the several parts of the plant; I now would direct attention to the composition of this ash, which will constitute the second division.

B. *Of the Quality of the Ash from the several parts above mentioned.*

This series of analysis by Mr. Fromberg, has already involved a very great amount of labor, and is not yet by any means finished, extending only over seven weeks of the fourteen, in which the determinations of the quantity of ash were made. They extend to the 16th of July; and, so far as they go, present a complete view of the curious and interesting changes which take place during the development of the various parts of the plant. As before, I will place the leaf first.

1. *Composition of Ash from the Leaf of Unripe Oats at different periods of growth.*

Table VI.

	June 4.	June 11.	June 18.	June 25.	July 2.	July 9.	July 16.
Potash and soda,	24·60	23·51	26·21	28·10	18·78	16·09	18·35
Chlorid of sodium,	16.34	13·54	11·30	7·56	7·92	4·09	0·30
Lime,	8.44	7·24	7·33	6·74	6·91	5·93	5·13
Magnesia,	5.33	3·11	3·47	3·06	2·39	2·35	1·63
Oxyd of iron,	0.61	0·52	0·72	0·99	0·40	0·34	0·55
Sulphuric acid,	11.74	12·85	10·59	7·88	9·50	6·45	13·05
Phosphoric acid,	16.16	10·57	10·12	8·76	6·92	6·44	2·91
Silica,	16.58	28·54	30·31	36·50	47·62	58·28	58·22
	99·80	99·88	100·05	99·59	100·14	99·97	100.14

Perhaps the most striking feature in this table is the gradual disappearance of the chlorid of sodium (common salt); from 16 per cent., in seven weeks it decreased to less than a third of a per cent. A large quantity of soda yet remains, nearly all, no doubt, in the state of sulphate. The phosphoric acid, too, disappears in a great degree. There were at first probably phosphates of potash and soda, but these must have left the leaf to supply the grain, and on the 16th of July the small quantity of phosphoric acid left was nearly all in combination with lime, magnesia, and iron. The oxyd of iron seems to have fluctuated in its proportions less than any of the other substances.

2. *Of the Composition of Ash from the Stalks of the Unripe Plant.*

TABLE VII.

	June 4.	June 11.	June 18.	June 25.	July 2.	July 9.	July 16.
Potash and soda,	24·94	21·45	26·49	28·86	36·26	30·10	42·43
Chlorid of sodium,	32·66	34·65	24·94	24·57	11·62	17·82	4·46
Lime,	2·40	4·22	3·74	2·42	2·64	1·60	4·12
Magnesia,	0·88	3·20	2·20	2·58	1·17	2·27	1·47
Oxyd of iron,	0·39	0·30	0·40	0·58	0·88	0·68	0·62
Sulphuric acid,	6·15	7·82	8·51	4·87	7·98	9·09	7·84
Phosphoric acid,	16·15	13·96	12·55	7·81	2·21	5·57	6·31
Silica,	16·29	14·32	20·41	28·08	36·64	32·39	34·85
	99·86	99·92	99.24	99·77	99·40	99·52	100·33

The decrease in the quantity of chlorid of sodium is here also very remarkable, from 32½ to 4½ per cent. The phosphoric acid continued without much variation until the 25th of June, when the oat itself began to form; by the 2d of July the oats had shot up from the stalk and become visible; in that week a marked and sudden decrease took place in the phosphoric acid. In the two succeeding weeks it began again to increase. No very great changes seem to have taken place in the other constituents, excepting the gradual increase of silica. The composition of the stalk on the 16th of July differs very greatly from that of a mature stalk, as will afterwards be seen. It was then still green and vigorous, growing rapidly, and serving as a canal for the conveyance of a great portion of their food to the other parts of the plant. The inorganic ingredients, therefore, might be expected to vary, as we see them, with the fluctuations of temperature more or less favorable to vegetable growth.

3. *Composition of Ash from the whole Oat, at different periods of its growth.*

TABLE VIII.

	July 2.	July 9.	July 16.
Potash and soda,	32·92	31·31	31·37
Chlorid of sodium,	10·37	8·10	0·61
Lime,	2·70	5·40	6·76
Magnesia,	3·44	4·52	2·94
Oxyd of iron,	0·39	0·21	0·35
Sulphuric acid,	10·35	12·78	16·42
Phosphoric acid,	14·02	20·09	15·19
Silica,	24·40	17·05	26·05
	98·59	99·46	99·69

During these three weeks the oat attained nearly its full length, but was yet quite green, and the grain had scarcely begun to form in the interior of the husk. The above table, therefore, only enables us to compare the earliest part of its growth with the latest as afterwards given. The diminution of chlorine is, however, to be noticed as very great in the short space of three weeks. I think the large quantity of sulphuric acid present at this time would have diminished, as I have seldom found so much in the ash of the ripe oat.

4. *Comparative View of the Composition of the Ash from the Leaf, Stalk, Oat, Knots, and Chaff, on the* 16*th of July.*

TABLE IX.

	Leaf.	Stalk.	Knots.	Chaff.	Oat.
Potash and soda, . .	18·35	42·43	39·21	15·39	31·37
Chlorid of sodium, .	0·30	4·46	0·60	2·01	0·61
Lime, ...	5·13	4·12	4·75	4·58	6·76
Magnesia, . . .	1·63	1·47	4·51	3·10	2·94
Oxyd of iron, . .	0·55	0·62	1·02	1·50	0 35
Sulphuric acid, . .	13·05	7 84	27·94	9·90	16 42
Phosphoric acid, . .	2·91	6·31	9·03	7 26	15·19
Silica, ...	68·22	34 85	13·23	56 38	26·05
	100·14	100·33	100·29	100·12	99·69

On the 16th of July the plant was in the midst of its most rapid growth, and just half-way between the time when it appeared above ground in June, and when it was cut on the 3d of September. In a subsequent table will be found a comparison of the ash from these parts of the plant when fully matured.

5. *Organic Constituents of the Unripe Plant.*—In connexion with the first chapter of my subject, I have hitherto said nothing of the organic constituents of the unripe plant. Mr. Fromberg has determined the nitrogen in the unripe oat at six periods of its growth, and also when it had become fully ripe. The following table gives his results.

TABLE X.

	July 16.	July 30.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.	Quite ripe.
Per centage of nitrogen in undried oat,	0·51	0·51	0·62	0·66	0·97	1·52	1·87
Do. do. in dried oat, . . .	1·71	1 35	1·38	1·31	1·79	2·20	2·18
Do. do. of protein compounds in undried oat, ...	3.24	3·24	3·90	4·15	6·10	9·58	11·80
Do. of do. in dried oat, . .	10·75	8·50	8·69	8·25	11·26	13·84	13·72

The steady increase of nitrogen from the 30th of July is very striking. Had time permitted, it would have been of much interest to determine the other organic constituents, both proximate and ultimate. This tempting field we have been obliged to leave for future exploration. I now pass on to that part of the investigation upon which I have, myself, been principally engaged.

II. OF THE RIPE PLANT.

It now remains to consider the plant in a state of maturity, both as to its inorganic and its organic constituents. To the inorganic part I shall first direct attention, and here, as in the first chapter, I shall take up different portions of the plant in succession.

1. *Of the Ash yielded by the Straw.*—It has been shown by Professor Johnston,* that the ash from the straw of all the corn

* See his *Elements*, p. 44.

crops varies in quantity at different heights of the same stalk. To ascertain the nature and extent of this variation in the oat straw I considered a point of importance, and to it I first directed my attention. Each straw was divided into three equal parts, the bottom, the middle, and the top. These were separately burned in the same manner, and with the same precautions as have already been described under the unripe plant, each burning being repeated until two or more trials were found to agree.*

The following table gives a comparative view of the per-centage of ash in these three parts, from five different samples of straw of the localities stated over each column. The ash is calculated dry, and the average per-centage of water given in the upper line.

Table XI.

	Hopeton, Hexham, Northumberland.	Hopeton, Kilwhiss, Fife.	Dun, Swanston, Edinburgh.	Potato, Hexham, Northumberland.	Sandy, Kilwhiss, Fife.
Average of water, . .	11·21	10·11	9·36	10·99	9·19
Per cent. of ash in top straw,	4·95	5·44	8·25	9·23	10·01
Do. do. in middle straw,	6·11	4·23	6·53	7·41	9·01
Do. do. in bottom straw,	5·33	5·86	7·19	9·76	7·30

The above table establishes two facts: 1. That there is a great difference in the quantity of ash yielded by the same straw at different heights. 2. That the ash yielded by the same part varies greatly in different specimens; and that this holds true even when the samples are of the same variety of oat, as is seen in the Hopeton oats above. Thus far the results of Professor Johnston are confirmed. There is not, however, a regular gradation in the quantity of ash, from the top downwards. In only one case, that of the Sandy oats, is this gradation to be observed. It may be that, if I had taken but one straw at a time, and accurately divided it, the result would have been different. I am inclined to doubt this, however; for the straw of the oat crop is well known to be more irregular in quantity than that of any other corn crop: and table twelve shows that the average quantity of its ash is equally variable: this variation may very probably extend to different parts of the same stalk. Even if the averages of the above parts are taken, we still find a great difference in the amount of ash.

* The straw of the ripe oat generally burns with difficulty, if the heat be too great it fuses, enveloping in a kind of glass some of the carbonaceous matter; it is then almost impossible to burn it white. I have often been obliged to burn samples for more than twenty-four hours. The addition of peroxyd of mercury has been proposed, and would undoubtedly be effective in whitening the ash, but I have feared that it would decompose some of the chlorides, and have therefore not made use of it.

The following table illustrates this.

Average per-centage of Ash in Six Samples of Oat Straw.

TABLE XII.

	No. 1, Hopeton.	No. 2, Hopeton.	No. 3, Dun.	No. 4, Sandy.	No. 5, Potato.	No. 6, Potato.
Average per cent. of ash.	5·46	5·02	7·29	9·11	8.76	8·65

We see here a range of a little more than 4 from the lowest to the highest per-centage. If there were 3000 lbs. of straw upon an acre, the difference between the weights of inorganic matter carried off by the two crops, Nos. 2 and 5, would amount to about 128 lbs. per acre. Though they do not exactly agree, yet there is a much nearer approach to agreement in the two samples of Hopeton oats, and in the two samples of Potato oats, seeming to indicate that the average quantities of ash are more nearly alike in the same variety. This is very singular if true, but needs further proof. If the average of the above six trials can be considered as a standard, the usual per-centage of ash in oat straw is about 7·50.

The foregoing points as to the quantity of ash, being, as I hope, now sufficiently distinct, I come to an inquiry of much importance; do these differences in the quantity extend to the quality of the ash also? I shall proceed to show—1. That the ash varies in quality at different heights of the same stalk. Dividing the straw into three parts as above, and analyzing the ash from each part separately, the results are as follows.*

---

* It is proper here to introduce a brief account of the method which I have followed in the analyses of these ashes.

I have always divided them into three portions. 1. That which was soluble in water; 2. That which was soluble in acid; 3. That which remained insoluble. It is not necessary here to enter upon a detail of the reasons for this division; suffice it to say, that it was made as being likely to throw light upon various physiological questions, connected with the mode of growth and the circulation of the plant. Each division was subject to analyses separately.

I. *The watery solution.*—This was first evaporated to dryness, heated to drive off organic matter, and weighed. To the dry mass water was then added, and a small portion always refused to re-dissolve. This was, in several instances, analyzed, and found to be chiefly soluble silica. In my later analyses this was added to the acid solution, to save time.

To the re-dissolved part of the watery solution—

1. Nitrate of silver was added to throw down the chlorine, the liquid being previously acidulated by nitric acid. The precipitate was collected, burned and weighed, with the usual precautions.

2. The excess of silver having been thrown down by hydrochloric acid, and removed by filtration, nitrate of baryta was added to obtain the sulphuric acid. This precipitate was allowed to stand at least twelve hours before filtration.

3. After removing the excess of baryta from the solution by sulphuric acid, hydrosulphuret of ammonia was added, to throw down the manganese.

The phosphoric acid was determined by the method of Berthier, well known to analytical chemists—an excellent method when the usual precautions are employed, and there is no iron in the solution.

4. The solution was next evaporated to dryness, and the sulphate of potash and soda weighed together, then re-dissolved, and the potash obtained by the bi-chlorid of platinum. The precipitate, collected and weighed in the usual manner, was

Composition of Ash from Oat Straw at three different heights. Hopeton Oat from Mr. Harbottle, Hexham, Northumberland.

TABLE XIII.

	Top Straw.	Middle Straw.	Bottom Straw.
Sulphuric acid, ...	38·55	18·45	16·10
Chlorid of sodium, (common salt,) .		3·03	15·36
Potash and soda, ...		21·80	40·17
Phosphates of lime, magnesia and iron,	2·84	3·03	0·78
Lime, ...	7·02	7·23	6·06
Magnesia, ...	2.84	2·91	2·07
Oxyd of iron, ...	0·30	1·40	0·61
Soluble silica, ...	5·13	7·34	5·03
Insoluble silica, ...	43·31	33·14	12·29
	99·99	98·33	98·47

In reference to the above analyses, I wish to direct attention to several points.

1. To the great difference in the proportion of salts soluble in water. Part of these are grouped together in the top straw analyses; with the addition of the soluble silica, their amount is 42 per

---

calculated as sulphate; this, subtracted from the united weight of the sulphates as weighed above, gave the loss as sulphate of soda, from which the soda was calculated.

II. *The acid solution.*—1. Ammonia was added to throw down the phosphates. The precipitate was always a mixture of phosphates of lime, magnesia and iron. It was fused with carbonate of soda, the phosphoric acid determined by Berthier's method, and the lime, magnesia, &c., in the usual way. This method of analyzing phosphates is by no means a perfect one, but with certain precautions very good results may be obtained. I have tried various other methods with bad success. One of these has been highly recommended; it is that of throwing down the phosphoric acid as a phosphate of the peroxyd of iron, from a solution in acetic acid. The precipitate obtained is so variable in its composition, that it is always necessary to analyze it separately, and the whole process is so uncertain, that after many trials I abandoned it.

2. The lime was thrown down by oxalate of ammonia, and collected after standing at least twelve hours.

3. As I found, in almost every instance, potash and soda in this part of the acid solution, it became necessary to determine the magnesia in some other than the usual way, by phosphate of soda. The solution was therefore evaporated nearly to dryness, mixed with a little peroxyd of mercury, and rather strongly heated. The chlorids of potassium and sodium decompose with great difficulty, and that of magnesia with ease; the latter was therefore by heating converted into caustic magnesia, and separated by washing with *boiling* water. The solution, containing the potash and soda, was now evaporated to dryness, and they were determined as above.

III. *The insoluble portion.*—1. This was fused with five times its weight of carbonate of soda, the fused mass dissolved in hydrochloric acid, and the silica obtained in the usual way.

2. The phosphates were precipitated by ammonia, and, after weighing, were analyzed with the phosphates of the acid solution.

3. The lime was thrown down as usual by oxalate of ammonia, and the magnesia by phosphate of soda.

4. Potash and soda. A small quantity of potash and soda is often present even in the insoluble part of the ash, and I have, therefore, in many cases been obliged to determine it by fusing with baryta in the ordinary way.

The above is an outline of a complete analysis, according to the methods I have generally pursued, supposing all the substances mentioned to be present. Of course their presence or absence was previously ascertained by a qualitative examination, and the analysis modified accordingly. The quantity I considered proper for analysis was from 20 to 30 grains.

cent., in the middle straw it is 55 per cent., in the bottom straw 77 per cent. The increase of these soluble salts, therefore, is very great as we proceed downwards, the proportion being nearly twice as great at the bottom as at the top.

2. To the abundance of sulphuric acid and the total absence of phosphoric acid in the watery solution.

3. That as the salts soluble in water increase from the top downwards, the silica increases from the bottom upwards. This seems to be an invariable law. The *quantity* of ash, as I have shown, varies, being sometimes greater in one part and sometimes in another; but whichever part this may be, whether the top or the bottom has most *ash*, in *every* case that I have examined, the top has the most silica, and the bottom the most salts soluble in water.

Having thus shown that different parts of the same straw vary, I proceed to prove, in the second place, that the same parts vary in different straws. In order to make my results bear upon as many questions as possible, I have selected two samples of the same variety of oats grown on two widely different soils. No. 1, was from a light rather sandy loam, of good quality. No. 2, was from a poor mossy soil, where the great difficulty is to make the straw stand.

Table, giving the composition of Ash from Straw of two specimens of Hopeton Oats.

TABLE XIV.

	No. 1. Top Straw.	No. 2. Top Straw.	No. 1. Middle Straw.	No. 2. Middle Straw.	No. 1. Bottom Straw.	No. 2. Bottom Straw.
Salts soluble in water, chiefly sulphates and chlorids,	41·96	71·70	55·22	84·03	77·46	90·26
Phosphates of lime, magnesia and iron, ...	2·94	0·77	3·03	1·51	0·78	2·21
Lime and magnesia, . .	11·29	14·34	9·70	8·73	9·16	2·65
Silica, ...	43·75	13·18	32·05	5·72	12·55	4·86
	99·94	99·99	100·00	99·99	99·95	99·98

On comparison of the above analyses, it is first to be noticed, that there is an extraordinary difference in the per-centage of salts soluble in water, in each part of the two samples. The top straw and middle straw of No. 2, each contain about 30 per cent. more than the corresponding portions of No. 1.

2. That this difference is equally great as regards the silica.

3. That the lime and magnesia also in both instances are greatest in the top straw.

This table may be considered a very excellent illustration of the extent to which the soil modifies the composition of the ash. No. 1, is a fair example of a healthy straw. No. 2, being the same variety of oat, has been grown where its wants were not fully supplied. I have said that on the mossy soil from which this sample came, the great difficulty was to make the straw stand. The above analysis shows that a want of silica was probably the cause of this difficulty. It is a curious fact in accordance with the above, that the addition of a very fine siliceous sand to some places on this soil has in a great degree remedied this weakness of straw. The abundance of alkalies present in the soil, judging from the quantity in the above ash, may facilitate the solution of this finely divided silica. The *quantity* of ash in the two samples does not greatly differ,—see Table VI. No. 2 seems to have endeavored to supply the want of silica by potash and soda. Sprengel has made an analysis of ash from oat straw; but his results differ much from mine. He gives for instance 80 per cent. of silica. Fifty per cent. is the largest quantity I have observed even in the top straw. The variations that I have found are, however, so great, that I hesitate to pronounce his analysis erroneous. Some peculiar circumstances may have caused the presence of even this extraordinary quantity.

Before leaving for the present the subject of the straw, I may mention, that I have, so far as my time permitted, turned my attention to the disease called the *smut* in oats, and have several analyses of ash from the smutted straw. I regret much that they are not in a sufficiently advanced state for publication. So far as they go, they indicate a derangement in the circulation of the plant, especially in the top straw.

The following comparison will show that in *quantity* the ash does not materially differ from that of the healthy straw.

TABLE XV.

	Top straw.	Middle straw.	Bottom straw.
Ash from healthy straw, ...	5·64	7·89	9·17
Ash from smutted straw, . . .	6·52	6·10	7·78

2. *Of the ash yielded by the leaf.*—This part of the plant, though it withers away, and seems of little consequence when the corn is ripe, is yet of vital importance during its growth, and therefore demands our attentive consideration.

It yields more ash than the straw, in some cases fully twice as much; and this ash, like that of the straw, varies in quantity with the soil, the manure, and the variety of oat.

The following table gives the per-centage of ash and of water, in six samples of leaf. The ash, as usual, is calculated dry.

TABLE XVI.

	Hopeton Oats.		Dun	Sandy	Potato Oats.		Mean of
	No. 1.	No 2.	Oats.	Oats.	No. 1.	No. 2.	trials.
Of Water, ...	9·08	9·57	10·11	10·95	10·33	11·02	10·14
Of Ash, ...	7·19	8·44	10·29	14·79	14·59	20·90	12·70

In this table the differences are much greater than those which appeared in the straw. The leaf from the potato oat No. 2, has nearly three times the per-centage of ash yielded by that from the Hopeton oat No. 1. The potato oat leaf came from an extraordinary crop on a rich loam; the Hopeton oat leaf from a very inferior straw on a poor soil.

In separating the leaf from the stalk, I took the whole leaf from the knot to which the bottom is attached, thus including the part which wraps around the stalk.

It occurred to me that there might be a difference in the quantity of ash yielded by this latter part, compared with that portion of the leaf which projects from the stalk. I accordingly separated the leaf of a Sandy oat into two parts, and separately determined the ash with the following result.

TABLE XVII.

	Ash calculated dry.
Ash from top of the leaf, ...	16·22
do. from bottom, ...	13·66

This difference in the quantity of these two ashes, is what we should have been led to expect from the previous determinations of ash in the straw, where it was in a majority of cases most abundant at the top.

There are fewer disturbing causes in the circulation of the leaf than in that of the straw, and we may perhaps rely with more certainty on a regular gradation of ash from the top to the bottom.

The quality of the ash from the leaf differs from that of the straw. The following extended analysis is of the ash from what may be considered a fair specimen of a healthy leaf, neither excessively luxuriant, nor at all stinted in its growth. It is from the same Hopeton oat of which the straw ash analyses were given in Table XIII.

Composition of Ash from the Leaf of Hopeton Oats, from Mr. Harbottle, Hexham, Northumberland.

TABLE XVIII.

	Per-centage.
Sulphuric acid, ...	14·80
Chlorid of sodium, (common salt,)	2·29
Potash, ... } Soda, ... }	14·89
Phosphates of lime, magnesia, and iron, . . .	6·13
Lime, ...	6·99
Magnesia, ...	2·55
Soluble silica, ...	5·90
Insoluble silica, ...	45·75
	99·30

The watery solution contained about 37 per cent. of this ash, and from the above amount of sulphuric acid, it is quite plain that about 30 per cent. were sulphates. The soluble and insoluble silica together constitute more than half of the ash.

The leaf acts a most important part in the economy of the plant; the organic food which is derived from the atmosphere is absorbed through the pores of the leaf. In order to perform this function, it must spread out a broad expanded surface, which will come in contact with as much as possible of the surrounding air. This leaf, so extended and yet so thin, requires a degree of stiffness that it may stand forth from the stalk, and wave in the breeze, rather than hang helplessly down as if withered. For this purpose a strong framework must be furnished. In Table XVI, the average per-centage of ash from six samples of leaf, is 12½, and of this fully one half is silica. It is, I think, not unnatural to conclude that this large quantity of ash, so great a part of which is silica, is conveyed to the leaf for the purpose to which I have alluded. When the plant is uncommonly vigorous, and the leaf expands to an unusual breadth, this framework (see Table XVI) may amount to even 20 per cent.

I have now to show that the ash of the leaf varies in quality as well as quantity, and for this end give the three following analyses.

Composition of Ash from three samples of the Oat Leaf.

TABLE XIX.

	Hopeton Oats.		Sandy Oats.
	1. Light loam.	2. New moss.	Gravelly loam.
Salts soluble in water, chiefly sulphates and chlorids,	36·77	56·5	45·77
Phosphates of lime, magnesia and iron,	7·23	3·66	1·00
Lime and magnesia,	10·24	1·33	3·27
Silica,	45·75	38·5	49·96
	99·99	99·99	100·00

The general composition of the ash from the leaf does not greatly differ from that of some samples of top straw. To the insoluble silica in the lower line of the above, must be added, in each case, 4 or 5 per cent. of soluble silica included in the watery solution.

Having found that the top and bottom of the leaf yielded different quantities, I was desirous of further ascertaining if the quality differed also. The following table gives analyses of the ash from the two parts.

TABLE XX.

	Ash from Top of leaf.	Ash from Bottom of leaf.
Salts soluble in water, chiefly sulphates and chlorids,	43·26	48·28
Phosphates of lime, magnesia and iron,	0·85	1·15
Lime and magnesia,	3·76	2·78
Silica,	52·13	47·79
	100·00	100·00

The differences of composition in these two ashes are of the same character as those which have been noticed in the straw. Though not so striking as those differences, they show that the same rule as to the preponderance of silica at the top, and of soluble salts at the bottom, holds true in both these parts of the plant.

(*To be continued.*)

Art. XXVI.—*Observations on the uses of the Mounds of the West, with an attempt at their Classification;* by E. G. Squier, Chillicothe, Ohio.

The monuments of the Mississippi valley, are divisible into two grand classes, viz. the Enclosures, familiarly known as "Forts," and the Tumuli, or Mounds;* together they constitute a single system of remains, and are the work of the same people.

The enclosures, from their magnitude and other obvious reasons, have attracted, by far, the largest share of attention; and the character of some of them, with their walls and ditches and guarded ways, is manifest, and may be regarded as settled. Of the mounds, however, little has been hitherto said or known.—The popular opinion, based, in a great degree, upon the well ascertained purposes of the barrows and tumuli occurring in certain parts of Europe and Asia, is, that they are simple monuments, marking the last resting place of some great chief or distinguished individual, among the tribes of the builders. Some have supposed them to be the cemeteries, in which were deposited the dead of a tribe or a village, for a certain period, and that the size of the mound is an indication of the number inhumed! Others that they mark the sites of great battles, and contain the bones of the slain. On all hands the opinion has been entertained, that they were devoted to sepulture alone. This received opinion is not, however, sustained by the investigations set on foot by the writer and his associate, Dr. E. H. Davis, of Chillicothe, Ohio. Nearly one hundred and fifty mounds, embracing those of every size and description, within enclosures and out of them, in groups and isolated, have been carefully excavated under their personal supervision, and every fact of importance respecting them carefully noted. The conclusion, to which these observations have led, is, that the mounds were constructed for several grand and dissimilar purposes, or rather, that they are of different classes;—the conditions upon which the classification is founded being three in number—namely: position, structure, and contents. In this classification, we distinguish—

1st. Those mounds which occur in, or in the immediate vicinity of, enclosures, which are stratified and contain altars of burned clay or stone, and which were places of sacrifice, or in some way connected with religious rites and ceremonies.

2d. Those which stand isolated, or in groups, more or less remote from the enclosures, which are not stratified, which contain human remains, and which were the burial places and monuments of the dead.

---

* The term *Mound* is used, in this paper, in a technical sense as synonymous with *tumulus* and in opposition to embankment, rampart, *etc.*

3d. Those which contain neither altars nor human remains, and which were places of observation or the sites of structures.

These classes are broadly marked in the aggregate; but, in some instances, they seem to run into each other. Mounds of this mixed character, as well as those which, under our present condition of knowledge respecting them, do not seem to indicate any clear purpose, have been denominated *anomalous*. Of one hundred mounds excavated, sixty were altar or sacrificial mounds, twenty sepulchral, and twenty either places of observation or *anomalous* in their character. Such however, is not the proportion in which they occur. From the fact that the mounds of sacrifice, are most interesting and most productive in relics, the largest number excavated were of that class. In the Scioto valley the mounds are distributed, between the three classes specified, in very nearly equal proportions; the mounds of observation and the anomalous mounds constituting, together, about one third of the whole number.

Mounds of Sacrifice.—The general characteristics of this class of mounds are,—

1st. That they occur only within, or in the immediate vicinity of, enclosures, or sacred places.

2d. That they are stratified.

3d. That they contain symmetrical altars of burned clay or stone, on which are deposited various remains, which, in all cases, have been more or less subjected to the action of fire.

Of the whole number of mounds of this class, which were examined, *four* only were found to be exterior to the walls of enclosures, and these were but a few rods distant from the ramparts.

The fact of stratification, in these mounds, is one of great interest and importance. The feature has heretofore been remarked but not described with proper accuracy, and has consequently proved an impediment to the recognition of the artificial origin of the mounds, by those who have never seen them. The stratification, so far as observed, is not horizontal, but always conforms to the convex outline of the mound.* Nor does it resemble the stratification produced by the action of water, where the layers run into each other, but is defined with the utmost distinctness, and always terminates upon reaching the level of the surrounding earth. That it is artificial will, however, need no argument to prove, after an examination of one of the mounds in which the feature occurs; for, it would be difficult to explain, by what singular combination of "igneous and aqueous" action,

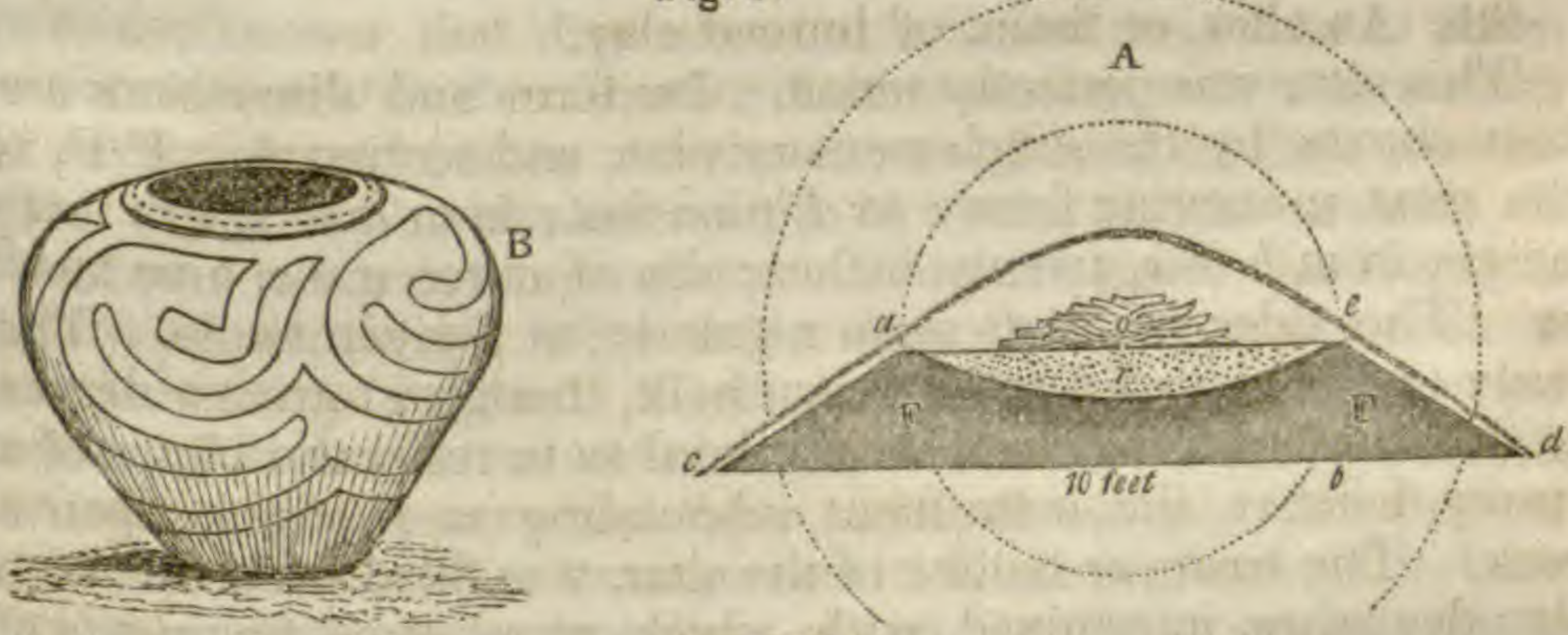
* Some of the mounds, on the lower Mississippi, are horizontally stratified, exhibiting alternate layers, from base to summit. These mounds differ in form from the conical structures here referred to, and were, doubtless, constructed for a different purpose. Prof. Forshey has described one which had layers of coarse bricks, at intervals, throughout its entire height.

stratified mounds were always raised over symmetrical monuments of burned clay or of stone.

The altars, or basins, found in these mounds, are almost invariably of burned clay, though one or two of stone have been discovered. They are symmetrical, but not of uniform size, and shape. Some are round, others elliptical, and others square, or parallelograms. Some are small, measuring barely two feet across, while others are fifty feet long by twelve and fifteen wide. The usual dimensions are from five to eight feet. All appear to have been modelled of fine clay, brought to the spot from a distance, and rest upon the original surface of the earth. In a few instances, a layer or small elevation of sand had been laid down, upon which the altar was formed. The elevation of the altars, nevertheless, seldom exceeds a foot or twenty inches, above the adjacent level. The clay of which they are composed is usually burned hard, sometimes to the depth of ten, fifteen, and even twenty inches. This is hardly to be explained, by any degree or continuance of heat, though it is manifest that, in some cases, the heat was intense. On the other hand, a number of these altars have been noticed, which are very slightly burned, and such, it is a remarkable fact, are destitute of remains.

The characteristics of this class of mounds will be best explained, by reference to the accompanying illustrations. It should be remarked however, that no two are alike in all their details.

Fig. 1.



The mound, a section of which is here given,* occurs in "Mound City," a name given to a group of *twenty-six* mounds,

* Horizontal scale of section *fifteen* feet, and the vertical *six* feet, to the inch.

embraced in one enclosure, on the banks of the Scioto river, three miles above the town of Chillicothe. It is seven feet high by fifty-five feet base. A shaft, five feet square, was sunk from its apex, with the following results:—

1st. Occurred a layer of coarse gravel and pebbles, which appeared to have been taken from deep pits, surrounding the enclosure, or from the bank of the river. This layer was one foot in thickness.

2d. Beneath this layer of gravel and pebbles, to the depth of two feet, the earth was homogeneous, though slightly mottled, as if taken up and deposited in small loads, from different localities. In one place appeared a deposit of dark colored, surface loam, and by its side, or covering it, there was a mass of the clayey soil of greater depth. The outlines of these various deposits could be distinctly traced.

3d. Below this deposit of earth, occurred a thin and even layer of fine sand, a little over an inch in thickness.

4th. A deposit of earth, as above, eighteen inches in depth.

5th. Another stratum of sand, somewhat thinner than the one above mentioned.

6th. Another deposit of earth, one foot thick, beneath which was—

7th. A third stratum of sand, below which was—

8th. Still another layer of earth, a few inches in thickness, which rested on—

9th. An altar, or basin, of burned clay.

This altar was perfectly round. Its form and dimensions are best shown by the supplementary plan, and section A. F F, is the altar, measuring from *c* to *d*, nine feet; from *a* to *e*, five feet; height from *b* to *e*, twenty inches; dip of curve *a r e*, nine inches. The sides *c a*, *e d*, slope regularly, at a given angle. The body of the altar is burned throughout, though in greater degree within the basin, where it was so hard as to resist the blows of a heavy hatchet, the instrument rebounding as if struck upon a rock. The basin, or hollow of the altar, was filled even full with fine dry ashes, intermixed with which were some fragments of pottery, of an excellent finish and elegant model, ornamented with tasteful carvings on the exterior. One of the vases, taken in fragments from this mound, has been very nearly restored. The sketch B, presents its outlines, and the character of its ornaments. Its height is six, its greatest diameter eight, inches. The material is hardly distinguishable from that composing the pottery of the ancient Peruvians, and in respect of finish, it is fully equal to the best Peruvian specimens. A few convex copper discs, much resembling the bosses used upon harnesses, were also found.

Above the deposit of ashes, and covering the entire basin, was a layer of silvery, or opaque mica, in sheets, overlapping each other; and, immediately over the centre of the basin, was heaped a quantity of burned human bones, probably the amount of a single skeleton, in fragments. The position of these is indicated by *o* in the section. The layer of mica and calcined bones, it should be remarked to prevent misapprehension, were peculiar to this individual mound, and were not found in any other of the class.

It will be seen, by the section, that, at a point about three feet below the surface of the mound, a human skeleton was found. It was placed a little to the left of the centre, with the head to the east, and was so much decayed as to render it impossible to extract a single bone entire. Above the skeleton, as shown in the section, the earth and outer layer of gravel and pebbles, were broken up and intermixed. Thus while, on one side of the shaft, the strata were clearly marked, on the other they were confused. And, as this was the first mound of the class excavated, it was supposed, from this circumstance, that it had previously been opened, by some explorer, and it had been decided to abandon it when the skeleton was discovered. Afterwards the matter came to be fully understood. No relics were found with this skeleton.

It is a fact well known, that the modern Indians, though possessing no knowledge of the origin or objects of the mounds, were accustomed to regard them with some degree of veneration. It is also known, that they sometimes buried their dead in them, in accordance with the almost invariable custom which leads them to select elevated points, and the brows of hills, as their cemeteries. That their remains should be found in the mounds, is therefore a matter of no surprise. They are never discovered at any great depth, not often more than eighteen inches or three feet below the surface. Their position varies in almost every case;—most are extended at length, others have a sitting posture, and others still seem to have been rudely thrust into their shallow graves, without care or arrangement. Rude implements of bone and stone, and coarse vessels of pottery, such as are known to have been in use among the Indians, at the period of the earliest European intercourse, occur with some of them, particularly with those of a more ancient date; while modern implements and ornaments, in some cases of European origin, are found with the recent burials. The necessity therefore of a careful and rigid discrimination, between these deposits and those of the mound builders, will be apparent. From the lack of such discrimination, much misapprehension and confusion have resulted. Silver crosses, gun barrels and French dial plates, have been found with skeletons in the mounds, yet it is not to be concluded that the mound builders were Catholics, or used fire-arms, or understood

French. Such a conclusion would, nevertheless, be quite as well warranted, as some which have been deduced from the absolute identity of certain relics, taken from the mounds, with articles known to be common among the existing tribes of Indians. The fact of remains occurring in the mounds, is in itself, hardly presumptive evidence that they pertained to the builders. The conditions attending them can alone determine their true character. As a general rule, to which there are few exceptions, the only authentic and undoubted remains of the mound builders, are found directly beneath the apex of the mound, on a level with the original surface of the earth; and it may be safely assumed, that whatever deposits occur near the exterior surface are of a date subsequent to their erection.

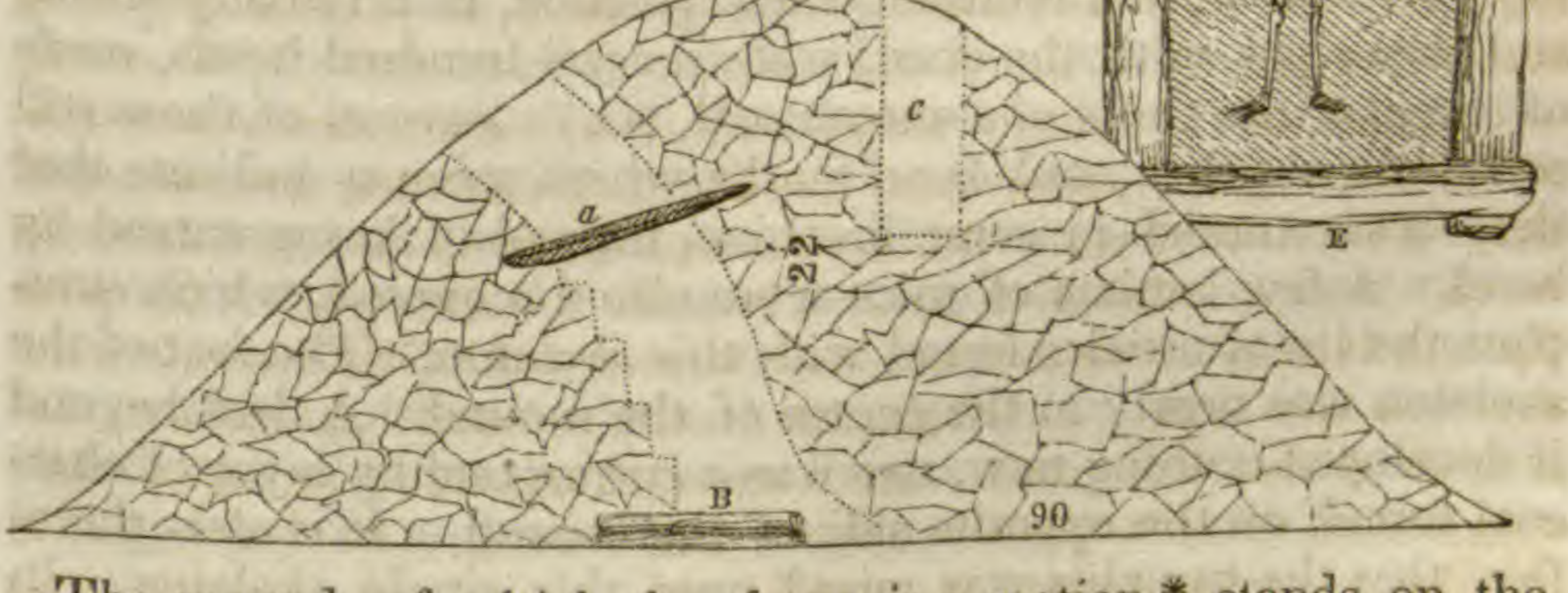
In the class of mounds now under consideration, we have data which will admit of no doubt, whereby to judge of the origin, as well as the relative periods, of the various deposits found in them. If the stratification already mentioned as characterizing them, is unbroken and undisturbed, if the strata are regular and entire, it is certain that whatever occurs beneath them, was placed there at the period of the construction of the mound. And if, on the other hand, these strata are broken up, it is equally certain, that the mound had been disturbed, and new deposits made, subsequent to its erection. It is in this view, that the fact of stratification is seen to be important, as well as interesting: for it will serve to fix, beyond all dispute, the origin of many singular relics, having a decisive bearing on some of the leading questions connected with American Archæology. The thickness of the exterior layer of gravel, etc., in mounds of this class, varies with the dimensions of the mound, from eight to twenty inches. In a very few instances, the layer, which may have been designed to protect the form of the mound, and which purpose it admirably subserves, is entirely wanting. The number and relative position of the sand strata are variable; in some of the larger mounds, there are as many as six of them, in no case less than one, most usually two or three.

In one case which fell under our observation, and in another, of which we have an account from the person who discovered it, the altar was of stone. This altar was elevated two and one half feet above the original surface of the earth, and was five feet long by four broad. It was a simple elevation of earth packed hard, and was faced, on every side and on top, with slabs of stone of regular form, and nearly uniform thickness. They were laid evenly, and, as a mason would say, "with close joints," and though uncut by any instrument, the edges were straight and smooth. The stone is "the Waverly sandstone," underlying the coal series, thin strata of which cap every hill. This stone breaks readily, with a rectangular fracture, and hence the regularity of the slabs is not so much a matter of surprise. This altar bears the marks of fire, and fragments of the mound builders' ornaments were found on and around it. What had originally been deposited there was probably removed by the modern Indians, who had opened the mound and buried one of their dead on the altar.

Mounds of this class are most fruitful in relics of the builders. On the altars have been found, though much injured and broken up by the action of fire, instruments and ornaments of *silver*, *copper*, *stone* and *ivory*; beads of silver, copper, *pearls* and shell; spear and arrow-heads of flint, quartz, garnet and *obsidian*; fossil teeth of the shark; teeth of the alligator; marine shells; galena; sculptures of the human head, and of numerous animals; pottery of various kinds, and a large number of interesting articles, some of which evince great skill in art. No description of these can be given here.

Mounds of Sepulture.—The mounds of sepulture stand apart from the enclosures, and, in their average dimensions, greatly exceed those of the first class. The celebrated mound at Grave creek was of this class. They lack the gravel and sand strata, which characterize those already described, and are destitute of "altars." They invariably cover a skeleton, (sometimes more than one, as at Grave creek,) which, at the time of its interment, was enclosed in a rude framework of timber, or enveloped in bark or coarse matting, the traces, in some instances the very *casts* of which, remain. The structure of one mound of this class, will serve to exhibit their peculiarities.

Fig. 2.



The mound, of which the above is a section,* stands on the third "bottom" or terrace of the Scioto river, six miles below the

* Horizontal scale *thirty* feet, and vertical *fifteen* feet, to the inch.

town of Chillicothe. There are no enclosures nearer than a mile, though there are three or four other mounds, of smaller size, on the same terrace, within a few hundred yards. The mound is twenty-two feet high, by ninety feet base. The principal excavation was made, (as represented by the dotted lines in the section,) from the west side, commencing at about one-third of the height of the mound from the top. At ten feet below the surface, occurred a layer of charcoal, (*a*,) not far from ten feet square, and from two to six inches in thickness, slightly inclined from the horizontal, and lying mostly to the left of the centre of the mound. The coal was coarse and clear, and seemed to have been formed by the sudden covering up of the wood, while burning, inasmuch as the trunks and branches retained their form, though entirely carbonized, and the earth immediately above, as well as below, was burned of a reddish color. Below this layer, the earth became much more compact and difficult of excavation. At the depth of twenty-two feet, and on a level with the original surface, immediately underneath the charcoal layer, and, like that, somewhat to one side of the centre of the mound, was a rude timber framework, (B,) now reduced to an almost impalpable powder, but the *cast* of which was still retained in the hard earth. This enclosure of timber, measured from outside to outside, was nine feet long by seven wide, and twenty inches high. It had been constructed of logs laid one on the other, and had evidently been covered with other timbers, which had sunk under the superincumbent earth, as they decayed. The bottom had also been covered with bark, matting, or thin slabs,—at any rate, a whitish stratum of decomposed material remained, covering the bottom of the parallelogram. Within this rude coffin, with its head to the west, was found a human skeleton, or rather the remains of one, for scarcely a fragment as long as one's finger could be recovered. It was so much decayed that it crumbled to powder, under the lightest touch. Around the neck of the skeleton, forming a triple row, and retaining their position, as originally strung and deposited with the dead, were several hundred beads, made of ivory, or the tusks of some animal, (C.) Several of these still retain their polish, and bear marks which seem to indicate that they were turned in some machine, instead of being carved by hand. A few laminæ of mica were also discovered, which complete the list of articles found with this skeleton. The foot of the skeleton was nearly in the centre of the mound. A drift beyond it developed nothing new, nor was a corresponding layer of charcoal found, on the opposite side of the mound. It is clear therefore, that the tumulus was raised over this single skeleton. In the case of a mound of this class, opened at Gallipolis, on the Ohio river, the chamber enclosing the skeleton was found just below the original surface,—a fact which can always be detected by a strongly marked line, and the uniform drab color of the earth beneath it.

The layer of charcoal is not uniformly found in mounds of this class, though it is a feature of frequent occurrence. It would seem to indicate that sacrifices were made for the dead, or that funeral rites of some kind were celebrated. The fire, in every case, was kept burning for a very brief space, as is shown by the lack of ashes, and the slight traces of its action left on the adjacent earth. That it was suddenly heaped over, is also proved by the facts already presented.

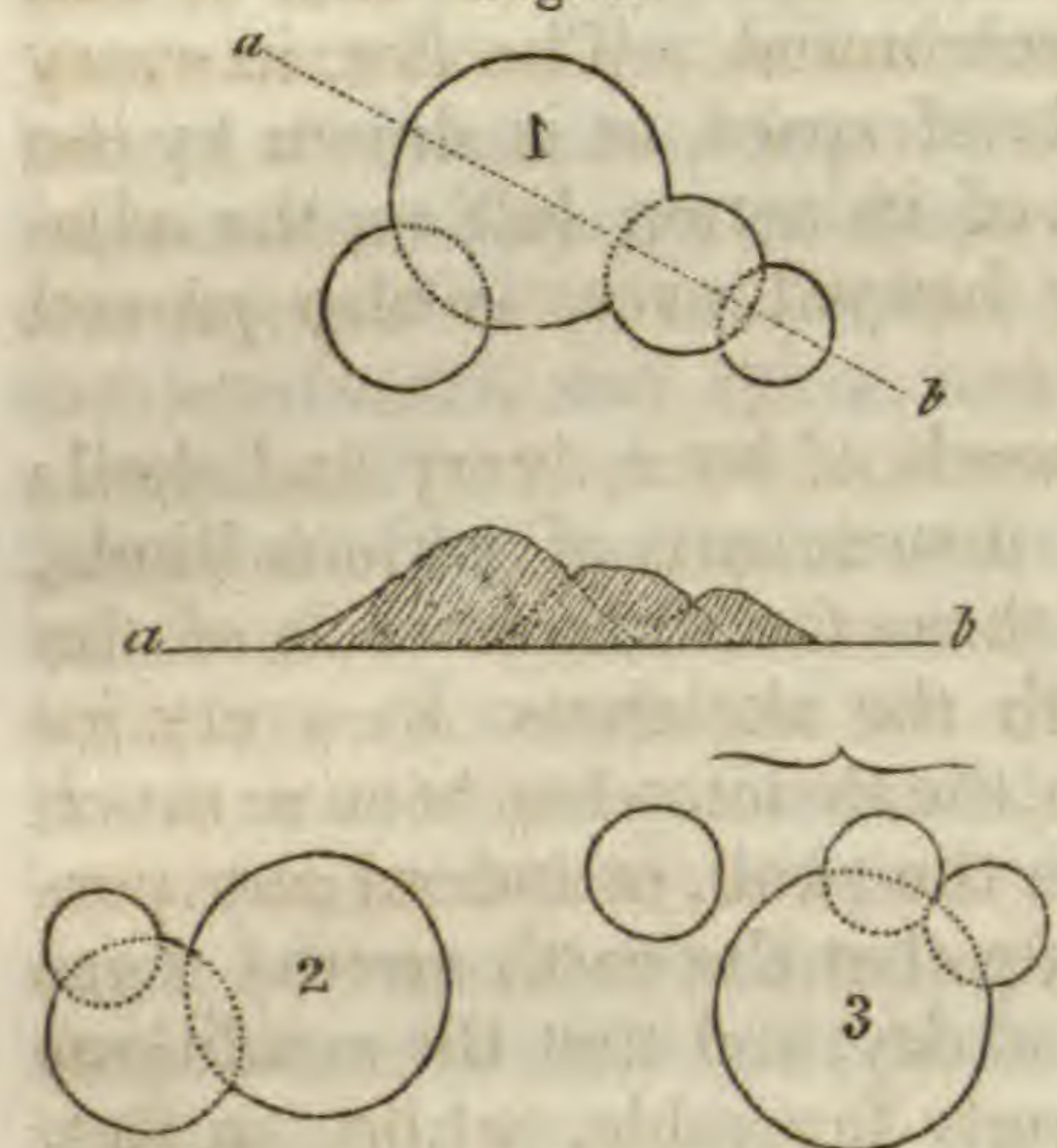
Bracelets of copper and silver; beads of bone, ivory and shell; mica plates and ornaments; stone instruments of various kinds, some of which are identical with those found in mounds of the first class, etc. etc., are found with the skeletons. In every instance falling within our observation, the skeleton has been so much decayed, that any attempt to restore the skull, or indeed any portion of it, was hopeless. Considering that the earth around these skeletons is wonderfully compact and dry, and that the conditions for their preservation were exceedingly favorable, while, in fact, they are so much decayed, we may form some estimate of their remote antiquity. In the barrows and cromlechs of the ancient Britons, entire and well preserved skeletons are found, although having an undoubted antiquity of 1500 years.

In some of the sepulchral mounds, as has already been stated, the sarcophagus, if we so please to term it, was omitted by the builders, the dead body having been simply enveloped in bark or matting. Perhaps this course was most frequently pursued. In these cases, the original surface appears to have been carefully smoothed and leveled, for a space ten or twenty feet square, which space was covered with bark. Upon this was deposited the dead body, and, by its side, such personal ornaments or implements as were deemed proper, the whole being covered over with another layer of bark, and the tumulus raised above. Instances have occurred in which it is clear that burial by *incremation* was made, but these are comparatively rare.* In the celebrated mound at Grave creek, *two* sepulchral chambers were discovered, one at the base, another at a higher point. The lower one contained a single skeleton, and the upper two. This mound, in this respect, is somewhat extraordinary. It may be conjectured, with some appearance of reason, that it contained the bones of the family of a chieftain, or distinguished individual, among the builders. It is common to find two or three, sometimes four or five, sepulchral mounds, in a group. In such cases, it is always to be remarked, that one

* Did the scope or limits of this paper permit, the facts bearing upon this point would be here presented. As it is, the reader is respectfully referred to certain publications which are shortly to appear, under the auspices of the New York Ethnological Society.

of the group is much the largest, twice or three times the dimensions of any of the others, and that the smaller ones are arranged around its base, generally joining it, thus evincing an intended dependence and close connection between them. Plans of three groups of this description are given in the annexed figures. May we not conclude that such a group is the tomb of a family—the principal mound covering the head of the same, the smaller ones its various members? In the Grave creek mound, it is possible that, instead of building a new mound, an additional chamber was constructed upon the summit of the one already raised—a single mound being thus made to occupy the place of a group.

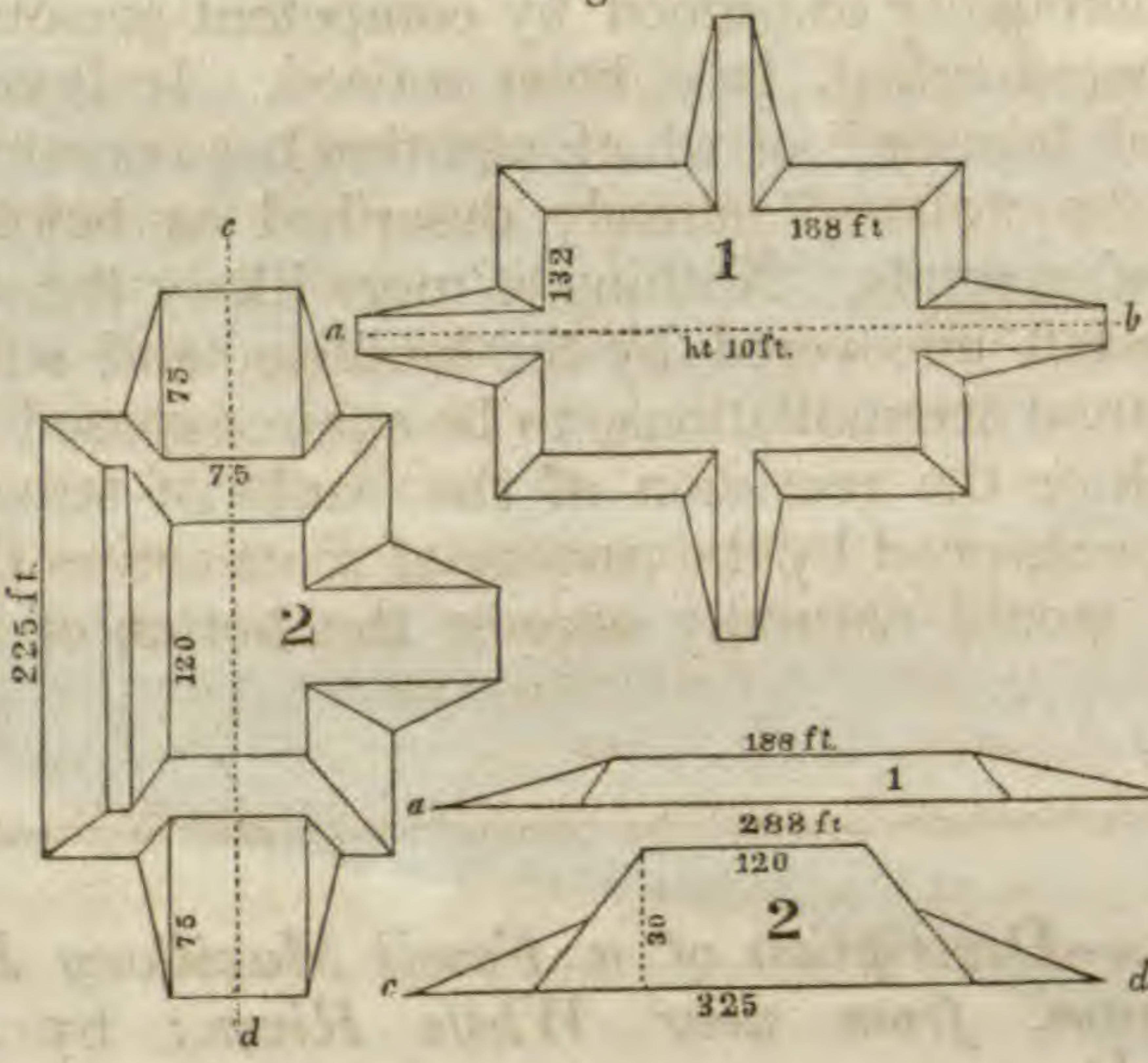
Fig. 3.



Mounds of Observation.—On the tops of the hills and on the jutting points of the table lands, bordering the vallies in which the earthworks of the West are found, mounds occur in considerable numbers. The most elevated and commanding positions are frequently crowned with them, suggesting at once the same use to which the cairns of the Celts were applied—that of signal or alarm posts. On a high hill, opposite Chillicothe, 600 feet in height, the loftiest in the whole region, one of these mounds is placed. A fire built upon it would be visible for a distance of fifteen or twenty miles up and down the river, as well as for a number of miles up the valley of Paint creek,—a broad and fertile valley, abounding in ancient monuments. Between Chillicothe and Columbus, a distance of 45 miles, there are about twenty mounds, so placed that, it is believed, if the country were cleared of forests, signals by fire could be transmitted, along the whole line, in a few minutes. Our examination of this description of mounds, from a variety of causes, has been comparatively limited. So far as our personal observation goes, they contain none of the remains found in the two classes of mounds, just described; and, although there are traces of fire around most of them, the marks are not sufficiently strong to justify fully, the inferences that they were *lookouts* and fires used as the signals. Indeed, it is certain that, in some cases, they contain human remains, undoubtedly those of the mound builders. It is possible that a portion were devoted to sepulture, another portion to observation, or that some answered a double purpose. This is a point which remains to be settled, by more extended observation.

There is another description of mounds which should properly be here mentioned. Their purposes admit of no doubt. They consist of pyramidal structures, or "elevated squares," and are found almost invariably within enclosures. They are sometimes of large dimensions. Those at Marietta are fair examples of the class, and No. 1, Fig. 4, exhibits their structure and dimensions.

Fig. 4.



No. 2, is an elevation of a similar mound, on the banks of Walnut Bayou, Madison Parish, Louisiana, and is introduced, incidentally, to show the connection between the monuments of the lower Mississippi and Mexico, and those of the Ohio valley. None of these, so far as examined, contain remains. They were obviously designed as the sites of temples or structures which have passed away, or as "high places" for the performance of certain ceremonies. Perhaps they deserve to occupy a place by themselves, in the classification here attempted.

Anomalous Mounds.—It will be impossible, within the compass of this paper, to enter into the details which a proper notice of these mounds would require. Such a notice would necessarily involve a description of almost every one thus characterized. A single mound was examined which contained an altar and also a skeleton with its rude enclosure of wood. It was elliptical in shape, measuring 160 feet in length, 60 in width, and 25 in height. The altar occupied one centre of the ellipse, the chamber of the skeleton the other. Of the twenty-six mounds embraced in "Mound City," *six* are of very small dimensions, not exceeding three feet in height. Within each of these was deposited a quantity of burned human bones, in fragments, not exceeding, in any case, the amount of a single skeleton. No relics were found with these, though in one instance a fragment of an altar, a couple of inches square, was observed with the bones, leading to the conclusion that they were taken up from the altars, in the adjacent larger mounds, and afterwards finally deposited here.

General Observations.—Whether these classes are maintained throughout the West, is a question which a systematic examination, carried on over a wide field, alone can determine. In almost every case, falling within our knowledge, when mounds have been thoroughly examined by competent persons, some of the features here marked, have been noticed. It is conjectured, that the "brick hearths," of which mention has occasionally been made, were the "altars," already described as belonging to a certain class of mounds. Nothing is more likely than that some of them were left uncovered by the builders, and subsequently hidden by natural accumulations, to be again exposed by the invading plough or the recession of the banks of streams. The indentations occasioned by the passage of roots across them, or by other causes, would naturally suggest the notion of rude brick hearths.

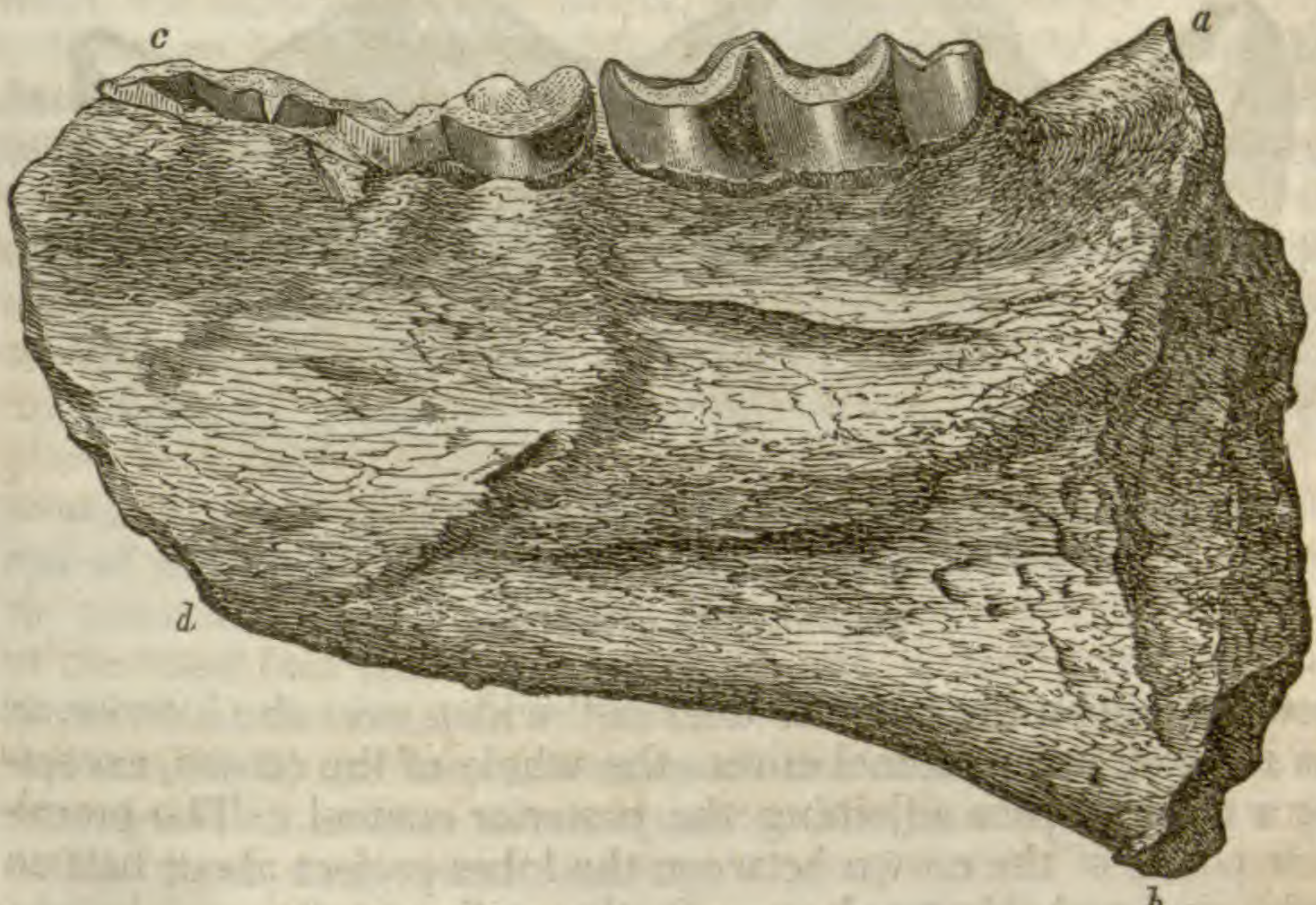
Art. XXVII.—*Description of a Fossil Maxillary Bone of a Palæotherium, from near White River;* by Hiram A. Prout, M. D.

The Palæotherial bone here described, was sent to me sometime ago by a friend residing at one of the trading posts of the St. Louis Fur Company, on the Missouri River. From information since obtained from him, I learn that it was discovered in the Mauvais Terre, on the White River, one of the western confluents of the Missouri, about one hundred and fifty miles south of St. Pierre, and sixty east of the Black Hills, at a point which would very nearly correspond with the intersection of latitude 43° with longitude 26° west of Washington.

The Baculites and the Inoceramus which accompanied it, and which I at first supposed belonged to the same locality, were found in another formation—probably the cretaceous—distant about one hundred miles, and included in the Grande Detour or Great Bend of the Missouri River. The Inoceramus appears to correspond precisely with that figured by Professor Hall, in Frémont's Expedition: it has however both valves, and may possibly be a distinct species.

This fossil bone is a fragment of the inferior maxillary of the left side, consisting of the posterior part of the bone, together with the last three molar teeth. The ramus is much fractured and presents an irregular surface; yet the general direction of its outline may be made out. The length of this fragment is fifteen inches, its depth from the highest point of the ramus (*a*) to the lowest (*b*), is nine and a half inches: it narrows regularly forward so as to measure only three and a half inches from the lower surface of the bone at (*d*), to the alveolar process of the antepenultimate tooth at (*c*). The inner surface of the

Fig. 1.



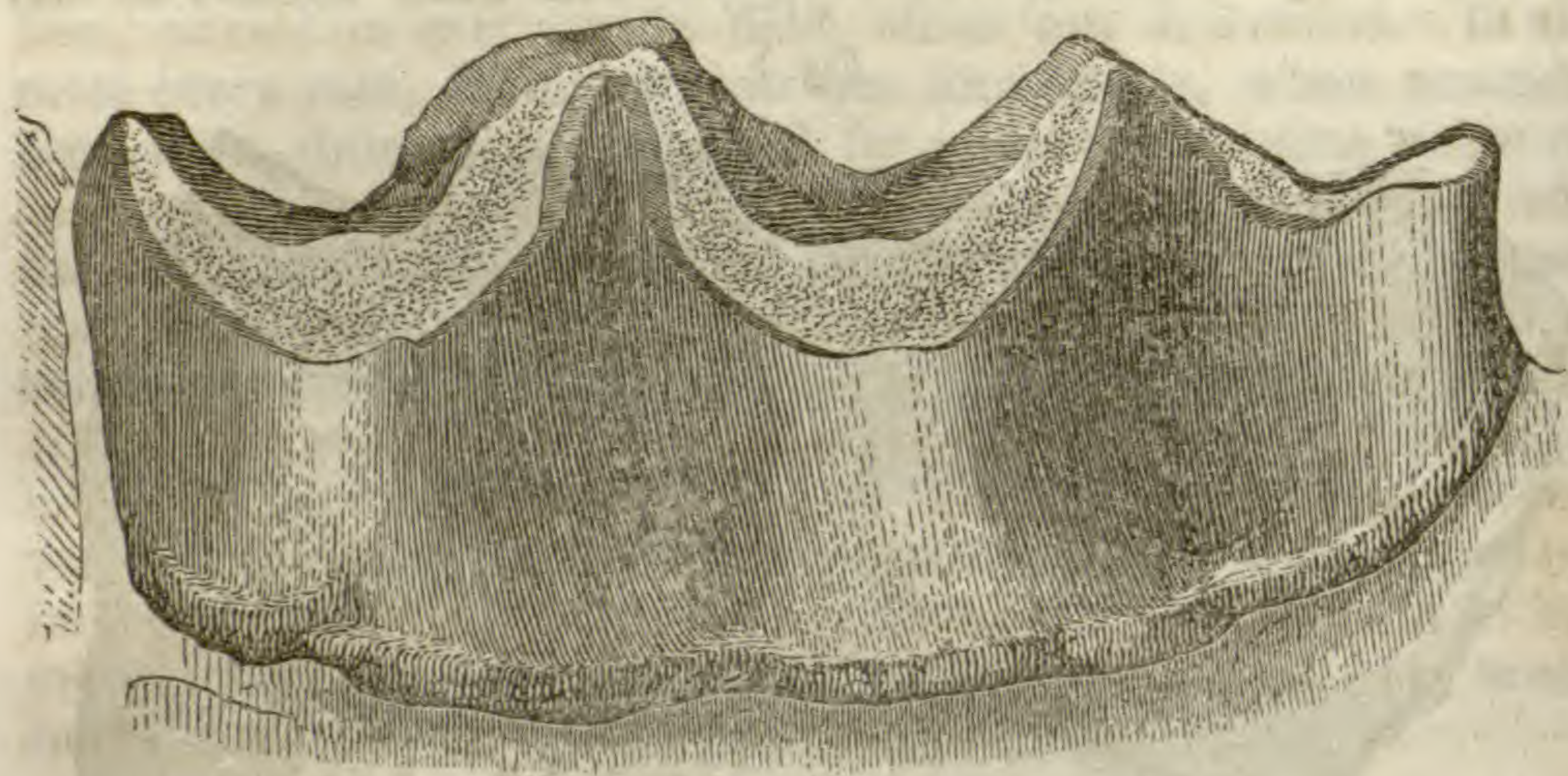
One-fourth the natural size.

bone is more uniform, being marked merely by depressions for the attachment of muscles. The alveolar portion is here very prominent and well rounded, the teeth being planted more than an inch from a vertical line which is tangential to the inner surface of the bone. It is covered in places with a concretionary matter which could not be removed without injury to the specimen; on analysis, this was found to consist chiefly of carbonate of lime, with some alumina, and a small proportion of silex.

The last molar tooth has the three lobes of the Palæotheria, as shown in fig. 2. The inner surface is nearly smooth and flat, and shows no trace of lobes. The size of the tooth from posterior to anterior sides is $4\frac{1}{2}$ inches, of which $1\frac{5}{8}$ inches belong to the *anterior* lobe, the *same* to the *middle*, and $1\frac{1}{4}$ inches to the *posterior*. In an upper view, the two larger lobes have a deltoid form, with the sides somewhat convex, and a rounded outer angle. The thickness through from the outer to the opposite side, is $1\frac{3}{4}$ inches. The enamel of the inner side folds over the surface, covering nearly a semicircular space, and leaving between it and the edge of the posterior enamel, a sub-crescent-shaped space (deltoido-lunate) of dentine, somewhat concave, which is nearly seven-eighths of an inch broad at its widest part.

These crescent-shaped areas of the two lobes are connected by a continuous tract of dentine, nearly 1½ lines wide at the narrowest part; and the same tract continues from the middle lobe to the

Fig. 2.



Four-fifths the natural size.

posterior; upon the latter it does not widen over the interior, as the reflexed inner enamel covers the whole of the crown, excepting a narrow space adjoining the posterior enamel. The prominent points of the crown between the lobes project about half an inch; and probably much more in the perfect tooth.

The *fifth* and *sixth* molars (*first* and *second* true molars) resemble the one described, (except that they want the third lobe,) and the dentine area on the crown of each lobe is much larger. The sixth is 3½ inches from front to posterior side. The posterior lobe is 2 inches from the outer to the inner surface, and 1⅞ inches long in the line of the jaw. The whole distance on the jaw occupied by the three teeth is eleven inches. In the largest Palæotherium, hitherto described, the P. magnum, the same teeth occupy a space scarcely one-third that of the Missouri animal.

St. Louis, Dec. 10, 1846.

Art. XXVIII.—*Observations upon the Development of Electricity in Bands of Leather;* by John M. Batchelder.

Having had an opportunity to examine the electrical condition of the bands of a cotton mill, and finding them very highly excited, many interesting facts were brought out, which I here detail.

The mill is situated on the sea-coast of Maine, where the climate is very moist and consequently less favorable for the development of electricity than the dry and elevated lands of the interior of the country. There are several hundred bands in a mill, all of which are electrically excited in a greater or less degree; those which turn upon wooden drums or pullies, whereby they are partially insulated, become very highly charged, the intensity of the excitement being much increased by the crossing of the band, the transmission of power, and a high velocity.*

The one which was used for making most of the experiments detailed below, is about thirty-five feet in length, nine inches wide, and moves sixteen hundred feet per minute, passing around two wooden drums, which revolve upon an iron shaft one hundred and eighty times per minute, and in clear weather a spark may be taken on the knuckle held below the band at a distance of one foot and five inches.† Owing to the imperfect conducting power of the leather, this discharge is local; were it to take place from all parts of the excited surface at the same instant, it would be unsafe to discharge it in this manner. On presenting the end of the finger the striking distance is found to be three feet; the point of a black lead pencil shows a distinct brush when held in the hand four feet from the band, and a steel point becomes luminous at the distance of seven feet. When the bands are in this condition, the first processes of the cotton manufacture are attended with serious inconvenience; the fine filaments of the cotton repel each other, causing a great deal of waste, and in several instances the "drawing," as it is termed, has been lifted from the machine to a band four feet distant from it. These difficulties are now partially removed by extending a conductor of wire to an iron steam pipe which passes through the rooms, and by emitting jets of steam near those bands that are most highly charged. It is probable that the finest kinds of yarn can never be profitably manufactured in this country, the moist climate of England being much more favorable for this branch of the trade.

Let a piece of leather about two feet in length, with one edge slightly curved, be presented to the band, and a succession of brilliant flashes and jets is immediately produced, giving a very perfect imitation of the Auroral light. While engaged in this experiment, I noticed that, in some cases, the current of electricity continued to flow in the direction first established, even when a substance of the same conducting power is held nearer to the excited band; for instance, if a piece of leather be bent like a horse-shoe, and the extremities be brought towards the band in

---

* Dr. Franklin suggested to his friend, Mr. Bowdoin, that a portable electrical machine might be constructed by making the cylinder of leather, stuffed and properly mounted.

† In Vol. xxxvii, p. 197, of this Journal, a band is mentioned which gives a spark of two inches in length.

such a manner that a pencil of light may be seen passing to *one* extremity, and then the leather be so inclined that the distance from the *other* extremity to the band is but half the distance of *that* receiving the electricity, the jet still continues to flow in its first direction in preference to taking the shorter path offered by the opposite end. There is evidently a tendency in the fluid to follow in the direction first commenced.

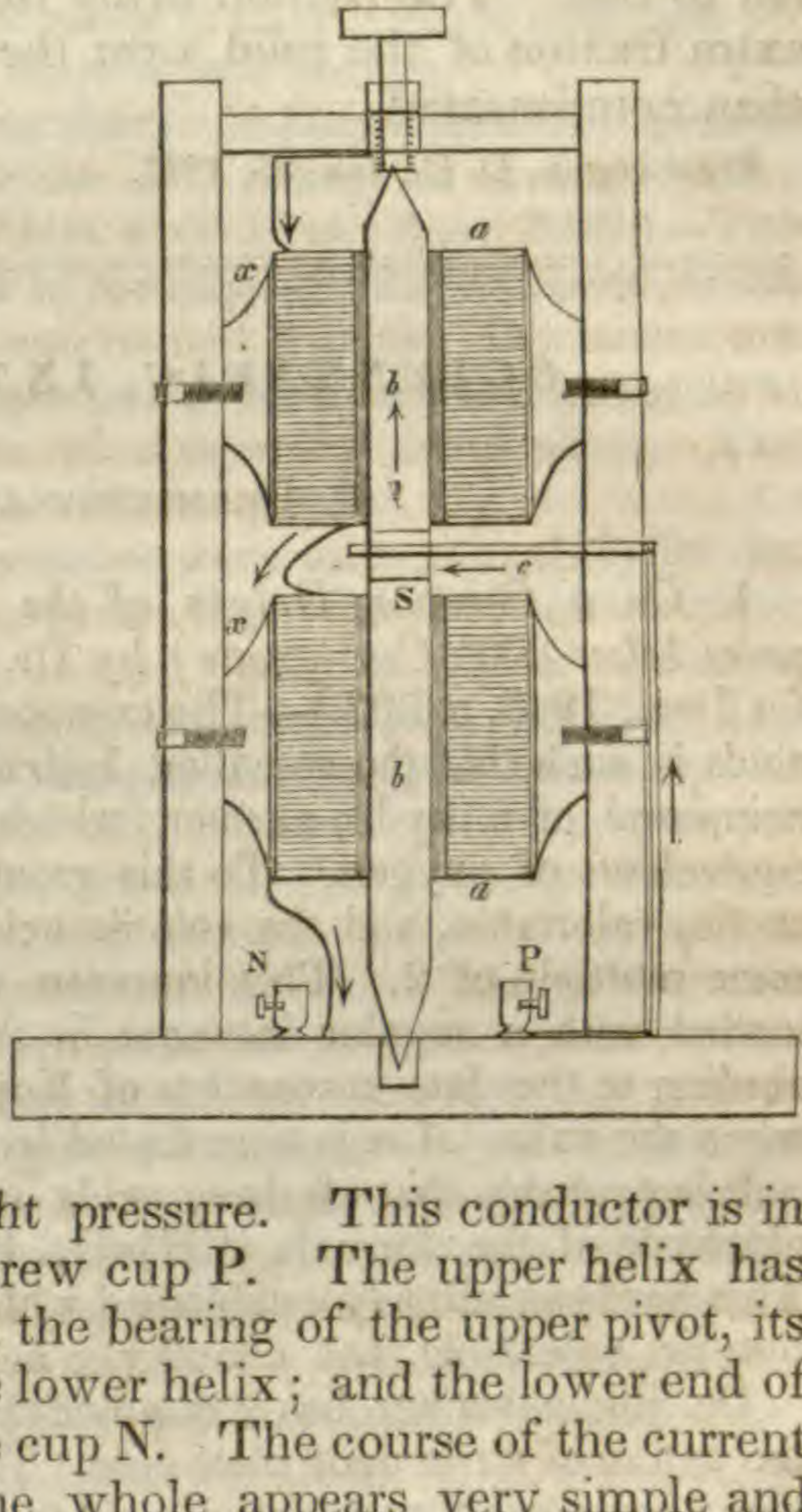
For the purpose of ascertaining whether metallic particles would become luminous in an atmosphere highly charged with electricity, very minute particles of metallic dust were projected against the belt, but I was unable to detect any light either during their ascent or descent. The passage of a jet of steam through the same atmosphere was not attended with light.

Let two imperfect conductors be placed at equal distances from the band, their points directed towards it and separated a few inches from each other, then if air be blown violently from a glass tube upon one of the jets, it will disappear; the other now conveying a larger quantity of the fluid becomes brighter; let the tube be directed to this and it is extinguished, the light appearing again upon the first, thus changing from one to the other as rapidly as the tube can be moved.

It hence appears probable, that the flickering of the Auroral columns may, to a certain extent, be attributable to the motion of the air.

Art. XXIX.—*Revolution of a Magnet on its own Axis without the use of Mercurial Conductors, and also without Visible Support;* by Chas. G. Page, M. D., Prof. Chem., Columbian College, Washington, D. C.

The rotation of a magnet upon its own axis is among the most interesting of all the phenomena connected with the reciprocal action of magnets and currents, and various ingenious improvements have been made upon the original device of Ampère for its illustration. The use of mercurial conductors—a feature common to them all—is objectionable for several reasons. To dispense with the mercurial cells, and substitute for them solid conductors, seemed to require some other changes in the arrangement, by which greater magnetic power should be employed, than can be imparted to bars of steel of the dimensions usually adopted. The friction of a platinum wire attached to the magnet in the usual manner, and revolving in a circular cell of mercury, though very trivial in itself, operates considerably to retard the motion of the magnet, for the reason that the point of resistance is very far from the centre of motion. By the substitution of solid connexions for the mercurial, the resistance is brought much nearer to the centre of motion, and amounts perhaps to very little more than under the old plan. In order to obtain a powerful magnet for this purpose, I make an arrangement similar to that shown in the accompanying figure, which represents a vertical section through the centre of the apparatus. *a*, *a*, are two helices of insulated wire, secured to the posts of the framework by means of the blocks of hard wood *x*, *x*. The bar of soft iron *b*, *b*, is about ten inches long and one inch diameter, and delicately supported upon steel pivots. The helices through which the bar passes, have a central opening sufficient to allow a space of about one-sixteenth of an inch between them and the surface of the bar. Near the centre of the bar, at S, it is covered with a thin ferule of silver with which the conductor *c*, also of silver, is in contact by slight pressure. This conductor is in connexion with the binding screw cup P. The upper helix has one of its ends connected with the bearing of the upper pivot, its other with the upper end of the lower helix; and the lower end of the latter is connected with the cup N. The course of the current is seen by the arrows, and the whole appears very simple and easy of construction. The bar of soft iron and other parts of the instrument may be much smaller than the dimensions above given, but I have preferred for my own use the very large size as better for "class illustration." The helices being connected with twelve or more pairs of Grove's battery, the bar of soft iron becomes powerfully magnetic, and by the action of the current passing through its upper half, revolves with astonishing rapidity. By substituting for the current through the upper half of the magnet, one of much greater quantity from an independent single pair of plates, the effect is greatly increased and exhibits the most rapid rotation I have ever witnessed. But the most interesting feature in connection with this instrument, is, that during the rapid motion the bar is without visible support, the upper and lower bearings serving only as guides to keep it in place. By inspection of the figure it will be seen that the magnetic bar projects farther below the lower helix, than it does above the



upper. When this is the case, the action of the current in the helices raises the bar from off its rest below, the pivot being however retained within the socket to keep the bar in place. Play enough should be given in the socket above, to allow the bar to rise. The friction being thus very much diminished, the extra friction of the solid, over the mercurial connexions, is more than compensated.

Washington, D. C., Jan. 25, 1847.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On a Common Origin of the Acids* $(CH)nO_4$ *with a boiling point below* 300° *Centigrade;* by Dr. Jos. Redtenbacher, (Phil. Mag. for Dec., 1846, p. 503.)—The composition of a large number of organic acids is such that the so-called *hydrated* acids may be represented as composed of a hydro-carbon, which is a multiple of CH, and four equivalents of oxygen. To this group of homologous acids belong the acetic, valerianic, and the volatile acids of butter, in which *n* is always some multiple of 2. This increase in the value of the factor is attended with a regular increase in the boiling point of the acid. According to the late researches of Kopp and Fehling, it equals 20° C. when the value of *n* is augmented by 2.

It is probable that all these acids may be produced from bodies like aldehyde of the formula $(CH)nO_2$, by a simple process of oxydation. This has been already established with regard to the acetic, metacetonic, butyric, valerianic, and enanthylic acids.

Dr. Redtenbacher has examined the volatile acids which result from the action of nitric upon oleic acid. The oleic acid was boiled in a retort with an excess of strong nitric acid till all oily matter disappeared. Water was then added and the mixture distilled. The product collected in the receiver consisted of a stratum of the oily acids and a watery solution of the more soluble ones. The oily portion was neutralized by baryta and the different salts separated by crystallization. The aqueous solution contained acetic, metacetonic, and butyric acids, and an examination of the baryta salts showed that not less than nine acids had been formed, of the type $(CH)nO_4$; the value of the factor being augmented by 2 from 4 to 20, and the boiling point rising from 120° C. to 280° C. They were the acetic, metacetonic, butyric, valerianic, caproic, enanthylic, caprylic, pelargonic, and capric. The metacetonic acid is obtained by the action of potash on sugar, and by the oxydation of metacetone (an aldehyde); the butyric, caproic, caprylic, and capric, are known as the volatile acids of butter, and the pelargonic acid is so named from its supposed identity with a fatty acid, discovered by Pless in the rose geranium, *Pelargoniun roseum.*

This origin of the volatile fatty acids gives a key to the mode of their formation in nature. The experiments of the author and others upon the fat of fowls, geese, snakes, badgers, hares, and particularly that of man, show that small portions of these acids, principally the caprylic, caproic, and valerianic, are always present. The odor of caprylic acid, when much diluted with air, resembles closely that of the sweat of a healthy man, and Dr. Redtenbacher suggests that as this acid is present in considerable quantities in human fat, it may pass off with the perspiration, after strong exercise and heating.

2. *On the Solution of Oxygen in fused Litharge, and the circumstances attendant upon the production of Litharge on a large scale;* by M. Fel. Le Blanc, (Ann. de Chim. et de Phys., Apr., 1846.)—The opinion of M. Fournet that litharge is per-oxydized during fusion, is not confirmed by Le Blanc, who has ascertained that the phenomena are owing to a simple solution of oxygen and probably azote, analogous to the absorption, or rather solution of oxygen by fused silver. The quantity is stated to be about $1\frac{1}{2}$ cub. in. per pound.

At Poullaouen, where the experiments were made, about 20,000 lbs. of argentiferous lead are operated upon at a time. The *abstricks* or black litharge, containing sulphur, are drawn off first. At the end of sixteen to twenty hours they are succeeded by the marketable litharge. The pure article is received in a conical iron pot of thirty quarts capacity. It immediately solidifies at the surface and becomes yellow or greenish yellow in color. After a time the mass cracks in every direction, sometimes with a sort of explosion, and becomes a friable, crystalline, reddish litharge, which, after preparation, is sold. The yellow crust retaining its color and cohesion, is set aside and revived. If the vessels are too small the whole mass retains the yellow color and does not exfoliate. The red litharge did not give off oxygen by heating, and yet when suddenly cooled assumed the yellow form. Operated upon by nitric acid, no peroxyd was formed, showing the absence of minium. This is another case of dimorphism, resembling that of sugar, arsenious acid, iodid of mercury, &c. G. C. Schaeffer.

3. *On the Estimation of Silver, by Gay Lussac's Process, when Mercury is present;* by M. A. Levol, (Ann. de Chim. et de Phys., Apr., 1846.)—The assay of silver by Gay Lussac's method has become universal. One single exception to the perfection of the process has remained, viz., the presence of mercury, and this is not of common occurrence. M. Levol has conquered this difficulty by the following process:—

The assay, as usual, is dissolved in 5 cub. centimeters of nitric acid of 32° Baumé; it is then supersaturated with 25 cub. cent. of caustic ammonia; the normal liquor is then added, and finally the excess of ammonia supersaturated by 20 cub. cent. of acetic acid. The operation is finished in the usual manner.

Gay Lussac (Ann. de Chim. et de Phys., June, 1846) has verified the accuracy of Levol's process, and proposed to shorten it by adding at once 10 grammes of acetate of ammonia. Acetate of soda answers equally well. The nitric acid should be completely saturated by the soda of the acetate. G. C. S.

4. *A new Method of estimating Lead;* by M. Flores Domonte, (Comptes Rendus, May, 1846.)—This process is similar to that of Pelouze for copper. The lead is thrown down and redissolved by caustic

potash, and then precipitated by a standard solution of sulphuret of sodium. The mode of operation is precisely the same as with copper, (see this Journal, ii Ser., vol. ii, p. 259,) with this difference, that as the equivalent of lead is higher than that of copper, the solution of sulphuret of sodium should be diluted with three parts of water. This method gives results within one per cent.; and sometimes much nearer.

Tin, antimony and arsenic, do not interfere with the process, and it is not necessary to filter from the insoluble oxyds. Iron, nickel, and cobalt, although not often met with in the assay, are said not to affect the result. Zinc precipitates after the lead, and by the change in color of the precipitate in fact assists in determining the total absence of lead.

When copper is present it is first determined by the method of Pelouze; a like per-centage of copper is then added to one gramme of pure lead and the analysis of the mixture shows how many divisions are to be subtracted on account of the copper.

Bismuth interferes with the estimation of the lead, but from its high price is not likely to be present as an adulteration. G. C. S.

5. *On the Solubility of Alumina in Ammoniated Water;* by F. Malaguti and J. Durocher, (Ann. de Chim. et de Phys., Aug., 1846, and Comp. Rend., May, 1846.)—This research is intended to establish;—

That if ammonia is employed to precipitate alumina in the absence of ammoniacal salts, a *very considerable* proportion may remain in the solution;

That the quantity of ammoniacal salt, necessary for the complete precipitation of the alumina, increases with the *volume of the solution;*

That even in the absence of salts of ammonia, the alumina may be *entirely* precipitated from the solutions, irrespective of their volume or of the quantity of ammonia contained in them, provided a sufficient time be allowed to elapse between the precipitation and filtration, the air being carefully excluded;

That the most suitable reagent for the complete precipitation of alumina, without reference to the volume of the solution, the absence of ammoniacal salts, or the length of time, is the sulphuret of ammonium.

The authors seem to undervalue the precautions given by Rose, Fresenius, and others, for undoubtedly accurate results have been obtained by these methods: neither do they assign any determined rate of solubility to alumina, which of course is impossible, as spontaneous separation takes place. Still, however, these researches are of value, as they show the liability to error and the amount of error possible.

It is worthy of remark that the spontaneously precipitated alumina is no longer gelatinous, but granular and less soluble in acids.

G. C. S.

6. *Action of Perchlorid of Phosphorus on Organic Substances;* by Aug. Cahours, (Comptes Rendus, May, 1846.)—The perchlorid has no effect upon carbo-hydrogens, such as benzine and retinaphtha, but the hydrate of phenyle and anisol (differing from the former by the addition of two equivalents of oxygen) are violently attacked, and form new compounds. The alcohols are known to produce chlorid, when treated with perchlorid of phosphorus—by the elimination of O_2 without replacement, and by the substitution of Cl for H. The action upon

bodies containing O_4, such as benzoic acid, would become interesting, as we should reproduce the compounds of the benzoyle series.

Experiment confirmed this conjecture. Benzoic acid was violently attacked by the perchlorid, with the formation of a substance in every respect identical with the chlorid of benzoyle formed from oil of bitter almonds. Cinnamic and cuminic acids, in like manner, formed true chlorids of cinnamyle and of cumyle, which were decomposed slowly by water, rapidly by an alkaline solution, and which formed amides by the action of dry ammonia.

The acid of the acetic series did not afford analogous results.

The reaction upon a volatile acid containing O_6, was found to be the same; anisic acid gave chlorid of anisyle by the loss of O_2 and the substitution of Cl for H. The substance obtained was perfectly pure, reformed anisic acid under the influence of alkalies, and gave anisamide with ammonia.

These results are highly curious, for as M. Cahours remarks, the action of amalgam of potassium, discovered by Melsens, in restoring a chlorine compound to its primitive, renders us able to return from benzoic acid to oil of bitter almonds—from cinnamic acid to oil of cinnamon. As these metamorphoses are in a contrary direction to those hitherto possible, the perchlorid of phosphorus becomes one of our most important reagents, leading to the formation of many new and interesting compounds. G. C. S.

7. *On the transformation of Hippuric acid into Benzoic acid and Sugar of Gelatine;* by M. Dessaignes, (Ann. de Chim. et de Phys., May, 1846.)—When hippuric acid is boiled for about a half an hour in hydrochloric acid, it no longer crystallizes on cooling, but is decomposed and affords the quantity of benzoic acid indicated by theory. After separating the benzoic acid, the filtrate, on evaporation, yields long prismatic crystals which are acid and contain nitrogen—hydrochloric acid enters into their constitution. These crystals neutralized by carbonate of lead or soda yielded, after the chlorids had been separated from the solution, a crystalline substance with a sweet taste, and containing nitrogen. This, M. Dessaignes found to be sugar of gelatine. In fact $C_{18}H_9NO_6—C_{14}H_6O_4=C_4H_3NO_2$, and if we add to this one and a half equivalents of water, we obtain half an equivalent of sugar of gelatine, according to Mulder and Boussingault. M. Dessaignes, however, thinks that to this residue we must add two equivalents of water, and that the true formula of gelatine sugar is $C_4H_5NO_4$. This conjecture is verified by the analysis of Laurent, given on next page.

The action of nitric, sulphuric and oxalic acids is attended with a similar transformation of the hippuric acid. Finally, potash or soda in excess produces the same effect. Hippuric acid therefore resembles the acid amides, for when boiled with acids or alkalies, the elements of water are added, and it is transformed into an acid and a base containing nitrogen, which in this case replaces ammonia. The attempt to combine benzoic acid and sugar of gelatine and thus to reproduce hippuric acid, was not successful. G. C. S.

8. *Benzoic Compounds.*—Pelouze having obtained a crystalline substance by the action of moist chlorine on the oil of bitter almonds, Laurent found on analysis that it had the composition of benzoic acid,

but was distinguished by forming benzamide under the action of ammonia. In attempting to form this substance, Laurent obtained only benzoate of hydruret of benzoyle. This latter gave C. 76·20, H. 5·45, answering to the formula $C_{56}H_{24}O_{10}$, or one equivalent of benzoic acid and three equivalents of hydruret of benzoyle. This differs from the formula of Liebig, which combines two equivalents of the hydruret with one of acid. G. C. S.

9. *On Sugar of Gelatine, &c.*; by Aug. Laurent, (Comptes Rendus, May, 1846.)—A perfectly crystallized specimen gave C. 32·10, H. 6·66, N. 18·95, corresponding to the formula $C_4H_5NO_4$ proposed by Dessaignes. Sugar of gelatine is, therefore, isomeric with the carbonate of methyle or urethylane. G. C. S.

10. *On the Amides*; from a letter of Malaguti, (Comptes Rendus, May, 1846.)—With a view to the study of these compounds, Malaguti has prepared large quantities, and has added several amides to the list of those already known. He says, there is no difficulty in preparing them and in discovering new ones. When we have an acid, we have generally an ether, and when we have an ether we have an amide. The difficulty consists in the preparation of very pure acids.

A preliminary investigation of the action of heat upon these compounds, leads to some interesting results which we cannot, however, give in detail. The mode furnished is to examine the action of heat upon the salt of ammonia, and to separate these results from those produced by the heating of the amide; in this way the decomposition peculiar to the latter, is supposed to be shown. G. C. S.

11. *Asparamide.*—When pulverized asparamide is acted upon by an alcoholic solution of potash, there forms immediately a syrupy matter, scarcely soluble in the supernatant liquid; washed with alcohol and dried, it gives the formula $C_8H_7N_2O_6K$, or asparamide, in which one equivalent of hydrogen is replaced by one equivalent of potassium. A similar compound with copper has been obtained by Piria.

As other amides form saline compounds with metals, Laurent remarks that as chemists do not admit the existence of water in amide, he does not see why they suppose the acids called *hydrated*, to contain water, for the reaction with bases, is in both cases precisely the same.

G. C. S.

12. *On the Formation of Chloro-cyanilide and Fluo-silicanilide*; by Aug. Laurent and J. Delbos.—(Comptes Rendus, Apr., 1846.) The action of ammonia upon acids forming amides and of the remarkable base aniline forming analogous compounds, anilides, has led Laurent and Gerhardt to the investigation of the combinations of these bodies with the fluorids and chlorids.

With chlorid of cyanogen and fluorid of silicon, aniline forms apparently homogeneous substances, but which are in reality mixtures of the anilides above named with chloro-hydrate of aniline in the one case, and fluo-hydrate of aniline in the other.

By analogy it is very probable that the corresponding combinations of ammonia are in reality mixtures of amides and salts of ammonium.

G. C. S.

13. *On the Growth of Bone in the Hog*; by M. Boussingault, (Ann. de Chim. et de Phys., Apr., 1846.)—This curious investigation

is in part a sequel to that of the development of fat in animals, and based upon facts determined during that investigation.

The ashes of the skeleton of a pig just littered weighed 20·73 grammes, containing 84 per cent. phos. lime and 11 p. c. phos. mag. A hog at eight months, fed in the usual manner, gave 1353 grms.; phos. lime 91·3 p. c., phos. mag. 3·6 p. c. A third, the same weight as the last when killed, was fed for ninety-three days on potatoes, and gave 1586 grams. of bone ashes, containing phos. lime 92·4 p. c., phos. mag. 3·8 p. c. Thus during the first eight months, and on a rich diet, the assimilation of bony matter proceeded rapidly. But during the ninety-three days the hog was fed with potatoes, the increase per day was much less than before. On examining the ash of the potatoes, it was found that the whole quantity consumed by the animal, had not supplied as much lime as the hog had assimilated in that time, and when the quantity of lime in the excrement, which was also analyzed, was taken into account, the deficiency was still greater.

The analysis of the water taken with the potatoes (the exact quantity used being known) showed that the deficiency of lime was supplied from the water, and that the two sources together had furnished no more lime than the hog had used. Without the water then, the animal would have suffered and after a time have died.

The author insists upon the great importance of the saline contents of spring water, both as furnishing the required salts to stock, and finally adding to the value of the manure. That the quantity of the salts is not unworthy of notice, is shown by a computation of the inorganic matter taken in the drink of the cattle at Bechelhoun; in one year this amounts to 876 kilogrammes, about 1800 lbs. The artesian well at Grenelle brings to the surface in each year 59,860 kilogrammes or about 134,700 lbs. of solid matter, nearly all of which is useful in the animal or vegetable economy. G. C. S.

14. *Gun-Cotton.*—Pelouze has pointed out various characters distinguishing the Xyloidine of Braconnot from gun-cotton, and he gives to the latter, (or the material obtained by the action of nitric acid on vegetable fibre without a destruction of its texture,) the name of *Pyroxyline.*

Pelouze mentions the following points of difference.

Xyloidine is very soluble in nitric acid, and this solution which is rapidly made, is destroyed in twenty four hours or less, it becoming changed into a deliquescent acid, as determined by Pelouze eight years since.

Pyroxyline does not dissolve even in an excess of nitric acid; it remains in it for days without alteration, or even loss of weight.

Xyloidine leaves a considerable residue of carbon when inflamed or detonated.

Pyroxyline leaves no residue, and comports itself very differently as is well known.

Xyloidine may be analyzed like other organic matters by means of oxyd of copper, with the single precaution of augmenting a little the proportion of this oxyd.

Pyroxyline in the same circumstances, explodes and breaks the vessel, even when one hundredth the quantity is used.

Five milligrammes of *xyloidine* heated in a tube full of mercury are decomposed without danger, while the same quantity of *pyroxyline* produces a violent detonation.

One hundred parts of dry starch, dissolved in concentrated nitric acid precipitated by water immediately after the disappearance of the starch, give for a maximum 128 to 130 parts of *xyloidine.*

One hundred parts of cellulose (cotton or paper) in contact with mono-hydrated nitric acid, either for a few minutes or several days, affords 168 to 170 parts of dry *pyroxyline.*

Xyloidine as long since determined by Pelouze, consists of one equivalent of starch in which one equivalent of nitric acid has replaced the elements of one of water.

Pyroxyline has been found by the same chemist to consist of cellulose, with the addition of two equivalents of mono-hydrated nitric acid and the removal of one equivalent of water, giving the formula $C^{12}H^{9}O^{9}$, $2NO^{5}$, $2HO$, or without hypothesis $C^{12}H^{11}O^{21}N^{2}$.

According to the late investigations of T. Ransome, (Phil. Mag., Jan., 1847,) the composition of gun-cotton is expressed by the formula $C^{12}H^{8}O^{20}N^{2}$; and it results from common cotton by the removal of two atoms of hydrogen, and the addition of two atoms of nitric acid. Explosion produces carbonic oxyd, water and nitrogen, and no nitrous acid. Messrs. Porrett and Teschemacher have shown that cyanogen also is produced. The editors of the Philosophical Magazine suggest, that Mr. Ransome's results may be a consequence of combustion at a lower temperature than is required for the combination of nitrogen and carbon.

Pelouze states that in France the cost of 170 kilogrammes of gun-cotton (exclusive of labor) will be 317 francs, (the cotton 200, the nitric acid 100, and the sulphuric acid 17 francs.) The gun-paper will be still cheaper; made from paper pulp, the cost will be, he says, about 97 francs for 100 kilogrammes, excluding the cost of labor.

Unprepared cotton becomes explosive when dipped in a strong solution of chlorate of potash; and the force of gun-cotton is increased by immersing it after preparation in a similar solution.

The gun paper is to become an important material in pyrotechnics. Dipped in solutions of nitrate of strontia, sulphate of copper, nitrate of baryta, it has afforded fine red, green and white lights. The combustion is rendered slow by the immersion in metallic salts, which is highly favorable for pyrotechnic purposes.

This material is also valuable for the manufacture of percussion caps, and bids fair to supplant other fulminating compounds for this purpose, on account of the safety and cheapness of its preparation.

15. *Arsenic in Mineral Waters;* (L'Institut, No. 670, Nov. 4, 1846.)—Arsenic has been found, by M. Valchner, in various mineral waters at Viesbade in Germany, and this has been confirmed by M. Figuier. The last mentioned chemist has ascertained that the arsenic is in the state of arsenous acid, and that the proportion is nearly 0·045 grammes for 100 litres of the water. He detected no arsenic in the waters of Passy.

16. *On Fluorine;* by M. Louyet, (L'Institut, No. 673, Nov. 25, 1846.)—M. Louyet concludes from his researches that fluorine is a colorless gas, possessing odor, having the power of bleaching vegetable

colors, decomposing water at the ordinary temperature in the light, attacking glass feebly if at all, acting upon almost all the metals but not attacking gold or platina, or at least, not except in the nascent state. His experiments on the equivalent of fluorine, fix it at 239·81. He finds that it presents stronger analogies with oxygen and sulphur, than with chlorine, bromine, and iodine, and the allied bodies.

17. *Silica*, (L'Institut, Dec. 2, 1846, No. 674.)—M. Kopp offers several reasons for considertng SiO^2 the formula of silica, instead of SiO^3. They are based on the following considerations ;—1, the density and relation of volume of the compounds of silicium and boron, as compared with chlorine and fluorine; 2, the density of the vapors of the silicic ethers; 3, analogies between silicic, titanic, and tantalic acids; 4, simplicity of composition of the fluo-silicates; 5, the more simple formulæ for the most of the silicates; 6, the augmentation of the number of the simple and neutral silicates, adopting the formula SiO^2; 7, diminution of the great basicity of the silicates, which seems to have little relation with the comparative feebleness of the acids; 8, a new and much more general classification of the family of feldspars.

18. *Nitrification*, (L'Institut, Dec. 2, 1846, No 674.)—M. Dumas states that when a current of moist air containing ammonia is directed upon a solution of potash, the temperature being at 100° C., a quantity of nitrate of potash is formed through a change of the ammonia into nitric acid. He remarks that this experiment, which accords with the labors of M. Kuhlmann on nitrification, was suggested to him by observations which he had recently made upon the conversion of sulphuretted hydrogen into sulphuric acid.

19. *Phosphate of Lime in Organic Beings*, (L'Institut, Dec. 2, 1846, No. 674.)—M. Dumas attributes the disaggregation of bones on exposure in the soil, and the removal of the phosphate of lime by water, to two causes, the one of feeble intensity and acting rarely, the other of great force and always in action. The first depends on the *ammoniacal* salt in waters, which salt enables them to dissolve phosphate of lime; this salt is every where present, but in so small a quantity as to have comparatively little influence. The second depends on carbonic acid, which appears to be the true solvent of phosphate of lime; for waters charged with carbonic acid, dissolve large quantities of it. Alkalies and ebullition separate the carbonic acid and precipitate the salt. The action of this acid is so powerful that shavings of ivory placed in a bottle of seltzer water, are softened in twenty-four hours as if in chlorohydric acid; and the seltzer water contains, afterwards, all the phosphate of lime contained in the ivory. This property, adds Dumas, enables us to understand the introduction of phosphate of lime into plants. These facts explain the disaggregation of bones, and the dissemination of the phosphate of lime in the soil through the carbonic acid contained in rain waters; they show how, in the animal economy, bones may be redissolved by the venous blood charged with carbonic acid; they indicate the part which the fluorid of calcium acts in the teeth, in protecting the osseous portion from the carbonic acid disengaged from the lungs, and dissolved also in the saliva, which at the same time is alkaline to neutralize the action of the acid. Dumas suggests the use of carbonated waters for persons affected with calculi of phosphate of lime.

20. *On Elliptic Polarization;* by Mr. Dale, (Proc. Brit. Assoc., from Athen, Sept. 19, No. 986.)—The paper which I have to read to the Section, relates to some new observed facts in the subject of elliptic polarization, which appear to point out the physical element on which depends the different action of metals on light, as compared with transparent substances in general. They have already been communicated to the Ashmolean Society at Oxford, but I have been induced to bring them forward at present, with a view of more readily gaining for them the notice of those interested in optics. This peculiar action, it will be remembered, is of this kind: first, that the metals (and metallic sulphurets, &c.) have no angle of complete polarization for common light; and secondly, that a plane polarized ray becomes elliptically polarized after reflexion from their surfaces, whereas it remains plane polarized after reflexion from glass and such like bodies. Endeavors have naturally been made to account for these phenomena on the principles of the undulatory theory; and always, apparently, on the supposition, that the laws of reflexion from transparent (uncrystallized) bodies were already rigorously given by Fresnel's formulæ, but that a new and distinct theory was required for metallic reflexion. Thus assuming that the two classes of phenomena were abruptly separated, without any intermediate links of connexion. It has, indeed, long been known that several transparent or translucent substances have no angle of complete polarization. Thus, Biot (Traité de Physique, iv, 288) has excepted sulphur and the diamond; and Sir John Herschel (Optics, Art. 845; see also 831) excludes from the general rule, besides the metals, those substances which have the adamantine lustre; which term is applied, in Mohs's system of crystallography, to several of the minerals to be presently spoken of, as resembling the metals in another respect. I do not know that any writer, except Mr. Green, (in Camb. Phil. Trans., vol. vi,) has stated this exemption to be general for all substances having a high refractive index; but it is important to recall this experimental fact to our attention, on account of its coincidence and harmony with the new result which I have now to state. It consists in this: that these same highly refractive substances resemble the metals also in a second respect—that they confer elliptic polarization on a plane polarized ray reflected from them. The following list of substances, in which this property was observed, will be found to contain most of those at the top of Sir D. Brewster's list of refractive indices:—

Indigo—which is remarkable for possessing the metallic lustre without containing any metal.

Artificial realgar.

Diamond—of which three specimens were tried.

Sulphuret of zinc in transparent crystals.

Glass of antimony—translucent.

Sulphur—melted on a polished slip of zinc foil.

Tungstate of lime—transparent.

Carbonate of lead in crystals, clear and limpid as glass.

Hyacinth, or zircon—translucent.

Arsenious acid.

{ Garnet.
{ Idocrase.

Helvine. Labrador hornblend.

Of which the last five possess the property in a very slight degree only. The test used in every case was the dislocation of the rings of a plate of calc spar; of which a very good specimen was used, capable of exhibiting eight or nine red rings: and all the experiments were made by candle-light, which is indispensable. It will secure greater confidence in these results to say, that all the specimens which I submitted to Prof. Powell's examination, in a different instrument, were found by him to produce the above effect; and from his published observations several more cases may be quoted in confirmation of the general result: such are—chromate of lead, litharge, plumbago, and Indian ink. The natural conclusion from these facts appears to be, that in a perfect mathematical theory of reflexion, both cases should be embraced in one set of formulæ, of which some terms or coefficients should be insensibly small, except when the refractive index was very large; that, *strictly* speaking, no substances *completely* polarize common light at any angle, but that the residue of unaltered light is too feeble to affect the eye, when the refractive index is below a certain limit;—and that plane polarized light always becomes elliptically polarized, but that the virtual difference of paths of the two compact vibrations parallel and perpendicular to plane reflexions is insensibly small, except the refractive index surpass a certain value greater than the refractive indices of felspar and sapphire—which I found to produce no dislocation of the rings. It is remarkable that such formulæ have, some time since, been deduced from a very profound mathematical investigation, by Mr. Green, in the Cambridge Philosophical Transactions, vol. vii;—whose results, however, do not seem to have met with much attention. Now, however, that they have met with the above undesigned general confirmation, it seems very desirable that they should be compared with the numerical results of experiments of Sir D. Brewster and Prof. Powell. Mr. Green adopts, as part of the basis of his calculation, the original view of Fresnel,—that the vibrations of a polarized ray are perpendicular to the plane of polarization; but as this point is a matter of dispute among mathematicians, I have thought of an experimental method by which this point might, as I think, be decided, independently of all theory. It consists in the observation of the shifting of the fringes produced by two pencils of light polarized in the same plane on interposing in their paths a piece of compressed glass. This last apparatus is to be constructed in the following manner:—A strip of clear plate, four or five inches long by half an inch broad, is to be provided; and its narrowest faces (or narrowest long sides of the parallelopiped) are to be carefully polished, and rendered perfectly plane and parallel to each other,—at least, in the middle part of their length, through which the light is to pass. And the glass must be so well annealed and so free from striæ as to allow of the formation of fringes by interfering pencils which have traversed it. It is to be provided with a wooden frame and screw, capable of compressing it in the middle. (A similar apparatus has already been employed by Brewster, Ling and Pouillet, to show that glass under pressure possesses double refraction.) We may now proceed to the experiment itself. Let us suppose, then, that the arrangements have been made in a darkened room for producing the interference of two pencils of light, which are to be polarized in the same plane, by passing, for example, through the same tourmaline plate. This arrangement might, in fact, be that of Fresnel, in which a slender beam is reflected from two glass plates very slightly inclined, provided that the light were incident at the polarizing angle of glass. And, for the sake of clearness, let us suppose the two foci, or virtual foci, to be vertically one above the other, the plane of polarization to be vertical, and the glass to be interposed with its length horizontal. Then, in its natural state, it will produce no displacement of the fringes, if made carefully after the above description. But let us consider what will be its effect, if interposed in its bent state. The elasticities on its convex and concave sides are different in this respect, that the particles are dilated or compressed *parallel to the length of the glass:* whereas little or no alteration of elasticity is produced in a plane perpendicular to the length of the glass. Hence, if the vibrations of the two polarized pencils are really executed perpendicularly to the plane of polarization, or parallel to the length of the glass, (according to the arrangement above agreed upon,) they will be propagated with different velocities, and the fringes will be displaced parallel to the length of the glass, in a direction which might be inferred from some statements of Sir D. Brewster, but which is quite unimportant to the present purpose. If, however, on the other hand, the vibrations be executed in the plane of polarization, or perpendicular to the length of the glass, the two rays will traverse the glass with almost, or quite, the same velocities, and the fringes will either not be displaced at all, or to a far less amount than in the preceding case.

21. *On certain cases of Elliptic Polarization of Light by Reflexion;* by Prof. Powell, (Proc. Brit. Assoc., from Athen., Sept. 19, No. 986.) —From the principle investigated by Fresnel, that polarized light changes its plane, in reflexion, by a certain law dependent on the incidence (from transparent media) and the extension of a similar law to reflexion from a second surface, by Sir D. Brewster, (Phil. Trans. 1830, p. 148,) other formulæ were obtained by the last named philosopher to express the varied phenomena observed by himself (Phil. Trans. 1841) in the reflexion of polarized light from thin films, in extension of those previously investigated by Mr. Airy and M. Arago. The whole subject was reduced to the principles of the undulatory theory by Dr. Lloyd, (see Brit. Assoc. Report, 1841, Sect. proceedings, p. 26,) who pointed out the further theoretical result that, owing to the difference of phase or retardation thus produced in the two portions into which the reflected light is divided, polarized light reflected by a thin plate will, in general, become elliptically polarized. It is certain, however, that, in a great number of cases of thin plates examined by the author of this communication, no ellipticity can be detected. Glass superficially decomposed and giving brilliant tints produces no ellipticity, except in those instances where it has a decided *metallic* lustre. Vapor condensed on soaped glass, (in the manner described by Sir D. Brewster,) oil of turpentine, cassia, &c. between glass plates, (the upper being slightly prismatic, to separate the reflexions,) are equally without effect. The theory, therefore, clearly needs some further modification to express the conditions under which the effect may be sensible. There are, doubtless, many cases of thin plates in which elliptic polarization

is produced, as in the films formed on metallic plates by Nobili's process, and by heat, as investigated by the author of this communication: or, again, as in mica which has become laminated, &c. But in these cases the *modus operandi* is well understood;—in the former, from the enormously high refractive power, and in the latter from the crystalline structure. In the case of China ink observed by the author, the ellipticity appears equally, whether it be in the form of a film or in a solid mass—though it is only seen in the purest specimens. In the numerous other cases examined by Mr. Dale, it does not appear that any thing like films can be supposed; the only condition seems to be the high refractive power. It may still be a question, then, whether the theory proposed independently by M. Cauchy and by Mr. Tovey be not more easily applicable,—since it requires nothing but the very simple and admissible hypothesis, that the *molecules of æther*, for a minute depth within the surface, are *unsymmetrically distributed*. (See the author's treatise on the Undulatory Theory applied to Dispersion, &c.) In various substances containing but a very small proportion of metal, ellipticity has been detected, in addition to those enumerated by the author on a former occasion. Among these are Prussian blue, and the meteorite from the Cape of Good Hope, described in the Philosophical Transactions, 1839 and 1840,—which contains only about 33 per cent. of protoxyd of iron, very small portions of oxyds of nickel and chrome, and a trace of metallic iron, (see Phil. Trans. 1829, i, 86.)

II. Mineralogy and Geology.

1. *Analysis of the American Mineral Nemalite;* by Prof. Connell, (Proc. Brit. Assoc., from Athen., Sept. 26, No. 987.)—This mineral bears a striking resemblance to asbestus, so that by the eye it can hardly be distinguished from it. It was first chemically examined by Mr. Nuttall, who ascertained that it differs entirely in constitution from asbestus, and concluded, from his experiments, that it consists essentially of magnesia and water, with a little oxyd of iron and lime. It was subsequently examined by Dr. Thomson, according to whom it also contains 12½ per cent. of silica. The constituents found by the latter were—

Magnesia,	51·721
Silica,	12·568
Peroxyd of iron,	5·874
Water,	29·666
	99·829

The result which I have obtained differs somewhat from both the preceding. According to each of the previous experimenters the mineral is soluble in acids without effervescence. But I have found that even perfectly fresh portions of the specimens which I have of the mineral from Hoboken, in America, sensibly effervesce when dissolved in acids, showing that some carbonic acid is contained in it. I have also found only a very minute quantity of silica, the mineral leaving scarcely any residue when dissolved. The amount of water was determined by ascertaining the quantity of water collected by ignition in a tube of German glass twice bent, and containing at one end fused chlorid of calcium. The carbonic acid was estimated by the loss of weight on treating a portion of the mineral with dilute acid, in a little bottle connected with a tube containing chlorid of calcium. The solid constituents were determined by ordinary methods. The result was—in 100 parts—

Magnesia, ...	57·86
Protoxyd of iron, ...	2·84
Silica, ...	0·80
Water, ...	27·96
Carbonic acid, ...	10·
	99·46

Considering the protoxyd of iron as replacing a little magnesia, the mineral appears to be a combination of hydrate of magnesia and hydrated carbonate of magnesia. The formula

$$5\,MgO.\,HO + MgO.\,CO_2.\,HO$$

will nearly express its constitution, and gives—

Magnesia, ...	61·67
Water, ...	27·24
Carbonic acid, ...	11·09
	100·

The native hydrated carbonate of zinc (*zinkblüthe*) is a mineral of analogous constitution.

2. *Reclamation respecting the Identity of Pinite, Chlorophyllite, and other Minerals, with the species Iolite;* by CHARLES UPHAM SHEPARD, M. D.—In a paper by Mr. W. Haidinger published in Pogg. Annal., 1846, lxvii, 441, (and referred to in the last volume of this Journal, p. 418,) wherein the identity above mentioned is fully treated, the writer has overlooked an article by myself, published in 1841, Vol. xli, p. 354, of this Journal, entitled "*On two decomposed varieties of Iolite.*" Those varieties were the *Pinite* of Haddam, Ct., and the *Chlorophyllite* of Dr. Jackson. Mr. Haidinger appears also to have been unacquainted with the fact that the 2d edition of my Treatise on Mineralogy, (New Haven, 1844,) refers, (p. 141,) not only both of the above varieties to Iolite, but likewise the *Gigantolite*, the *Fahlunite*, the *Esmarkite*, and the *Hydrargillite* of Rose, to the same species.

New Haven, Oct. 30, 1846.

There is this difference between the results of M. Haidinger and Prof. Shepard: the latter described the minerals above referred to as *decomposed* iolite and *varieties* of that species; while the former speaks of them as mineral species (with chemical formulas) resulting from the *alteration* of iolite. The change is dependent on chemical affinities; and another species may be formed as much as when pseudomorphous specular iron is derived from magnetic iron.*—EDS.

* "To the foregoing remark of the Editors, Prof. Shepard wishes to add, that what he claims is simply to have first pointed out the relation between the above mentioned substances (chlorophyllite, pinite, &c.,) and iolite, analogous to that which is admitted to exist between Rensselaerite and pyroxene, or the greenish grey talcy crystals from Amity (called pseudolite by Nuttall) and spinel. If Mr. Haidinger or any other mineralogist thinks it proper to construct chemical formulas for those decomposed or altered minerals, and to introduce such minerals as species, possessing a coördinate natural history value with iolite itself, Mr. Shepard by no means puts in a claim of priority as regards such labors."

3. *Chiolite, a new mineral from Miask;* by Fr. v. Wörth, (Verhandl. Min. Ges. zu St. Petersburg, 1845–46.)—Chiolite is a massive mineral resembling cryolite. It occurs granular, with a shining lustre, and presenting a grayish, yellowish, or snow white color. The streak is snow white. The hardness is between calc spar and fluor spar. Specific gravity of the masses 2·6209; of the powder 2·770. The structure of the massive pieces is imperfectly foliated, and the surface of foliation exhibits a lustre between greasy and vitreous. The specimen examined by M. Wörth, indicated that it was associated with lithia mica, massive fluor spar, and quartz. It melts easily in the flame of a candle, but at first decrepitates. Its transparency increases in water.

According to the chemical analysis of A. Chodnew, it consists of aluminium 16·48, sodium 25·72, potassium 0·58, magnesium 0·76, yttrium 1·04, fluorine 56·00=100·38, giving the formula $2Na\mathbf{F}l + \mathbf{Al}\,\mathbf{F}l_3$. Cryolite differs in containing, for the first term, $3Na\,\mathbf{F}l$, and also in its higher specific gravity. The name chiolite is from the Greek word for snow.

4. *On the alleged Coëxistence of Man and the Megatherium;* by C. Lyell, (addressed as a letter to the Editor of the Times, and published in the Times of Dec. 8, 1846.)—Sir: A considerable sensation appears to have been caused in the minds of the scientific, and part of the unscientific public, by the announcement in many of the newspapers of the discovery in America of a fossil human bone associated with the remains of the megatherium and other extinct quadrupeds. I have only just read in the last number of the Athenæum, (December 5, 1846,) a brief notice of the reported discovery, copied from an American paper, and which the editor has inserted with a judicious caution to his readers that no competent authority has yet vouched for all the facts. I feel sure that the story relates to part of a human pelvis (a fragment of the *os innominatum*) which was shown to me at Natchez last spring, together with several very remarkable remains of megatheroid animals. I visited Natchez in March last, on which occasion I was informed of the antiquity assigned to the human relic, and having examined carefully into the evidence, came to the conclusion that the proofs of the coëxistence of the human individual with the megatheroid and other extinct quadrupeds found in the vicinity was altogether unsatisfactory. We are indebted to the skill and indefatigable industry of Dr. Dickerson of Natchez, for having formed a splendid collection of organic remains, derived from the superficial deposits of that neighborhood. All these he had the kindness to show me, and afterwards accompanied me to the principal spots where they had been procured. One of these, distant about six miles from Natchez, has been named by him the Mammoth ravine, from the skeleton of the mastodon discovered there; and it was there also that the fragment of the human pelvis, supposed to have been contemporaneous with the megatherium, was picked up.

In order to explain its position, a few words on the geology of the region will be indispensable. The broad, flat, alluvial plain of the Mississippi is bounded on its eastern side by a table-land about two hundred feet higher than the river, and having a very gentle upward slope to the eastward or towards the interior. This elevated platform ends abruptly at Natchez, in a line of perpendicular cliffs, or bluffs, the base of which is continually undermined by the Mississippi. The vertical section here exposed to view affords the geologist a fine opportunity of studying the composition and succession of the strata for a vertical thickness of rather more than two hundred feet. The whole deposit is of comparatively modern date, the upper sixty feet consisting of clayey loam, containing shells of recent species, and the lower of sand and gravel without organic remains, except some wood and silicified corals washed out of older rocks. The yellow loam at the top bears a singularly close resemblance to the fluviatile silt, or "loess," as it is termed, of the valley of the Rhine, between Cologne and Basle, and, like it, contains abundance of freshwater and land shells, of which I myself obtained more than twenty species, now in my cabinet in London. They belong to the genera Helix, Helicina, Pupa, Succinea, accompanied or rather replaced in a few places where the loam passes into shell-marl, by Lymnea, Planorbis, Physa, and Cyclas. All the species are identical with testacea, now inhabiting the same part of the United States. With these shells are found, at different depths, some in the loam, and some in the clay at the bottom of the loam, the scattered bones and occasionally entire skeletons of the mastodon, megatherium, mylodon, casteroides, equus, bos, and other quadrupeds. If in any part of this formation, whether at the depth of ten feet or one hundred, any remains of man lie buried by natural causes in undisturbed loam or clay, the antiquity of the human race is thereby established to an extent far greater than has ever yet been made out in any instance which I have had an opportunity of investigating. It would follow that the human race had survived the extinction of one group of terrestrial mammalia and seen another succeed and replace it; and also that man had lived in North America when the geographical configuration of the country was very different,—in other words before the valley of the Mississippi, or even some of the strata forming its boundary rocks, were in existence. Every deposit entering into the composition of the bluffs of the Mississippi valley must be older than the alluvial plain and delta of that river; and we thus obtain, independently of any evidence attesting great changes in the animate world, a measure for estimating the *minimum* of time which has elapsed since the bluffs originated. For we must allow a sufficient series of years for the deposition of all the sedimentary matter forming the plain and delta of the great river. I have endeavored to calculate the period, (one of enormous duration relatively to the historical epoch,) and explain my views on the subject, in a lecture delivered to the British Association at their meeting at Southampton, and a correct, though incomplete, abstract of that communication appeared in the Atheneum, for Sept. 26, 1846.*

To come then to the point—what proof is there that the geological position of the human pelvic bone was such as to demonstrate its anteriority in date to the entire hydrographical basin of the Mississippi, and the formation of its alluvial deposits and delta? The yellow shelly loam or loess, before mentioned, extends for twelve miles inland or eastward from the river; and in consequence of its incoherent and destructible nature, every streamlet flowing over it cuts out for itself, in its way to the Mississippi, a deep gully or ravine. This denudation has of late years proceeded with accelerated speed, especially in the

* This volume, p. 34.

course of the last thirty or thirty-five years. Some attribute the increased erosive action to partial clearings of the native forest; others to the effects of the great earthquake of New Madrid in 1811–12, by which this region was much fissured, ponds being dried up, and some landslips caused. Colonel Wiley, a proprietor in this part of the state of Mississippi, and who well remembers the district before the year 1812, assured me that the Mammoth ravine although now seven miles long, and in some parts sixty feet deep, with its numerous ramifications, has been entirely formed since that year when the earthquake occurred. He has himself ploughed some of the land exactly over the spot where the ravine is now situated.

It is however enough for our purpose to affirm that whatever be the date of the origin of this watercourse, it has of late years been considerably enlarged and lengthened, its banks presenting everywhere precipices in which the loam, unsolidified as it is, retains its verticality, as is the case with its counterpart, the loess of the Rhine. Land shells are seen in great numbers at the depth of about thirty feet from the top, and the fossil bones of the mastodon, and other extinct quadrupeds, are usually picked up in the bed of the stream, after they have been washed out of the undermined cliffs, where, however, some few have also been observed *in situ.* Under these circumstances, as I was given to understand, the human pelvis was procured at the base of the cliff. Even if it had been dug out in the presence of a practical geologist, it would have been necessary for him to be more than usually on his guard against deception, for landslides have detached large masses from the cliffs, and these may easily cover human bones previously washed down by the stream or dislodged from the soil near the top of the cliff, where some old Indian graves, so common throughout the country, may have been undermined. It is not rare to find on shoals and on the shores of the islands in the Mississippi at low water, numerous bones of man mingled with those of extinct animals washed out of the bluffs. In these cases the human bones are as black as the quadrupedal fossils, having been apparently stained with peaty matter, in the soil where they were buried; but no geologist has ever ventured on this evidence, to infer the contemporaneousness of man and the fossil specimens thus accidentally associated.

After I had made up my mind that the remote antiquity of the human bone at Natchez was questionable, and that its occurrence in the ravine might be explained in the manner above suggested, I found that Colonel Wailes, a friend of Dr. Dickerson's, who accompanied us in part of our excursion, and who has also made a fine collection of the fossils of this neighborhood, not only shared my doubts, but had made the same conjecture respecting the probable manner in which the fossil may have been conveyed to the spot where it was found. I have the honour to be, Sir, yours, &c., CHARLES LYELL.

11, Harley street, Dec. 7.

5. *Notices of the Superposition of certain Minerals in some of the Metalliferous Deposits of Cornwall and Devon;* by WILLIAM JORY HENWOOD, F. R. S., F. G. S., Chief Commissioner of the Gongo Soco and Catta Preta Gold Mines, (from the L., E. & D. Phil. Mag., Nov., 1846, xxix, 359.)—The interesting communications of Messrs. Fox and Dana, induce me to present an abstract of observations on the superpo-

sition of certain minerals, made during my examination of the mines of Cornwall and Devon.

To enumerate all the substances of which the *lodes* in that district are composed and their respective localities, would be a tedious task, and at present perhaps not a very useful one: I have therefore tabulated the order in which only the more abundant of them occur. The nature of the (*country*) containing rock is prefixed:—the first column denotes the mineral adjoining the (*wall*) side of the *lode;* the second, that which rests on that named in the first; the third, the substance overlying the second, and so on: the last column contains the names of some of the localities. The italic letter denotes the crystalline; the Roman, the massive minerals.

Mineral adjoining *wall* of *lode.*	Mineral resting on that in first column.	Mineral resting on that in second column.	Mineral resting on that in third column.	Localities.
		Containing rock—GRANITE.		
Quartz	*Quartz*			Numerous.
Quartz	Opal			Wheal Cairn.
Quartz	*Quartz*	Chalcedony		Pedn-an-drea.
Quartz	*Quartz*	*Arseniate of iron*		Wheal Gorland.
Quartz	*Quartz*	*Wolfram*		St Michael's Mount.
Quartz	*Quartz*	*Arseniate of copper*		Wheal Unity.
Quartz	*Quartz*	*Uranite*		Gunnis Lake.
Quartz	*Oxyd of tin*	*Tungstate of lime*		Wheal Friendship.
Quartz	Native copper	*Red oxyd of copper*		Wheal Gorland.
Quartz	*Malachite*			Gunnis Lake.
Quartz	Mineral pitch			East Wheal Crofty.
Amethystine quartz	Quartz			Wheal Bellon.
Amethystine quartz	*Amethystine quartz*			Dartmoor.
Felspar	Phosphate of iron			Park-noweth.
Fluor	*Fluor*	*Quartz*		Wheal Gorland.
Oxyd of tin				All tin mines in granite.
Oxyd of tin	*Sulphuret of bismuth*			Balleswidden.
Hematite iron ore	*Specular iron ore*			Park-noweth.
Earthy brown iron ore	*Vitreous copper ore*	Black copper ore		Wheal Jewel.
Earthy brown iron ore	*Red oxyd of copper*			Wheal Gorland.
		Containing rock—GREENSTONE.		
Quartz	Stalactitic quartz.	*Quartz*		Wheal Edward.
Quartz	*Quartz*	*Arragonite*		Levant.
Quartz	*Quartz*	*Hydrous oxide of iron*		Restormel.
Quartz	*Quartz*	*Wolfram*		Poldice.
Quartz	*Quartz*	*Arseniate of copper*		Wheal Unity.
Quartz	*Quartz*	*Arseniate of lead*		Wheal Unity.
Quartz	Chlorite	*Oxide of tin*		Wheal Vor.
Quartz	Chlorite	*Arseniate of lead*		Wheal Unity.
Quartz	Fluor	*Fluor*		Wheal Unity Wood.
Quartz	Arsenical pyrites	*Arsenical pyrites*		Wheal Unity Wood.
Quartz	Earthy brown iron ore	*Phosphate of copper*		Gunnis Lake.
Quartz	Earthy brown iron ore	Pitch-blende		Wheal Edward.
Quartz	Earthy brown iron ore	*Uranite*		Wheal Edward.
Quartz	Earthy brown iron ore	Vitreous copper ore		Botallack.
Quartz	Carbonate of iron	*Spathose iron ore*		Botallack.
Quartz	Vitreous copper ore	*Arragonite*		Levant.
Quartz	Chlorite	Copper pyrites	Mineral pitch	North Roskear.
		Containing rock—FELSPAR PORPHYRY (Elvan).		
Oxyd of tin	Oxyd of tin			Wherry.
Silicate of tin				Wheal Coates.
Quartz	Earthy brown iron ore	*Blue carbonate of copper*		Ting Tang.
Quartz	Earthy brown iron ore	*Malachite*		Ting Tang.
Quartz	Copper pyrites			Ting Tang.
Earthy brown iron ore	Copper pyrites			Ting Tang.
Earthy brown iron ore	Native copper			Wheal Buller.
Earthy brown iron ore	Vitreous copper ore			Ting Tang.
Earthy brown iron ore	*Red oxyd of copper*			Ting Tang.
Earthy brown iron ore	*Arseniate of copper*			Ting Tang.
Earthy brown iron ore	Crysocolla			Ting Tang.

Mineral adjoining *wall* of *lode*.	Mineral resting on that in first column.	Mineral resting on that in second column.	Mineral resting on that in 3d column.	Localities.
		Containing rock—CLAY-SLATE.		
Quartz .	*Quartz* . .	*Quartz* . .	. . .	Wheal Friendship.
Quartz .	*Quartz* . .	*Copper pyrites* .	*Quartz* .	East Crinnis.
Quartz .	*Quartz* . .	*Sulphate of barytes*	. . .	United Mines.
Quartz .	*Quartz* . .	Copper pyrites .	*Copper pyrites*	United Hills.
Quartz .	*Quartz* . .	*Sulphuret of antimony*	. . .	Pengelly.
Quartz .	Chlorite . .	Oxyd of titanium	. . .	Virtuous Lady.
Quartz .	*Quartz* . .	*Blende* . .	*Fluor* . .	Polberrow.
Quartz .	*Quartz* . .	*Celestine* . .	. . .	Binner Downs.
Quartz .	Fluor . . .	Galena . .	. . .	Wheal Penrose.
Quartz .	Iron pyrites .	*Quartz* . .	. . .	West Pink.
Quartz .	Iron pyrites .	. . . . .	. . .	Numerous.
Quartz .	Iron pyrites .	Carbonate of iron	*Spathose iron ore*	Virtuous Lady.
Quartz .	Iron pyrites .	*Phosphate of iron*	. . .	Wheal Falmouth.
Quartz .	Iron pyrites .	Sulphuret of silver	. . .	Dolwath.
Quartz .	Earthy brown iron ore	*Red oxyd of copper*	. . .	Wheal Charlotte.
Quartz .	Earthy brown iron ore	*Carbonate of lead*	. . .	Pentire-glaze.
Quartz .	Earthy brown iron ore	*Phosphate of lead*	. . .	Wheal Alfred.
Quartz .	Earthy brown iron ore	*Sulphate of lead*	. . .	Mellanear.
Quartz .	Hematite iron ore	Oxyd of manganese	. . .	Restormel.
Quartz .	*Wood tin* . .	. . . . .	. . .	Polberrow.
Quartz .	*Oxyd of tin* .	. . . . .	. . .	Numerous.
Quartz .	Native silver .	. . . . .	. . .	Herland.
Quartz .	Sulphuret of silver	. . . . .	. . .	Wheal Brothers.
Quartz .	*Red silver ore* .	. . . . .	. . .	Dolcoath.
Quartz .	Native copper .	. . . . .	. . .	Numerous.
Quartz .	Vitreous copper ore	*Vitreous copper ore*	. . .	Wheal Speed.
Quartz .	Vitreous copper ore	*Capillary red oxyd of copper*	. . .	Providence.
Quartz .	*Buntkupfererz* .	. . . . .	. . .	Wheal Falmouth.
Quartz .	Copper pyrites .	. . . . .	. . .	Numerous.
Quartz .	Copper pyrites .	*Sulphuret of bismuth*	. . .	Fowey Consols.
Quartz .	*Tennantite* . .	. . . . .	. . .	Fowey Consols.
Quartz .	Copper pyrites .	*Fluor* . . .	. . .	Polberrow.
Quartz .	*Red oxyd of copper*	. . . . .	. . .	Numerous.
Quartz .	Galena . .	*Galena* . .	*Quartz* .	Wheal Rose.
Quartz .	*Blende* . .	Pearl-spar . .	. . .	Union Mines.
Quartz .	*Blende* . .	*Fluor* . . .	. . .	West Pink.
Quartz .	*Galena* . .	*Blue lead ore* .	. . .	Wheal Hope.
Quartz .	Blende . .	*Blende* . .	. . .	Union Mines.
Quartz .	Mineral pitch .	. . . . .	. . .	South Towan.
Quartz .	Carbonate of lime	. . . . .	. . .	Binner Downs.
Chlorite .	*Oxyd of tin* .	. . . . .	. . .	Numerous.
Pearl-spar	*Copper pyrites* .	. . . . .	. . .	Caun Quarry.
Fluor .	Copper pyrites .	. . . . .	. . .	Wheal Unity Wood.

As the foregoing table is a first attempt at arranging these facts, it will doubtless be found susceptible of many improvements.

For the present I abstain from mentioning inferences, though many are obvious enough.

6. *Geological Society of France*, (L'Institut, Dec. 2, 1846, No. 674.)—The *Reunion Extraordinaire*, at Alais, commenced on the 30th of August. On the first day a memoir was read by M. l'Abbé Chamousset, on the mineralogical and geological productions of Alais, and another by M. J. Teissier, on the means of introducing water into the village of Alais. On the next day, the Society commenced their scientific explorations; they first examined the dolomite and lias of the vicinity, the Oxford formation of Mount Hermitage, and the contact of the *keuper* and the coal formation near Provençal and elsewhere; they examined the latter beds from Rochebelle to the bridge of Tamaris, and ended by visiting the great iron founderies and forges of the region. The 1st of September, they examined the coal basin of Alais through a great part of its extent, which exhibits extensive foldings and dislocations. M. Emelien Dumas read, on this occasion, a detailed memoir accompanied

with plates, on the coal basins of Bessèges and Alais. M. J. de Malbos read a memoir on a fossil plant of the green sand, before found in other formations by MM. Faujas de Saint Fond and Dunoyer. The 2nd of September was occupied by a continuation of the coal explorations. The 3d was devoted to an examination of the lacustrine formation and neocomian limestone on the route by Méjanes, Saint-Hyppolyte-de-Caton, Euzet; a marly limestone, in the lower part contains menilites, fossil fish, insects and vegetables.

7. *Volcanic Dust of Hecla;* by Dr. Traill, (Proc. Roy. Soc., Edinb., ii, 56, Dec. 1845.)—Dr. Traill read an account of dust falling from the atmosphere on the 2d and 3d of September last, in the islands of Orkney.

This dust was observed by a gentleman in the island of Rousay, falling from the air on the morning of the 2d. It was collected by another at Skaill, on the western shores of Pomona, on the morning of the 3d; and by two other gentlemen in Kirkwall on the same day. It appears also to have fallen in several other parts of Orkney, probably over all the islands; and was observed also to reach the northern coasts of Caithness, within an area of which the radius cannot be less than 30 or 40 miles.

It covered, to the depth of from $\frac{1}{12}$ to $\frac{1}{6}$ inch, linen laid out to dry, glass frames in gardens, and the leaves of plants of every kind, with a fine brownish-grey dust, almost impalpable to the touch, but meagre and grinding between the teeth. It does not effervesce with acids, and consisted chiefly of silex, alumina, oxyd of iron, with a trace of lime.

This dust bears much resemblance in composition and appearance to that which covered the decks and rigging of vessels in the West Indian seas, when the eruption of the Soufrière took place in St. Vincent, in 1812. Those who collected the dust in Orkney, state the probability that it proceeded from some eruption of Hecla, as the ashes of that volcano *once* before fell in Orkney; and the wind for several days before the 2d of September had blown strongly from the N. W.

The truth is, that such an occurrence has at least three times before happened in the Orkney and Zetland Isles, when there has been an eruption in Iceland. In 1755, during a violent eruption of the Köttlugiær Jökul, showers of ashes fell in the Zetland isles. In 1766, during a great eruption of Hecla, showers of ashes reached the Orkneys, and were long remembered there under the name of the *black snow*. Again, in 1783, a similar dust was observed to descend in Orkney, which was coincident with a terrible eruption of the Shaptär Jökul; the most calamitous which ever happened in Iceland.

Thus, the volcanic ashes of that island have thrice before reached our northern islands; and recent intelligence brought by Danish fishing vessels from Iceland announces, that, in the end of August, after being quiescent since 1766, Hecla has emitted a violent eruption from its flanks; and there can be little doubt that the dust now exhibited is derived from that eruption.

The distance between Hecla and the Orkney Islands is about 550 miles. Volney and other writers assure us that the ashes of Etna are often carried to the plains of Egypt, or to double that distance; and the eruption of the Tomboro, as described by Raffles, in the eastern archipelago, appears to have exerted a no less astonishing projectile force.

8. *Volcano in the Red Sea;* (Athen., Nov. 28, No. 996.)—A despatch has been received at Lloyd's from the East India House, inclosing a copy of a letter from Lieut. Barker, of the Hon. East India Company's steam-vessel Victoria, announcing that on the 14th of August last, smoke was observed to issue from the summit of Saddle Island, in lat. 15° 7′ N., long. 42° 12′ E. The weather, at the time, was very squally, with thunder and lightning. Saddle Island is one of a group called Zebayer Islands in the Red Sea; in the direct track of vessels proceeding up and down. They are all of volcanic origin, but there is neither record nor tradition of their having been in active operation. Jibble Seer, in lat. 15° 32′ N., and long. 41° 55′ E., was observed to be smoking when visited by the officers of the Benares during the survey of the Red Sea,—but never since. There is a tradition among the Arab pilots of its having been on fire some fifty years ago; and it bears among many of them the name of Jibble Dookhan, or Hill of Smoke,—and has the appearance of having been in active operation at a much later period than the Zebayer Islands.

9. *Probable Submarine Volcano*, (Athenæum, Dec. 26, No. 1000.)—The ship Helena on her late passage from Batavia to Canton, when in latitude 16° N., long. 125° E., fell in with immense fields of floating pumice stones, apparently not having been long erupted, many of which were as large as a common bucket. The nearest land to windward was the Ladrones, about 1000 miles distant. It seems impossible that they could have come from thence—nor could they have come from Luzon, dead to leeward.

10. *Coal on the Rocky Mountains, discovered by Capt. Frémont;* by James Hall, (Frémont's Expedition, p. 297.)—A few miles up Muddy river, (long. 111°, lat. 41½°,) Captain Frémont collected a beautiful series of specimens of fossil ferns. The rock is an indurated clay, wholly destitute of carbonate of lime, and would be termed a "fire clay." These are probably, geologically as well as geographically, higher than the oolite specimens, as the rocks at this place were observed to dip in the direction of N. 65° W. at an angle of twenty degrees. This would show, conclusively, that the vegetable remains occupy a higher position than the oolite. Associated with these vegetable remains, were found several beds of coal, differing in thickness. The section of strata at this place is as follows:

	Ft.	In.
Sandstone, ...	1	0
Coal, ...	1	3
Coal, ...	1	3
Indurated clay, with vegetable remains, .	20	0
Clay, ...	5	0
Coal,		
Clay, ...	5	0
Coal,		
Clay, ...	5	0
Coal,		

The stratum containing the fossil ferns is about twenty feet thick; and above it are two beds of coal, each about fifteen inches. These are succeeded by a bed of sandstone. Below the bed containing the ferns, there are three distinct beds of coal, each separated by about five feet of clay. Before examining the oolitic specimens just mentioned, I compared these fossil ferns with a large collection from the coal measures of Pennsylvania and Ohio, and it was quite evident that this formation could not be of the same age. There are several specimens which I can only refer to the *Glossopteris Phillippsii*, (see description,) an oolitic fossil; and this alone, with the general character of the other species, and the absence of the large stems so common in the coal period, had led me to refer them to the oolitic period. I conceive, however, that we have scarcely sufficient evidence to justify this reference; and though among the fossil shells there are none decidedly typical of the oolite, yet neither are they so of any other formation; and the lithological character of the mass is not reliable evidence. Still, viewed in whatever light we please, these fossil ferns must, I conceive, be regarded as mostly of new species, and in this respect form a very important addition to the flora of the more modern geological periods.

III. Botany and Zoology.

1. *The Characters of some New Genera and Species of Compositæ from Texas;* by Asa Gray, M. D., (from the Proc. of the Amer. Acad. of Arts and Sciences, Dec., 1846.)

Genus Lindheimera, *Gray & Engelm., Pl. Lindh. ined.* (Secionideæ-Melampodineæ.)

Capitulum multiflorum monoicum; fl. radii 4–5 ligulatis, fœmineis, ad axillas squamarum invol. interiorum sitis; fl. disci circiter 20 tubulosis, sterilibus. Involucrum duplex, exterius e squamis 4–5 laxis linearibus foliaceis, interius totidem membranaceo-foliaceis oblongis planis disco longioribus. Receptaculum planum, paleis chartaceis ovariis sterilibus amplectentibus onustum, binis exterioribus basi cujusque squam. inter. invol. adnatis, persistentibus. Ligulæ ovales, breviter tubulatæ, involucrum vix superantes: corolla disci 4–5-dentata. Styli fl. ster. filiformes, indivisi, hispidi. Achænia radii ovalia, obcompresso-plana, marginato-alata, intus subcarinata, carina apice in dentem parvum reflexum producta, alis in pappum 2-dentatum extensis; disci abortivi.—Herba erecta, scabro-hispida, forte biennis; caule dichotomo; pedunculis subcymoso-paniculatis gracilibus monocephalis; foliis imis alternis, cæteris oppositis sessilibus oblongo-ovatis basi dentatis, summis pedunculisque glandulis patelliformibus conspersis. Flores aurei.

L. Texana.—In rupestribus sylvis circa New Braunfels, Texas, *Lindheimer.*—Genus eximium, Berlandieræ et Engelmanniæ cognatum, diximus in honorem ejus acerrimi inventoris qui floram Texanam largiter indagavit.

Genus Barrattia. *Gray & Engelm., Pl. Lindh. ined.* (Senecionideæ-Heliantheæ-Euhelianthææ.)

Capitulum multiflorum heterogamum; fl. radii ligulatis (circ. 10) neutris, disci tubulosis hermaphroditis. Involucrum imbricatum triseriale, squamis lanceolatis apice herbaceis disco brevioribus. Receptaculum convexum, paleis navicularibus persistentibus achænia amplectentibus. Corolla fere Helianthi. Styli rami elongato-subulati, hispidi. Achænia compresso-plana, emarginato-obcordata, glabra, immarginata, calva.—Herba valida perenni, strigosa, corymboso-ramosa; foliis omnibus oppositis deltoideo-ovatis vel subhastatis inciso-dentatis triplinerviis petiolatis, petiolis basi appendicibus foliaceis interpositis connatis; pedunculis solitaris elongatis monocephalis. Flores radii et disci flavi.

B. calva.—In rupestribus prope originem flum. Guadaloupe, Texas, *Lindheimer.*—Genus a Leighia diversa pappo plane nullo, ab Encelia achæniis non comosis, a Wulfia achæniis compresso-planis, etc., diximus in honorem Josephi Barratti, M. D., botanici inclyti, Salicum præcipue indagatoris.

It may be proper to append here the characters of another unpublished Helianthoid genus, which is even more closely allied to Encelia (although well distinguished by its pappus), and is also analogous to Agarista.

Genus GERÆA, *Torr. & Gray*, *Fl. N. Amer. ined.*

Capitulum multiflorum heterogamum; fl. radii (circ. 15) ligulatis, neutris, disci tubulosis hermaphroditis. Involucrum laxe imbricatum 2–3 seriale, squamis lineari-lanceolatis herbaceis. Receptaculum planum, paleis hyalinis oblongis achænia semi-amplectentibus deciduis onustum. Ligulæ cuneiformes, basi pilosæ: corolla disci fauce dilatato-cylindrica e tubo brevi villoso, 5-dentatæ. Styli rami in appendicem lineari-filiformam hispidam longe producti. Achænia oblongo-cuneiformia, plano-compressa, marginata, pilis argenteis prælongis (ad margines præsertim) villosissima. Pappus bisquamellatus, squamellis ex marginibus achænii ortis lineari-aristiformibus basi villosissimis corollam adæquantibus.—Herba annua? hirsuto cana; caulibus basi foliatis (foliis obovatis rhombeisve alternis) superne nudis subpaniculatis pedunculos paucos 1–2-cephalos gerentibus. Involucrum cano-villosum. Flores radii discique flavi.

G. canescens.—California, *Frémont*, *Coulter.* Nomen e γεραιός ob capitulum canum necnon comam achænii argenteam sumptum, ut contrarium generi analogo Agaristæ, *DC.* (quæ mythologice nympha erat venustissima).

Genus AGASSIZIA, *Gray & Engelm.*, *Pl. Lindh. ined.* (non *Chavan.*, nec *Spach.*)

Capitulum globosum, multiflorum, radiatum; ligulis fœminiis nunc difformibus. Involucrum disco brevius circa biseriale; squamis exterioribus lineari-oblongis, appendicula spathulata vel obtusa foliacea patente, intimis lineari-acuminatis. Receptaculum globosum alveolatum, alveolis valde dentatis fimbrilliferis. Ligulæ cuneatæ, palmato-3–4-fidæ, sæpe irregulares, tubuloso-difformes, vestigia staminum gerentes. Corolla disci Gaillardiæ, dentibus triangulari-lanceolatis. Styli rami ligularum lineares, subulato-apiculati; fl. disci ad basin appendicis brevissimæ nudæ clavato-obtusæ penicellati! Achænia turbinata, sericeo-villosissima. Pappus radii et disci conformis, e paleis 9 hyalinis ovatis uninerviis constans, nervo in aristam capillarem corollam adæquantem longe producto.—Herba biennis, acaulis; radice fusiformi; foliis varie 1–2-pinnatifidis, nunc sinuatis lyratisve; scapo 1–2-pedali toto nudo monocephalo. Capitulum Gaillardiæ, speciosum. Flores suaveolentes, disci flavi et purpurei, radii rubescentes.

A. suavis.—In campis Texanis prope Bexar et New Braunfels, *Lindheimer.*—Genus eximium Gaillardiæ proximum, at ligulis fœminiis, receptaculo globoso vere alveolato, habitu styloque proprio diversum, diximus in honorem celeberrimi amicissimique Agassiz.—Agassizia, *Chavan.*, est Galvesia, *Domb.* Agassizia, *Spach.*, est Sphærostigma, *Ser.*, et Holostigma, *Spach.*, subgenus merum Œnotheræ.*

2. *Helix annulata.*—From examinations of specimens of the Helix described on page 101, of this volume, lately received from Mr. Thomas R. Dutton, Dr. A. A. Gould has ascertained that it is only a young state of *H. striatella.* The note to page 101, was simply a remark based on the figures given by Mr. Case.—Eds.

3. *Ornithichnites.*—On page 79 of this volume, a statement made to us by Prof. Agassiz is inserted, respecting the number of joints in the different toes of birds, and the bearing of this fact upon fossil footprints.

The same relation was pointed out by Prof. Hitchcock in his Report on the Geology of Massachusetts, 1841, ii, 525, and adduced to prove that some of the tracks were actually those of birds. It is recognized by Dr. Deane, in vol. xlv, p. 180, (1843,) of this Journal, and also subsequently illustrated by him in the Boston Journal of Natural History, vol. v, 1845.

We are informed by Pres. E. Hitchcock, that the quadruped track figured by Dr. Deane on page 79 of this volume, (last number,) and supposed to be new, is the *Sauroidichnites palmatus* of his Geological Report, or the *Palamopus anomalus* of his new nomenclature as given in the Proceedings of the Association of American Geologists and Naturalists. He lately examined the original specimen in the collection of Mr. Marsh, and immediately recognized it as belonging to the species just mentioned.—Eds.

4. *Plesiosaurus megacephalus;* by S. Stutchbury, (Quart. Jour. Geol. Soc., No. 8, p. 411.)—This new species of Plesiosaurus was discovered in the gray lias of Somersetshire. Mr. Stutchbury, after a detailed description, mentions the following among the distinguishing peculiarities.

The neck is only one-third longer than the head; the head is as one to six of the whole length of the animal, and is equal in length to twenty of the cervical vertebræ; the tail is but one-third longer than the head. The cervical vertebræ are twenty-nine, out of ninety-four the whole number in the animal; they are slightly rugose and have a vertical height of seven inches and eight-tenths. The length of the humerus is thirteen and seven-tenths inches. The whole length is sixteen feet three inches.

5. *Physiological Remarks on the Statics of Fishes;* by Joh. Müller, (Ann. Mag. Nat. Hist., xviii, 69, July, 1486.)—Like all animals, fishes have a very delicate sense of the equilibrium of their body; they counteract any change in this respect by means of movements, partly voluntary, partly instinctive. These last are seen in a very remarkable manner in the eyes, and they are so constant, and so evident in the fish as long as it lives, that their absence suffices to characterize the death of the animal.

---

* The memoir of Prof. Gray, contains also descriptions of the new species *Vernonia Lindheimeri, Ageratum Wrightii, Brickellia cylindracea, Keerlia bellidifolia* and *Tetragonotheca Texana.*

The equilibrium of the body of a fish in the water is independent of the natatory bladder; this organ may even interfere with it; as the fish lies in its horizontal position with the back upwards, it depends solely on the action of the fins, and principally on the vertical fins.

The natatory bladder may assist the fish to increase or to diminish its specific gravity. By compressing the air which is contained in it, the fish descends in the water; and it rises again by relaxing the muscles which had served to compress the bladder. Moreover, the fish may remain at the bottom of the water, by the very fact of the pressure of the column of water on the air contained in the bladder.

By compressing more or less the posterior portion or the anterior portion of the bladder, the animal is able to render the anterior half or the posterior half of its body lighter at will; it can also take an oblique position, which allows a movement of rising or of descending in the water. The arrangement of the natatory bladder in some fishes appears to favor this action. The Cyprinoids and the Characi have two bladders, one before the other, communicating with one another by a narrow tube. The anterior bladder is very elastic, whereas the posterior one is but slightly so; and in proportion as the fish rises in the water, the anterior bladder, which is the most elastic, must considerably increase in volume, and thus keep the head of the animal up, whilst the contrary must be the case when the fish descends.—*Müller's Archiv*, 1845, p. 456.

IV. Astronomy.

1. *On the Attempts to explain the Projection of a Star on the Moon, during an Occultation;* by Prof. Powell, (Brit. Assoc., from the Athenæum, Sept. 26, 1846.)—Some remarks having been brought forward at the last meeting, relative to the singular phenomenon above named, in which "diffraction" was referred to as, at least, in a general sense, likely to afford an explanation, the author of this communication conceived that some observations which he had made might not be without a bearing on the question. "Diffraction" has often been appealed to in cases apparently of the same class; but, in the more strict and limited sense of the term, it cannot apply, since both the conditions and the resulting phenomena appear essentially different. The phenomena properly ascribed to "diffraction" exhibit *fringes*,—and suppose the edge of the intercepting body to be *within* the area of the rays. But there are some effects of a concomitant kind, which have been less attended to. One of the most remarkable of these is that described by Newton, (Opt., book iii, part i, obs. 5, 6, 7,) in which the light admitted through a hole one quarter of an inch in diameter, falling on the edge of an opaque body, besides the phenomena since called "diffraction," gave rise to long streaks or "trains" of light darting into the shadow perpendicular to the edge, shown on a *screen;* or, when the *eye* was substituted, producing a *luminous line* running along the edge, between it and the first fringe. It does not seem that any subsequent experimenter has reproduced this part of the phenomenon, and it probably requires the most extreme precaution. The author has succeeded in another way, as follows: The aperture being one quarter of an inch diameter, at a distance of about eight feet was placed a circular opaque disk, three quarters of an inch diameter; and at two feet beyond

it an eye lens of two inches focal length. The dark disk appeared with a trace of faint diffractive fringes round it; and a number of *streaks or trains of light* converging from its edge to its centre, which there crossing gave rise to a *bright round spot.* The appearance of *separate* streaks is clearly due to the irregularities of the edge; since with a *polished* edge they were not perceptible, and only a faint light was seen, but giving rise to a well defined bright circular spot at the centre. Corresponding streaks appeared when a straight edge was used perpendicular to it. Though, in this experiment, the edge is *within* the area of the rays, yet a part of the same phenomenon (viz., the line of light along the edge) is seen, even when the edge is *beyond* the rays, by the naked eye, or with a telescope. When the orifice of light is reduced to a mere point (as by using the sun's rays reflected from a very small globule of mercury,) and the rays are *wholly* intercepted by the disk at the distance of about two inches, so that both the luminous point and the disk may be seen at once in focus by a small telescope about twelve feet distant, the luminous patch on the edge of the disk at the part nearest the luminous point appeared to extend to a small distance *inwards*, and there the rays converging crossed, and diverged again faintly. This might possibly be regarded as affording some experimental imitation of the case of the star. The orifice is not an absolute point; but, if it were, the patch of light on the disk might appear like a projection of its image. Another explanation has been proposed of the phenomenon of projection; on the principle that, owing to *aberration*, the star being seen out of its true place, a screen, placed in its *true* direction, as the moon, would exhibit the star projected on its disk (Astron. Soc. Reports, vi, 246); and, taking into account the *proper motions* of the star, this will explain the appearance of the phenomenon in one instance and not in another, on the supposition that those proper motions are in opposite directions in the two instances. But this will not apply in the very instance to which reference has been made,—of the two stars 119 and 120 Tauri,—which have proper motions both in the same direction. Also the *principle* of this explanation is rendered questionable altogether, from what has been lately suggested by Prof. Challis, on the theory of aberration. The whole subject is, perhaps, not yet ripe for explanation, since the first astronomers are so much at variance as to the facts,—the appearance having been often seen by one observer, and not by another: while it is believed by some to occur or not, according as the attention is directed to the moon or to the star; which, if true, would seem to point to some ocular cause. Hence, a further accumulation of instances is much wanted: any statement of which Prof. Powell would be thankful to receive, addressed to him, at Oxford.

2. *Astronomical Observations made under the direction of* M. F. Maury, *Lieut. U. S. Navy, during the year* 1845, *at the U. S. Naval Observatory, Washington;* Vol. i, published by authority of the Secretary of the Navy.—In the number of this Journal for March, 1846, p. 294, we gave a brief description of the Naval Observatory at Washington, with a notice of each of the principal instruments. We concluded that notice with the remark, "The public are anxiously looking for the fruits of this noble establishment. May their reasonable expectations not be followed by disappointment." We confess we had at the time some misgivings as to the fate of this enterprise. The project of a National Observatory had hitherto received so little favor at Wash-

ington, that it seemed too much to expect that opposition would now entirely and forever cease. But thus far, opposition (if any has been entertained) seems to have remained quiet; and we are now presented with the first fruits of the Observatory, in a quarto volume of 550 pages. We could wish that the observations were printed from larger type, on thicker paper, and that the volume was furnished with a more substantial covering; but we feel under too great obligations to the late Secretary of the Navy, to complain.

The Observatory is furnished with five capital instruments, viz. an Equatorial of fifteen feet focus; a seven feet Meridian Transit; a five feet Mural Circle; a seven feet Transit in the Prime Vertical; and a thirty inch Meridian Circle. No report is made of observations with the equatorial for 1845, and those made with the meridian circle, proving unsatisfactory, are not yet published. The three remaining instruments furnished the observations of the present volume. The work with the meridian transit instrument commenced April 22, and by the close of the year, 3200 observations were obtained, being an average of about twelve per day. At the Greenwich Observatory, the number of transit observations averages about eight per day. The work with the mural circle commenced Jan. 21, and by the close of the year, 2100 observations were obtained, averaging about six per day. At Greenwich the average is about eight per day. As to *amount of work*, therefore, our own Observatory compares well with Greenwich. But a much more important question respects the *accuracy* of the observations. We may form some opinion on this point, by noting the accordance of the observations with each other. We have therefore selected the twelve stars which were most frequently observed with the transit instrument, and have compared the mean Right Ascensions deduced from them. These may be regarded as observed values of the *same* quantity; and the differences among them indicate errors of observation, or unknown causes of anomaly. The following Table shows the difference between the *greatest* and *least* observation of each star, reduced to its equivalent upon the equator; and for comparison we have made a corresponding selection from the Greenwich observations for 1837.

Washington.			Greenwich.		
Object.	No. obs.	Extreme diff'e.	Object.	No. obs.	Extreme diff'e.
α Andromedæ,	38	$0^s.24$	Polaris,	103	$0^s.24$
γ Pegasi,	40	24	Spica,	32	47
α Cassiopeiæ,	36	54	η Bootis,	31	28
θ^1 Ceti,	39	76	Arcturus,	47	35
α Lyræ,	32	70	ε Bootis,	39	22
δ Aquilæ,	36	49	α Cor. Borealis,	30	22
γ Aquilæ,	33	85	α Lyræ,	27	27
α Aquilæ,	33	54	γ Aquilæ,	37	28
ε Pegasi,	33	56	α Aquilæ,	47	38
ζ Pegasi,	38	67	β Aquilæ,	28	34
α Piscis Australis,	44	54	ζ Pegasi,	33	27
α Pegasi,	31	33	α Pegasi,	34	27

The average difference between the extreme observations at Washington is $0^s.54$; at Greenwich, $0^s.30$. We consider it highly creditable to the Washington observers, that in the first year of their experience, the results of their observations should accord nearly as well as those of the long practised observers of Greenwich.

We have instituted a similar comparison with regard to the observations with the Mural Circle. The following Table shows the difference between the greatest and least mean Declinations deduced from the twelve stars most frequently observed, excluding the reflected observations; and for comparison we have taken all the direct observations of the twelve stars most frequently observed at Greenwich in 1837, with the Troughton mural circle.

Washington.			Greenwich.		
Object.	No. obs	Extreme diff'e.	Object.	No obs.	Extreme diff'e.
Polaris,	135	4″·38	Polaris,	45	4″·11
α Persei,	16	3· 76	Sirius,	58	7· 79
α Ursæ Majoris,	20	6· 76	α Ursæ Majoris,	14	2· 32
β Ursæ Minoris,	16	4· 79	γ Ursæ Majoris,	21	4· 20
γ Draconis,	25	3· 37	ζ Ursæ Majoris,	20	4· 36
δ Ursæ Minoris,	17	5· 02	η Ursæ Majoris.	33	4· 40
α Lyræ,	48	6· 88	Arcturus,	15	3· 84
η Lyræ,	21	2· 58	β Ursæ Minoris,	18	3· 30
γ Aquilæ,	18	3· 11	η Draconis,	21	3· 75
61 Cygni,	19	4· 22	β Draconis,	14	4· 67
α Piscis Australis,	29	5· 50	α Lyræ,	13	3· 75
γ Cephei,	44	3· 99	φ Sagittarii,	14	3· 73

The mean of the differences at Washington is 4″·53; at Greenwich 4″·18; and the number of observations at Washington is the largest: from which we see that the Washington mural observations accord quite as well as those of Greenwich. We conclude, then, that the Astronomers at Washington are *good*, as well as *active* observers, and deserve the confidence of the public. We trust therefore that Congress will allow them a fair field for their activity; and we believe they will produce results highly creditable to our country, and important contributions to the science of Europe. We trust, moreover, they may be indulged in their favorite scheme, that of preparing an American Nautical Almanac. Is it not a disgrace that our national ships, to say nothing of our thousands of merchant vessels, should be indebted to a foreign country for a periodical without which not one of them would dare venture to sea? It is not true, as is sometimes thought, that the English almanac fully meets the American demand. A large amount of local science would find its appropriate place in an American Almanac, which could not be expected in a foreign one.

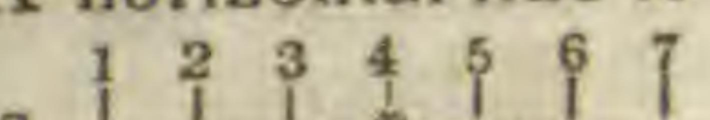
After the favorable opinion we have thus freely expressed respecting the Washington observations, perhaps we may be indulged in a few suggestions. We have remarked some deficiences which are excusable under the circumstances of the first volume, but which we hope may be remedied in future ones. We wish to see the observations of the sun, moon, and planets, fully reduced, and compared with the Nautical Almanac. The circumpolar stars α, δ, and λ, Ursæ Minoris, and 51 Cephei, are omitted in the catalogue, p. 272, and in the reductions, p. 246, although they were repeatedly observed. We do not understand the cause of this omission. We think there are too many interrogation points (?) in the table of mean declinations, p. 262, while most of the observations to which they are attached accord very well with the general mean.

It may seem almost puerile to descend to verbal criticism, but we confess we should be better pleased if there was a less parade of "nautical phrases." When we meet on almost every page such expressions as "fitting up an observatory from a girt-line—exactly amidships of the slab—like a close hatch on ship board—reckoning from the midship point—set to work right off the reel—level amidships of bearing bands—the bands to the mainmasts of a ship—midship points of the level guides—the instrument was landed on the V's—from the midships of one V to the midships of the other—the eye-piece was shipped—as taut as a bar"—we poor landsmen are obliged either blindly to guess at the meaning or betake ourselves to a vocabulary. It may be thought hard if a naval officer in a naval observatory cannot be allowed to speak his native dialect; but we would enquire whether this volume of Observations is addressed primarily to sailors. In conclusion we must again express the high satisfaction we have derived from an examination of this volume, and trust we may soon be favored with a copy of the observations for 1846.

3. *Memoria sopra i colori delle Stelle del Catalogo di Baily, osservati dal P. Beneditto Sestini della compagnia di Gesu.* Roma, 1845. 20 pp. 4to.

Stelle del Catalogo di Baily dal polo boreali fino a 30° *di Decl. Australe contrassegnate secondo i loro diversi colori osservati nella specola del Collegio Romano.* Fascicolo I. 12 maps folio.

We are here presented with a short Memoir on the colors of the stars of Baily's Catalogue, observed by P. B. Sestini at the Observatory of the Roman College, accompanied with maps, on which the observations are graphically represented. It is well known that different observers have given us materially different estimates of the color of many stars. It is important to know whether these differences arise from real changes of color; from atmospheric or instrumental causes; or from errors of observation. It is believed that some stars have undergone real changes of color within the period of history. Thus Sirius is now one of the whitest stars to be seen. But Horace denominates it 'rubra,' and Seneca calls it a deeper red than Mars itself; while Ptolemy confirms the same statement. β Geminorum is classed in the Almagest among the few stars of a red color, while at present it is decidedly white.

M. Sestini has therefore undertaken to make a careful estimate of the color of all of Baily's stars, expecting that we may hereafter be able to detect changes in some of them. From the well known purity of the Italian sky, and the excellence of the telescope employed, we have great confidence in Sestini's estimates. The colors are represented upon the charts in the following manner:—A horizontal line is drawn through the star, with seven vertical dashes, thus , three on each side of the star, and numbered from left to right. Number 1 denotes red, number 2 orange, 3 yellow, 4 green, 5 blue, 6 indigo, 7 violet. The white stars have no mark affixed to them. The Catalogue and Maps now published embrace all of Baily's stars for half the northern hemisphere, from the 12th to the 24th hour of R. A. We trust M. Sestini will be encouraged to complete the work he has begun, and will give us the colors of the remaining stars of Baily's Catalogue, and perhaps extend his plan so as to embrace a still wider range.

4. *Sixth Comet of* 1846, (Colla, in L'Institut, Nov. 11, 1846.)—A telescopic comet was discovered June 26, 1846, in *Scorpio*, near the star 595 Mayer, by the German astronomer, M. Peters, at the Royal Observatory at Naples. It was followed by him till July 23, during which period he secured observations on nine different evenings. It appears to have been observed nowhere else, except once at Rome. At the time of its discovery it was very faint, without sensible nucleus, and resembled nebula No. 19 of the 6th class of Herschel, from which it was about a degree distant. Its motion was northward and increasing in R. A., and its appearance always very dim. M. Peters computed the following parabolic elements.

Perihelion pass. 1846, May 30, 12^h 56^m 3^s m. t. Berl.

Long. of perihelion,	237° 20′ 23″·2	M. equin. Jan. 0.
" " asc. node,	258 44 47 ·6	M. equin. Jan. 0.
Inclination, . .	34 0 41 ·7	
Perihelion dist. .	1·6019	
Motion, ...	direct.	

M. D'Arrest of Berlin, also calculated two sets of parabolic elements. As neither of them well satisfied the observations, he computed the following elliptic elements, which agree better with the observations.

Epoch, 1846, July 21, 8^h Berlin.

M.	3° 6′ 47″·1	
L.	242 56 38 ·5	M. equin. 1846.
π	239 49 51 ·4	M. equin. 1846.
☊	260 12 25 ·1	M. equin. 1846.
i	31 2 14 ·4	
φ	49 10 34 ·3	
log. a	0·800762	
Sid. Revolution, . .	5804·3 days.	

5. *Hind's Comet*, (Colla, in L'Institut, Nov. 11, 1846.)—The telescopic comet discovered by Mr. J. R. Hind at London, July 29, 1846, (see ii Ser., vol. ii, p. 439,) had been detected two hours previous, by De Vico at the Observatory of Rome. It was observed during about a month. Various sets of the parabolic elements of its orbit have been published, differing widely from each other, and from the provisional elements furnished by Mr. Hind.

The elements by Funk, Powalsky, and Oudemans, agree tolerably well. The following is the set computed by Oudemans.

Perih. pass. July 28·502 m. t. Berlin.

Long. of perihelion, ...	2° 33′
" " asc. node, ...	147 10
Inclination, ...	64 42
Log. Perih. dist.	1·04621
Motion, ...	retrograde.

6. *Le Verrier.*—Honors have been falling thick about Le Verrier since his splendid discovery. He has been made an officer of the Le-

gion of Honor by the King of France; and besides, a chair has been established for him at the Faculty of Science at Paris, entitled Mathematical Astronomy or Celestial Mechanism. A bust of him has also been ordered by royal authority for the College of Saint-Lô, and M. Pradier is appointed to execute it. From the King of Denmark, he has received the title of Commander of the Royal Order of the Danebrog, and the Royal Society of London has conferred on him the Copley medal.

7. M. GALLÉ.—The cross of the Red Eagle has been conferred, by the King of Prussia, on the discoverer of Le Verrier's planet.

V. MISCELLANEOUS INTELLIGENCE.

1. *Effects of the Earth's Rotation upon Falling Bodies and upon the Atmosphere;* by W. C. REDFIELD, (communicated for this Journal.) —From the remarks which were made *On the Deviation of Falling Bodies from the Perpendicular*, before the British Association at Southhampton, by Professor Oersted and others, as noticed in the miscellanies of this Journal for January, p. 139, it appears that while the deviation towards the east is explained by the fact that the velocity of the earth's rotation is proportioned to the distance from the axis, the alleged deviation towards the *south*, in northern latitudes, is unaccounted for.

I apprehend that this latter deviation is due to the same cause as the former. While gravitation is found to be perpendicular to the surface, the direction of the rotary (or centrifugal force) is always in a plane, which is parallel to the plane of the equator, whatever the latitude. Hence this force acts obliquely to the perpendicular course of a falling body, from the beginning of its descent, and tends in northern latitudes, to lift the body southward, during its fall. Or to explain:—the latitude of any body situated above the surface of the earth is the same with that point on the surface, which is intersected by a line from the earth's center to the body. If then, the body have its distance from the surface increased in a plane parallel with the equatorial plane, it must diminish its latitude; for a line drawn between it and the earth's center, will intersect the surface nearer and nearer the equator, as the body recedes. Now the tendency of centrifugal force is to carry a body away from the surface tangentially, in the manner above stated, and consequently, besides producing an easterly motion in the falling body, it must also produce a southerly motion.

Again: if to a falling body, in the northern latitudes, there be superadded a force which is *centripetal in the plane of rotation*, this force, being perpendicular not to the surface but to the axis, must necessarily produce a deviation to the *northward*. I see not how this can be questioned: and, if true, it must equally follow that the *centrifugal* force which pertained to the body at the beginning of its descent, tending as it does *from* the axis, must produce a southwardly deviation.

Thus the resultant effect of the rotary force at the point where the body begins to fall, is such as will produce a *southeastwardly* deviation from the perpendicular during its descent, in northern latitudes.—It is hardly necessary to add, that a northeastwardly deviation from the perpendicular belongs to falling bodies in the southern hemisphere.

The increase of the rotary velocity and centrifugal force in proportion to the distance from the axis, I have been accustomed to consider as one of the causes which may serve to account for the non-appearance, and, as I think, the non-existence of those great ascending currents which have been ascribed to the equatorial regions of the atmosphere as well as of their alledged overflow towards the poles in the upper regions: for the increased centrifugal force, above that in the lower regions, not only opposes a flow towards the poles, but, in each successive plane of rotation in proceeding from the equator, becomes proportionally greater than the perpendicular elevation from the surface, in a ratio which increases with the increase of latitude.

Thus the immediate influence of the earth's rotation may be such as favors the production of currents in the higher regions of the atmosphere, moving from points between west and north in northern latitudes, and from between west and south in the southern hemisphere.

The law of increased density from the diminution of temperature, seems, likewise, to favor a greater oblateness of figure in the exterior portions of the earth's atmosphere than would otherwise be due to its relative conditions at different altitudes: as may be inferred from the contrary effect that is shown in the diminished oblateness of the earth which results from the increased density towards its center, as has been proved by Clairaut.*

According to these views, the greater expansion of the lower atmosphere which results from the increased temperature of the intertropical latitudes, may have little influence in determining the actual courses of circulation. It is not intended, however, to place undue reliance on these views, in estimating the dynamics of the atmosphere. It seems evident that there are other conditions which serve to counteract or prevent any general winds, as based solely or mainly on an alleged ascent of aërial currents in the equatorial region, from the lesser specific gravity of the lower atmosphere in the warm latitudes.

In a highly respectable work, the origin of the polar currents of the ocean has been referred, in a great measure, to the centrifugal force which is the result of the earth's rotation.† Now, if this view be so enlarged as to include *all* the physical influences and conditions (other than geographical variations of temperature) that must necessarily pertain to the diurnal rotation and orbital progression of the planet, I cannot see that the calorific theory of Halley is necessary for explaining the principal movements which are observed in our atmosphere.

New York, Jan 7, 1847.

2. *Smithsonian Institution.*—The Regents of the Smithsonian Institution held a session in Washington in the month of January, for the purpose of discussing plans for its organization, which should best promote the designs of the testator, "*for the increase and diffusion of knowledge among men.*" This clause in the will of Smithson, clearly indicates two entirely distinct objects, requiring two separate, but harmonious and confluent plans of conduct, for the full development of the greatest good of which the Institution is capable.

---

* Théorie de la Figure de la Terre; Paris, 1808.

† Library of Useful Knowledge, Art. *Physical Geography,* p. 28.

We understand that the Regents have decided to divide the available income of the fund, equally between the two recognized modes for increasing and diffusing knowledge, viz., by stimulating research, and by collections. The salary of the Secretary as head of the Institution, is to be equally assessed on the two divisions.

Under the first head it is designed to publish Transactions, to be called Smithsonian Contributions to Knowledge, in which shall appear those papers only, which are a positive addition to the great sum of human knowledge in whatever department. Original and important researches, whether undertaken on the suggestion and at the expense of the Institution, or the result of individual authorship,—elaborate memoirs, the costliness of whose publication would be a bar to their appearance at the charge of the author, or of scientific societies already organized, will find their place in these Transactions. Lines of research, suggested either by competent persons in the several departments of knowledge, or pointed out by the officers of the Institution, will be confided to able hands who may be encouraged by suitable grants of money to produce results in the branches committed to their care for publication. Premiums for investigations will be awarded, and the results published. In this way it is confidently believed, that the Institution will become a most important auxiliary to the science, literature, and arts of the country, and will accomplish in the most effectual manner the first object of its liberal founder.

Public lectures on various literary and scientific topics, by able men employed from time to time for the purpose, will be an important and popular means for the diffusion of knowledge; and the subsequent publication of such lectures at the discretion of the Regents, will extend the privileges of the Institution to those not resident at Washington. It is also proposed, we understand, to publish at stated intervals, condensed and well digested reports on the progress of the various departments of knowledge, somewhat after the manner of the annual reports of the Swedish Academy, but not confined to subjects of merely scientific interest. The best aid at the command of the Institution will be procured to elaborate these reports, as well as in the preparation of tracts or essays designed for wide distribution, on the plan of the publications of the London Society for the diffusion of useful knowledge. These will be sold at the minimum cost of production, so as to be accessible to all, while the usefulness of the Institution will be greatly extended by the extensive sale of its publications, which will thus return the cost of their production, to be again employed in similar channels. It is proposed to make arrangements with the Academy of Design, the Artists Fund Society, and similar institutions, for the exhibition of works of American art.

The second great department embraces objects of various interest and much importance. The custody and increase of all collections, in arts, science and literature, including books, cabinets of natural history, instruments, objects of art, antiquity and curious research, will all properly fall under this head.

An economical disbursement of the income, will thus enable the Regents to accomplish much more with a limited sum than might at first appear possible. Mr. Jewett, late Librarian of Brown University, Providence, R. I., has been appointed the Librarian of the Institution.

The Secretary of the Institution, (Prof. Joseph Henry,) has been directed to continue his researches and to report his results; to prepare a number of the Contributions for publication, and after communication with eminent scientific and literary men, to fix upon methods for executing the other plans "for the increase and diffusion of knowledge among men."

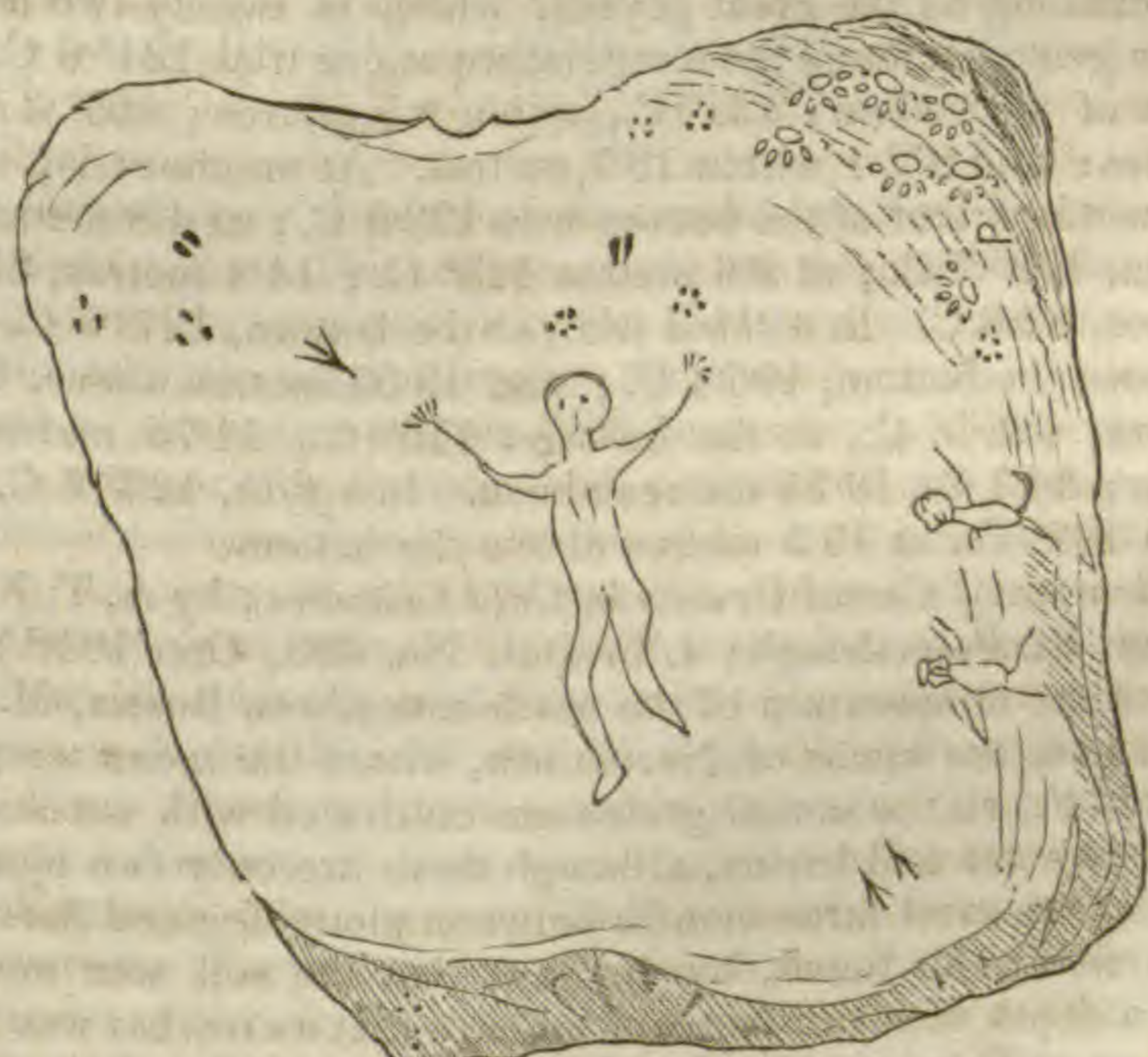
The organization also embraces the plan of setting apart certain evenings, for the purpose of enabling artists and inventors to exhibit and explain their instruments or works of art in the halls of the Institution, as in the Polytechnic Institution in London, to such as may attend the soirées.

The plans of Mr. James Renwick, Jr., of New York, for the building, were adopted with modifications, and it was agreed that the building should be erected gradually, out of the accruing income of the fund and funded interest. The plans are in the Roman style, and consist of a centre building and wings, the latter of which it is proposed to erect first as containing accommodations for a laboratory, lecture-room, temporary library, and gallery of art. Thus during the progress of construction, a part of the accommodations required can be furnished, and it is believed that with due economy, a suitable fire-proof building may be erected in the course of six or seven years, while the Institution is simultaneously yielding fruit of permanent value. A salutary dread of the fate of certain other public institutions, should deter the Regents from a lavish expenditure of their sacred funds in ornamental architecture. The Regents of this Institution are in fact the trustees and executors of the will of Mr. Smithson, and are bound by every obligation faithfully to discharge their trust, "the increase and diffusion of knowledge among men"—and not to paralyze their future usefulness by locking up their available means in an attempt at display, which at most can poorly compete with the stately structures of the national government. The General Post Office at Washington cost over half a million of dollars, the Patent Office $750,000, and the Treasury Department still more. Making every allowance for bad economy in the erection of these buildings, is it not quite impossible for the Smithsonian Institution, with its comparatively limited funds, to go a step beyond the bounds of absolute necessity? It is to be hoped, that under the design of erecting a monument to the memory of Smithson, they may not place a cenotaph over the buried usefulness of their sacred trust. This monument is to be built in the hearts of the people, and at every fireside in the land, and not in this land only, but everywhere; for the trust is given not for the benefit of the whole American people only, but for "mankind." The wise councils of those who have so far succeeded in harmonizing conflicting views, as to accomplish what we have already sketched, will have the hearty approval and coöperation of all those who desire the permanent prosperity of the Institution.

3. *Footprints and Indian Sculpture*, (communicated by Rev. E. H. Davis, of Chillicothe.)—During a late excursion along the Ohio valley for the purpose of examining some mural remains, our attention was directed by several persons to two sculptured rocks upon Guiandotte river, as something very remarkable. Taking nothing for granted received by hearsay, we determined to visit them; so we proceeded up the river about eighteen miles from its mouth, where we found the two rocks in question just below the falls.

While Mr. Squier was sketching these, I commenced a search among the other rocks in the neighborhood in quest of more hieroglyphics; some hundreds of these blocks of all sizes were strewed along the plain, having tumbled down from an unstratified layer of coarse sandstone, which occurs forty feet thick in the hill above. My efforts were crowned by the discovery of three others, mostly covered by a slip from the hill; sketches of these have also been taken. They resemble in every respect many other sculptured rocks found all over the Western States, wherever sandstone or even limestone exists suitable to be wrought by rude instruments. Some of the characters are like those upon the Dighton, Tiverton, and Portsmouth rocks, about which so much interest has been felt in the North of Europe. They are generally outline figures of full size, cut into the rock from one half to one inch in depth and the same in breadth. They consist of the human form, quadrupeds, birds, reptiles, dots and lines, with the tracks or footprints of animals and birds.

It is to these footprints that I wish to direct your attention in particular, as possessing some interest for the geologist, as well as the antiquarian. In many instances they are so well executed, and life-like, as to deceive the most experienced geologist; for example, the human footprints in the limestone near St. Louis, first figured and described by Mr. Schoolcraft,* which remained for many years a geological wonder, but were at last satisfactorily explained by Dr. Owen.† The Derry sandstone in Westmoreland County, Penn., with the supposed fossil footprints of birds and quadrupeds, described by Dr. King,‡ are of the same class of artificial tracks, and were correctly so considered by Mr. Lyell who examined them personally.§



The figure here given is a sketch of one of the Guiandotte rocks, covered as you will perceive with a variety of these sculptured tracks,

* Am. Jour. of Sci., vol. v, p. 223.
† The same, vol. xliii, p. 14.
‡ The same, vol. xlix, p. 216.
§ Second Series, vol. ii, p. 25.

as additional confirmation (if any should be needed) of the views of Dr. Owen and Mr. Lyell; to which I will add but one or two observations in conclusion.

1st. In nearly every instance where these footprints are found, they are in connection with well known Indian sculptured figures.

2d. They occur at all angles with the plane of strata, on the sides and ends of blocks as well as the top.

3d. Iron seams, as hard as steel, frequently occur in this sandstone; and wherever a footprint is found over one of them it is excavated on either side, leaving the seam as too hard for the instrument. As yet I have never met with any footprints in the Western States, that have not proved, upon a critical examination, to be sculptured by Indians.

4. *Hecla.*—From letters by M. Descloiseaux, (Comptes Rendus, Oct. 26, and Nov. 16, 1846.)—Mount Hecla is a very regular cone, with slopes of twenty-five to thirty degrees, covered with scoria and fragments. The height was determined by two observations at 1386·3, and 1396·8 metres, which is more than 160 metres less than former trigonometrical measurements. The great current of 1845 flowed to the west-south-west; the whole length is sixteen kilometers, (near ten miles,*) and the greatest breadth two kilometers. It is found covering declivities of all angles, from 0° to 25°, and every where the surface consists of blocks, often of large size, accumulated with some regularity, and forming a broad band having the lateral slopes thirty-five to forty degrees. Over the surface there are numerous fumeroles, about which no salts were observed excepting sal-ammoniac.

M. Descloiseaux has collected confervæ from the geysers, where the waters were at a temperature of 98° C. (= 208° F.)

Experimenting on the great geyser, which is twenty-two metres in depth, this geologist found the temperature at one trial 121°·6 C., within six metres of the bottom; 121° C., within 9·5 metres; 109°·3? within 16·3 metres; and 95°? within 19·7 metres. At another trial, the temperature within a foot of the bottom was 123·6 C.; at 4·8 metres above the bottom, 122°·7 C.; at 9·6 metres 113° C.; 14·4 metres, 83°·8 C.; 19·2 metres, 83·6 C. In a *third* trial, at the bottom, 127°·5 C.; 14·75 metres above the bottom, 106·4 C.; and 19·55 metres above, 85°·2 C. In a *fourth*, 126·5° C., at the bottom; 110° C., 14·75 metres above the bottom; 84·7 C., 19·55 metres above. In a *fifth*, 122°·5 C., at bottom; and 103° C., at 13·5 metres above the bottom.

5. *Cultivation of Cereal Grains in Cold Climates*; by A. T. Kupffer, (Acad. Sci. St. Petersburgh; L'Institut, No. 668, Oct. 1846.)—After speaking of the temperature of the earth in northern Russia, M. Kupffer states that near the mines of Nertchinsk, where the mean temperature is about 26° F., all the cereal grains are cultivated with success, especially summer rye and barley, although there are only two months and a half, or at the most three months between ploughing and harvest. In the same fields, he found, by digging, that the soil was completely frozen at a depth of seven feet, and so hard that a crowbar was required to turn it up. This was on a hot day near the middle of the month of August. M. Kupffer remarks, that as there is an increase of temperature in the earth downward, and also an external source of heat in the

* A kilometre is 3281 feet, or nearly *five-eighths* of an English mile.

sun, the depth at which ice occurs and the thickness of the bed of frozen earth, will vary with the season of the year. The summer heat is prevented from melting to much depth by the slow conduction of the earth and the amount of latent heat taken up by the process. In the mines of Trekhsvetitelski, situated 470 feet (Paris) above the magnetic Observatory of Nertchinsk, 2,470 feet above the sea, and where the mean temperature just above the soil should therefore differ about 1·5° F. from that of Nertchinsk, it was found that to 175 feet (the depth penetrated) there was not a drop of water; all was frozen. In the mines of Vosdvigensk, not far from Nertchinsk, and about 2,708 feet above the sea, flowing water occurs at a depth of 300 feet, having a temperature of 35°·8 F. To a depth of forty or fifty feet, the sides of the shafts were perfectly dry, and at this depth the mean temperature of 32° F., appears to be situated. This last point was not fully verified; but if true, it gives an increase of 3·8 F. in a depth of 250 feet, which accords very nearly with observations elsewhere.

In connection with this subject, the following table is given showing the increase of mean temperature, as we pass from the coast towards the interior of Russia, between the parallels of 50° and 60°.

	Latitude.	Longitude E. from Paris.	Height in English feet.	Mean temp.	Dif. mean temp. of summer & wint'r.
St. Petersburg, .	59°·57′	27°·59′	0	37·8F.	65·8F.
Moscow, . . .	55·45	35·17	400	38·5	71·6
Kasan, ...	55·48	48·48	150	35·0	75·9
Catherinenberg, .	56·50	58·14	820	33·1	76·8
Bogoslowsk, . .	59·45	57·39	600	30·9	79·2
Tomsk, ...	56·30	82·50	300	31·5	81·5
Barnaoul, . . .	53·20	81·07	400	31·5	82·9
Irkoutsk, . . .	52·17	101·15	1300	31·5	79·9
Nertchinsk, . .	51·18	117·01	2000	26·2	94·3
Iakoutsk, . . .	62·01	127·24		17·2	110·7

6. *On Comparative Analytical Researches on Sea Water;* by Prof. FORCHHAMMER, (Proc. Brit. Assoc., from the Athen., Sep. 26.)—In the ocean between Europe and America the greatest quantity of saline matter is found in the tropical region, far from any land; in such places 1,000 parts of sea water contain 36·6 parts of salt. This quantity diminishes in approaching the coast, on account of the masses of fresh water which the rivers throw into the sea: it diminishes, likewise, in the westernmost part of the Gulf stream, where I only found it to be 35·9 in 1,000 parts of water. By the evaporation of the water of this warm current, its quantity of saline matter increases towards the east, and reaches, in N. lat. 39° 39′ and W. long. 55° 16′, its former height of 36·5. From thence it decreases slowly towards the northeast: and sea water, at a distance of from sixty to eighty miles from the western shores of England, contains only 35·7 parts of solid substances; and the same quantity of salt is found all over the northeastern part of the Atlantic, as far to the north as Iceland, always at such a distance from the land that the influence of fresh water is avoided. From numerous observations made on the shores of Iceland and the Faroe Islands, it is evident that the waters of the Gulf stream spread over this part of the Atlantic Ocean; and thus we see that the water of tropical currents

will keep its character even in high northern latitudes. In the longitude of Greenland, and more than one hundred miles to the south of the southernmost point of that large tract of land, sea water contains only 35·0 in 1,000 parts. In going from this point towards the northwest, it decreases constantly; and in Dover Straits, at a distance of about forty miles from the land, it only contains 32·5 parts of salt in 1,000 parts of sea water. This character seems to remain in the current which runs parallel to the shores of North America; and at N. lat. $43\frac{1}{2}°$, and W. long. $46\frac{1}{3}°$, the sea water contained only 33·8 parts of salt. Thus tropical and polar currents' seem not only to be different in respect to their temperature, but also in the quantity of salt which they contain; and thence it follows, again, that while the quantity of water carried away from the *tropical sea* by evaporation is greater than that which rain and the rivers give back to the sea, the reverse takes place in the *polar seas*, where evaporation is very small and the condensation of vapor very great. The circulation must on that account be such, that a part of the vapor which rises in tropical zones will be condensed in polar regions, and, in the form of polar currents, flow back again to warmer climates. Although my analyses are only made on water from the ocean between Europe and America, yet little doubt can be entertained that also that part of the ocean which separates America from Asia is in a similar condition; and that currents flowing from the poles are the rule, and currents flowing towards the poles the exception. Besides the southerly direction, which any current flowing from the northern polar regions must take, it will, according to well known physical laws depending upon the rotation of the earth, always take a direction towards the west, and thus be driven towards the eastern shores of the continents; while any tropical current flowing towards the north will, according to the same laws of rotation, take a direction towards the western shores of the continents. This is at present the case in the Atlantic Ocean; and its effects upon the shores of Europe, which are surrounded by warm water from a branch of the tropical current, produce a mild and moist climate. The water of the different seas is much more uniform in its composition than is generally believed. In that respect my analyses agree with the newer analyses of atmospheric air in showing that the differences are very slight indeed. Sea water may contain more or less salt,—from a very small quantity, as in the interior part of the Baltic, to an amount of 37·1 parts in 1,000 parts, which I found in water from Malta, and which is the greatest quantity I ever observed; but the relative proportion of its constituent saline parts changes very little. In order to get rid of those differences which might arise from the different quantity of saline matter in sea water, I have compared sulphuric acid and lime with chlorine, and the following results are the mean of many analyses:—In the Atlantic, the proportion between *chlorine* and *sulphuric acid* is 10,000 to 1,188; this is the mean of twenty analyses, which differ very little from each other. In the sea between the Faroe Islands, Iceland, and Greenland, the same proportion, according to the mean of seventeen analyses, is 10,000 to 1,193. In the German Ocean, according to ten analyses, it is 10,000 to 1,191. In Davis's Straits, according to the mean of five analyses, it is 10,000 to 1,220. In the Kattegat, according to the mean of four analyses, 10,000 to 1,240.—Thus it appears that the proportion of sulphuric acid increases near the shores: a fact which evidently depends upon the rivers carrying sulphate of lime into the sea. The proportion between *chlorine* and *lime* in the Atlantic Ocean, according to the mean result of seventeen analyses, is 10,000 to 297; and in the sea between Faroe and Greenland, according to the mean of eighteen analyses, 10,000 to 300. Lime is rather rare in the sea around the West Indian Islands, where millions of coral animals constantly absorb it, the proportion, according to five analyses, being 10,000 to 247; and it is rather copious in the Kattegat, where the numerous rivers of the Baltic carry a great quantity of it into the ocean. The proportion there is 10,000 to 371, according to four analyses.

7. *On the Iron Manufacture of Great Britain;* by Mr. G. R. PORTER, (Proc. Brit. Assoc., from Athen., Sept. 26.)—Having called attention to the enormous demand for iron consequent on the general and simultaneous construction of railways in England, on the Continent, and in India, Mr. Porter said it was important to consider how that demand may be met, and also how, on the cessation of that demand, which must be temporary to a great extent, the ruinous depreciation of capital and suspension of employment, consequent on the change, may be averted. In 1788, the whole quantity of pig iron made in England and Wales, amounted to no more than 61,300 tons; of which 48,200 were made with coke of pit-coal, and 13,100 from charcoal: in the same year the amount raised in Scotland was 7,000 tons. In 1796, the quantity, owing to Watt's improvement of the steam engine, was nearly double, being—

England and Wales, . . .	108,993 tons.
Scotland, ...	16,086 "
Total	125,079 "

Ten years later, viz. in 1806, when it was proposed to tax the production of iron, an inquiry was made, and the production was found to have more than doubled in this decennial period, being—

England and Wales . . .	234,966 tons.
Scotland	23,240 "
Total	258,206 "

In 1823, this quantity had risen to 482,066 tons, and in 1830 it was further increased to 678,417 tons. But since 1830, in consequence of the introduction of the hot blast by Mr. Nelson, of Glasgow, rapid improvements have been made, and a most important saving of fuel effected. The results were thus stated:—In 1829, using coke and cold air, each ton of iron required for its production 8 tons, 1 cwt. 1 quarter of coal. In 1830, using coke and heated air, each ton of iron was made with 5 tons, 3 cwt. 1 quarter of coal. In 1833, using raw coal and heated air, each ton of iron consumed in its production, 2 tons, 5 cwt. 1 quarter of coal. The saving in fuel is thus seen to amount to 72 per cent.; and in Scotland the production of iron has risen from 37,500 tons in 1830 to nearly 500,000 tons in the last twelve months. There exists a prejudice against the hot blast iron which is gradually abating; and a similar prejudice long preventing the use of the black band ore, the value of which was discovered by Mr. Mushett so far back as 1801. In 1836, every iron-work in Great Britain was visited by M. F. le Play, chief engineer to the Paris Board of Works, and he estimated the amount produced that year at 1,000,000 of tons. In 1840, Mr. Jessop found that there were 402 furnaces in England and Wales, in which 82, or 1 in 5, were out of blast; and out of 70 furnaces 6, or 1 in 11, were out of blast. The quantity of iron made in 1840, was 1,343,400 tons; but in consequence of the commercial depression, this fell to 1,046,428 tons in 1842, being a depreciation of 22 per cent. He next directed attention to the effect of railways on the price of iron. In 1836 and 1837, Parliament passed 77 railway bills, of which 44 were for new lines, and the aggregate of extent about 1,200 miles, requiring a production of more than 500,000 tons of iron. The price of bar iron which had been 6*l.* 10*s.* per ton in 1834, rose to 7*l.* 10*s.* in 1835, and in 1836 to 11*l.*; but in 1837, the railway speculation had so far subsided, that only 15 acts for new lines were passed from 1838 to 1843,—the price of iron fell more rapidly than it had risen, and during this period, iron could be sold with difficulty at less than half the price it commanded in 1836. The average price of iron at Glasgow in 1844, was 2*l.* 5*s.* 6*d.* per ton; in March 1845, it rose to 5*l.*; and in May to 5*l.* 10*s.*;—this rise in price of 175 per cent., gave such stimulus to production, that the make of pig-iron, in Scotland, for the first six months of this year, was 260,000 tons, or at the rate of 520,000 tons per annum;—the production having been doubled since 1840. It is the opinion of the iron-masters that since 1840, nearly all the increased production of iron in the kingdom has been drawn from Scotland. It appears that the demand created by the new railways, has stimulated every establishment to its utmost limits of production. But in order to add materially to the make of iron, a great many circumstances must concur. One of the chief difficulties arises from the workmen: skill is necessary, and the number of those properly trained is so limited, that they make demands for an enormous and disproportionate increase of wages on the first appearance of prosperity. Thus the cost of production seems to have more than kept pace with the rise of price. From this, combined, perhaps, with other causes, the amount of production in England for 1845 was only 917,500 tons, being 238,000 tons less than the production of 1840. From comparing several returns, it is clear that we have no reason to dread a failure of material,—some valuable and extensive fields of black-band ore having been recently discovered in Wales; but it seems not improbable that the Staffordshire iron-works will soon experience a deficient supply of coal. A new source of supply has been found in the refuse and waste of the lead mines of Weardale. The *rider* of the lead ore is a true carbonate of iron, yielding from 25 to 40 per cent. A small blast furnace has been erected, at Stanhope, for smelting this *rider*, and pig-iron of a strong and excellent quality has been produced. In consequence of this success, the company has commenced the erection of very extensive smelting works, near Walsingham. The difficulty then arises in the supply of labor. It is hopeless to stimulate the exertions of the persons already employed. They are naturally ready enough to exact higher rates of wages when the demand for their labor becomes more urgent;

but, succeeding in this, they prefer to obtain the same amount of earnings, with higher rates of wages, to the securing of greater gains by the exertion of even the same amount of toil;—so that a greater urgency on the demand, may be, and frequently is, accompanied by a lessened production. During the period of depression the low price of iron led to its being extensively applied to various purposes of construction in civil and naval architecture. On the subject of iron ships, Mr. Porter entered into some calculations to show their economy;—but the subject will be found more fully discussed in our report of the Paper read by Mr. Fairbairn before the Meeting of the British Association in Glasgow, in 1840. Up to the beginning of the present century, nearly two-fifths of all the iron used in this kingdom was imported from the north of Europe; but in 1806 this proportion had fallen to one-eighth, and foreign iron is now only imported for the manufacture of steel. Our exports, on the contrary, have so increased as to become an object of national importance.—

In 1827 we exported 92,313 tons, declared value, . . £1,215,561.
In 1845 " 351,278 " " " . . . 3,501,895.

The increase of our exports appears to be contingent on a reduction of price, and must, therefore, be materially affected by variations in the cost of production. Should the new railways stimulate a much larger production of iron, the quantity produced will greatly exceed the demand so soon as those railways are completed, and then prices will fall, perhaps to a lower point than has ever yet been witnessed. This will, probably, cause iron to be applied to many new purposes, and particularly to the construction of ships, fire-proof houses, and frame-work houses for exports to new settlements. All this, however, must be the work of time; and it seems but too probable that, in the meanwhile, our iron-masters will have to undergo a somewhat lengthened season of adversity,—for the enduring of which they are, in a measure, prepared, from former experience.

8. *On Plate Glass making in England in* 1846, *contrasted with what it was in* 1827; by Mr. H. Howard, (Proc. Brit. Assoc., from Athen., Sept. 19, No. 986.)—The writer furnished carefully all the materials for establishing this comparison. Amongst other results he stated, that in 1827 plate glass was sold for about 12*s.* average per foot, to the extent of about 5,000 feet per week; in 1835, for from 8*s.* to 9*s.* per foot, to the extent of about 7,000 feet; in 1844, for from 6*s.* to 7*s.* per foot reaching about 23,000 feet; and in 1846, for from 5*s.* to 6*s.*,—about 40.000 feet per week. The sale is now about 45,000 feet weekly. He mentioned that, in 1829, a plate glass manufactory ceased operations because of the small profits realized when selling at 12*s.*; while in 1846, a company with a paid-up capital of 130,000*l.*, realized a net profit of 30,000*l.*, selling at from 5*s.* to 6*s.* Looking at this extraordinary increase, in spite of the severity of excise restrictions, the author asks, what would be the probable demand if the price were reduced to 4*s.* or 3*s.* 6*d.* per foot—which, free as the trade now is from excise interference, would yield an ample profit?

9. *A Review of the Mines and Mining Industry of Belgium;* by R. Valpy, Esq. of the Board of Trade, (Proc. Brit. Assoc., from the Athen., Sept. 19, No. 986.)—Mr. Valpy stated that, as a coal-producing

country, Belgium ranked the second in Europe. The ratio of the coal district to the total area is

	Acres.		Tons annually.
Great Britain $\frac{1}{20}$, or	2,930,000	producing	34,000,000
Belgium $\frac{1}{22}$, or	335,000	"	4,500,000
France $\frac{1}{210}$, or	630,000	"	3,783,000
Germanic Union	. . .	. .	3,000,000

In 1838 the total number of coal-mines in Belgium was 307, with 470 pits in work and 172 in process of construction, employing 37,171 persons; being an increase of 8,454, or 28 per cent. on the number employed in 1829. The increase of the quantity of coal raised was not accurately ascertained, but it appeared to be about 37 per cent. The average cost of production is 10*s.* 8*d.* per ton, and the average price 23*s.* 1*d.* for first quality, and 16*s.* 6½*d.* for the second quality of coal; the average rate of wages is 1*s.* 6$\frac{3}{10}$*d.* per day. The establishments for preparing other mineral productions for market in 1838 were, for iron 221, copper 8, zinc 7, lead 2; the total number of furnaces was 139, of which 47 used coke and 92 charcoal. The total number of accidents from 1821 to 1840 was 1,352, which occasioned severe injury to 882, and deaths to 1,710, making a total of 2,592 sufferers.

10. *On the Fairy-rings of Pastures;* by Prof. J. T. Way, (Proc. Brit. Assoc., Sept., 1846, from the Athenæum, Sept. 19.)—A description of these patches, with which most persons are familiar, was given by Mr. Way; and it was stated that the grass of which such rings are formed, is always the first to vegetate in the spring, and keeps the lead of the ordinary grass of the pastures till the period of cutting. If the grass of these fairy-rings be examined in the spring and early summer, it will be found to conceal a number of agarics, or "toad stools," of various sizes. They are found situated either entirely on the outside of the ring, or on the outer border of the grass which composes it. De Candolle's theory, that these rings increased by the excretions of these Fungi being favorable for the growth of grass, but injurious to their own subsequent development on the same spot;—was remarked on, and shown to be insufficient to explain the phenomena. A chemical examination of some Fungi (the true St. George's Agaric of Clusius—*Agaricus graveolens*) which grew in the fairy-rings on the pasture around the College at Cirencester, was made. They contained 87·46 per cent. of water, and 12·54 per cent. of dry matter. The ashes of these were found to contain: silica, 1·09; lime, 1·35; magnesia, 2·20; peroxyd of iron, trace; sulphuric acid, 1·93; carbonic acid, 3·80; phosphoric acid, 29·49; potash, 55·10; soda, 3·32; chlorid of sodium, 0·41.

The abundance of phosphoric acid and potash, existing, no doubt, as the tribasic phosphate of potash (3KO, PO_5), which is found in these ashes, is most remarkable. The author's view of the formation of these rings, is as follows:—A fungus is developed on a single spot of ground—sheds its seed, and dies;—on the spot where it grew it leaves a valuable manuring of phosphoric acid and alkalies—some magnesia and a little sulphate of lime. Another fungus might undoubtedly grow on the same spot again; but upon the death of the first, the ground becomes occupied by a vigorous crop of grass rising like a phœnix on the ashes of its predecessor. It would thus appear that the increase of these fairy-rings is due to the large quantity of phosphated alkali, magnesia, &c., secreted by these fungi; and, whilst they are extending themselves in search of the additional food which they require, they leave, on decaying, a most abundant crop of nutriment for the grass.

11. *Gun-Cotton.*—The results of the deflagration of gun-cotton have been determined as follows by Messrs. Porrett and Teschemacher, as stated by them in a paper read before the Chemical Society, on Dec. 6, (Pharm. Times, Dec. 19, 1846.)

52·53 grains of gun-cotton gave 100 cubic inches of gas, constituted as follows:

	Relative volumes.	Cubic inches.	Grains.
Carbonic acid,	2	14·286	7·157
Cyanogen,	1	7·143	3·965
Nitric oxyd,	5	35·715	11·478
Carbonic oxyd,	5	35·715	10·714
Nitrogen,	1	7·143=100	2·184=35·070

One hundred grains of the gun-cotton would consequently afford 64·550 grains of the mixed gases. The other ingredients obtained from the same quantity were, water 20 grains, carbon 5, and oxalic acid 8·125.

Since the printing of the account of gun-cotton on page 259, we have received a notice of the session of the Academy of Sciences of Paris for January 4, (L'Institut, No. 679,) containing the later investigations of M. Pelouze. His analyses have been numerous, and constant in their results. They give for *nitric cellulose* (or *Xyloidine*) the formula $C^{24}H^{17}O^{17}, 5NO^5$; and for *Pyroxyline* $C^{24}H^{20}O^{20}, 5NO^5, 5HO = C^{24}H^{17}O^{17}, 5NO^5, 8HO = C^{25}H^{21}O^{50}N^5$. As pyroxyline is shown by M. Richier to be entirely soluble in the acetic ethers of alcohol and spirits of wood, he was enabled to obtain it in powder, and in a state of purity proper for analysis. In the course of his investigations he analyzed *cellulose* and obtained Payen's result, $C^{12}H^{10}O^{10}$, or doubled (as Pelouze considers it) $C^{24}H^{20}O^{20}$. The composition obtained would imply that 100 parts of pure and dry cotton ought to give 174·9 parts of pyroxyline; and Pelouze found that it afforded 174 to 176 parts. He remarks that the gun-cotton dried at a temperature between 40° and 55° C. undergoes no sensible alteration. But towards 100° C. it gives out a very decided nitric odor and decomposes slowly. Between 100° C. and 110° C. it will lose in an hour a tenth by weight; at the same time it becomes yellowish and very friable, and often suddenly inflames. The combustion for analysis was made in the ordinary manner with oxyd of copper, and without the aid of any other substance besides metallic copper, which is necessary to destroy the nitrous compounds always produced in the elementary analysis of nitrogenous substances.

Pelouze states that the results of the detonation of pyroxyline may be represented as follows:—

46 volumes of carbonic oxyd,	.	$= C^{23}O^{23}$
2 volumes of carbonic acid,	.	$= CO^2$
10 volumes of nitrogen,	. .	$= 5N$
34 volumes of vapor of water,	.	$= 17HO$

besides the 8HO in the combination. These numbers, he adds, may be varied by many circumstances, of which pressure and temperature are most prominent.

J. Mickle, Esq., of Camden, N. Y., has applied gun-cotton to the movement of machinery, and it is said with apparent success. The gun-cotton is ignited by electricity.

12. *Lines of Electric Telegraph in the United States and Canada.*—

From	New York to Albany, via the towns on the eastern side of the Hudson,	150 miles.
"	Troy and Albany to Buffalo, . .	350 "
"	Buffalo to Toronto, ...	110 "
"	New York to Philadelphia, . . .	88 "
"	Philadelphia to Baltimore, . . .	115 "
"	Baltimore to Washington, . . .	40 "
"	Philadelphia to Pittsburg, . . .	317 "
"	New York to Boston, via New Haven, Hartford, Springfield and Worcester,	238 "
"	Boston to Portland, in Maine, . .	105 "
"	Boston to Lowell, ...	26 "
"	Boston to Albany, ...	200 "
"	Toronto to Montreal and Quebec, (constructing,)	450 "
		2189 "

On nearly all the above routes the line is double, one wire communicating with each intermediate place, and one connecting the extreme points. It is probable therefore, that nearly or quite four thousand miles of wire have been put up in the United States, and lines are already contracted for, to connect Washington with Charleston and New Orleans.

13. *The New Botanic Garden at Cambridge, Eng.;* (Athen., Nov. 28, No. 996.)—This garden has been commenced, the Vice-Chancellor having planted the first tree on the west side, near the spot intended for the entrance on the Trumpington road. The Professor of Botany subsequently followed his example, by planting one on the east side of the garden. Twenty men are actively engaged in deeply trenching and levelling about seven acres of the ground, intended for the immediate reception of as many of the principal groups of the larger descriptions of trees as can be procured before winter. The Curator, who is zealously superintending the work, has found both the depth and quality of the soil much superior to what he had anticipated; and he considers even the poorest portions, towards the south-west angle, perfectly suitable to certain tribes. The gentle undulations over the whole twenty acres, and the introduction of a large sheet of water where the depression is greatest, will tend greatly to break whatever of formality it may be necessary to observe in the scientific grouping of the various objects that are cultivated in a botanic garden.

14. *Ray Society.*—The prospectus of this valuable institution will be found under the covers of this number of our Journal. The Council of the Ray Society have requested Prof. B. Silliman, Jr., to act as their Local Secretary for the United States, and he will receive and forward subscriptions, and will soon have copies of the Society's publications to deliver to those who want them. For the particulars of titles, terms, &c., see the prospectus in our November number and also in the present.

15. *On the Duration of Life in the Members of the several Professions, founded on the Obituary Lists of the Annual Register*; by Dr. Guy, (Proc. Brit. Assoc., from Athen., Sept. 26, No. 987.)—The following table exhibits the average of such as had attained or outlived the ages specified :—

Age.	Army.	Navy.	Clergy.	Law.	Physic.	Learned Professions.	Fine Arts.	Literature and Science, English.	Literature and Science, Foreign.	Trade and Commerce.	General Average of England and Wales.	Nobility and Gentry.	Casper's Table of Medical Profession.
26 and upwards,	65·27	67·63	68·81	66·20	65·36	67·70	64·42	66·49	62·78	68·11			58·00
31	67·07	68·40	69·49	68·14	67·31	68·86	65·96	67·55	66·72	68·74			59·27
41	68·97	70·01	71·82	70·20	70·23	71·24	68·21	69·15	68·42	71·01			63·82
51	71·58	72·62	74·04	72·78	72·95	73·62	71·15	72·10	71·44	72·32	75·64	74·00	68·21

If we confine our attention to the last line of the table, we shall see that the duration of life among the higher classes is shorter than that of the mass of the people of England and of the provident members of the laboring class. In every age the navy possesses a very slight advantage over the army. The longevity of the clergy is superior to that of any of the other learned professions. The less favorable duration of medical life, in the tables published by Prof. Casper, of Berlin, is to be attributed to his having included a lower grade of the professions than those whose deaths are recorded in the Annual Register, probably such a class as the general body of medical practitioners in England. Both however show that medical men encounter the most danger at the early part of their professional career, and this is more apparent when the column of medical life is compared with that of law life. From his own and other tables Dr. Guy constructed the following summary at 51 and upwards :—

English males, - -	75·64	Army, - - -	71·58
Clergy, - - -	74·04	Foreign Literature and Science,	71·44
Gentry, - - -	74·00	Fine Arts, &c. - -	71·15
Medical men, - -	72·95	Painters, - - -	70·96
Lawyers, - - -	72·78	Chemists, - - -	69·51
Navy, - - -	72·62	English Literature (according to	
Trade and Commerce, -	72·32	Chambers), - -	69·14
English Literature and Science,	72·10	Members of Royal Houses (males),	68·54
Aristocracy, - -	71·69	Kings of England, - -	64·12

The brief discussion which ensued, turned chiefly on the value of the obituary of the Annual Register;—which, some thought, had not the uniformity necessary to furnish data sufficiently precise for the construction of tables.

16. *On the Mortality of Children;* by Mr. Wigglesworth, (Proc. Brit. Assoc, from the Athen., Sept. 19, 1846.)—It appeared that returns had been collected from 1987 families, in which the number of children was 10,076, giving an average of more than five in a family. The number of males was 5,091 and of females 4,985 which gives a proportion of fifty-one to fifty. From these Mr. Wigglesworth constructed a table, showing the number out of which one child would die in one year according to the experience of families.

Age.	Males and Females.	Males.	Females.
1	9·62	8·34	11·40
2	16·88	17·01	16·75
3	32·38	31·00	33·63
4	47·14	49·32	45·25
5	65·51	67·21	63·94
6	90·38	108·85	77·59
7	95·83	83·21	112·48
8	143·14	120·52	174·80
9	137·80	124·53	153·56
10	281·63	369·67	228·80
11	155·93	160·16	152·00
12	196·05	193·20	199·70
13	279·38	356·20	231·37
14	195·88	271·16	154·82
15	153·70	165·33	144·18
16	200·14	123·63	480·67
17	171·67	176·57	167·37
18	190·25	158·43	242·00
19	162·15	166·67	158·28
20	158·00	101·67	327·00
21	121·43	138·67	108·50

Taking the case of males and females conjointly, it will be seen that there is a gradual decrease from the 1st to the 8th year, and that there is an increase over the previous year in the 9th, 11th, 14th, 15th, 17th, 19th, 20th, and 21st years.—In males these fluctuations take place in the 7th, 11th, 14th, 15th, 17th, 19th, and 21st years.—In females there is a general decrease to the 8th year, and an increase in the 9th, 11th, 14th, 15th, 17th, and 21st year.—A table of diseases was then exhibited, from which it appeared that more males than females died of nervous diseases and from external causes; but that more females than males die of epidemic disease, and diseases of the respiratory organs.—These tables, from family returns, were then compared with similar tables constructed from the statistics of the Foundling Hospital, and were found to agree very closely in their results.

17. *Monument of the late* Thomas Say.—It gives us great pleasure to announce, that Mr. Alexander Maclure, the venerable and worthy brother of the late Mr. William Maclure, has ordered a neat and appropriate monument to the memory of Thomas Say; a man whose remarkable attainments in science, amiable heart, and elevated character, have associated his name with many delightful remembrances.

The monument has been executed in Philadelphia by those excellent artists, John Struthers & Son, and is now on its way to New Harmony, in Indiana, where Say died and is buried, and where Mr. Maclure resides.

Presuming that this testimonial to departed worth, will be regarded with interest by all who knew the subject of it, as well as by every lover of science, we subjoin an outline drawing of the monument, (which is of white Italian marble,) with a copy of the inscriptions on the four sides of the shaft.

(1.)

THOMAS SAY,
The Naturalist:
Born in Philadelphia,
July 27, 1787;
Died at New Harmony,
October 10, 1834.

(2.)

One of the Founders
Of the
Academy of Natural Sciences
of
Philadelphia,
January 25,
1812.

(3.)

Votary of Nature even from a child,
He sought her presence in the trackless wild;
To him the Shell, the Insect, and the Flower,
Were bright and cherish'd emblems of her power;
He saw in her a spirit all divine,
And worship'd like a pilgrim at her shrine,

(4.)

The Friend and Companion
of
William Maclure;
Whose Surviving Brother
Erected this Monument,
A. D. 1846.
A. M.

VI. Bibliography.

1. *Chemical Examination of the Urinary Calculi in the Museum of the Medical Department of Pennsylvania University;* by Robert Peter, M. D., Lexington, Ky., 1846.—This research embraced eighty-one specimens, of which seventy-eight were from the human subject; two from hogs, and one from a jackass. The State of Kentucky appears to furnish a remarkable number of calculi, owing probably to the prevalent use of maize and bacon as articles of food, both of which abound in earthy phosphates, while the waters of the same region are generally impregnated with salts of lime. Dr. Peter estimates one case of calculi to 16·050 of the inhabitants of Lexington, while in Ireland (pauper population) it is estimated by Dr. Yelloly as 1 in 875·000 per annum.

Among the specimens examined by Dr. Peter, are two of the very rare *cystic oxyd* weighing half and three-quarters of an ounce each.

The specimens were all sawn through the nucleus by a fine saw and the cortex and interior separately examined. Of the 78 calculi, the composition of the nucleus was uric acid mainly in 32, urate of ammonia in 26, oxalate of lime in 7, phosphates in 7, foreign substances in 4, cystine 2. The *bodies* are composed of uric acid mainly in 34, urate of ammonia in 2, oxalate of lime in 16, mixed phosphates in 16, triple phosphates in 4, cystine in 2.

The peculiarities presented by the Lexington collection, are a great deficiency in the proportion of pure uric acid in the nuclei, a great excess in the proportion of nuclei containing urate of ammonia and the earthy phosphates found in their general composition, an excess in the proportion of the mulberry or oxalate of lime calculus. Only a very small proportion of the cases of calculi occurring in the vicinity of Lexington have been preserved.

2. *Coast Survey: Report of* Prof. A. D. Bache, *Superintendent of the U. S. Coast Survey, showing the progress of that work for the year ending, Nov.* 1846. H. of Reps., U. S., Doc. No. 6.—This important national enterprize has given, under the administration of its present head, substantial proof of progress. It is now recognized as an object of the first importance to bring out the results of the survey as fast as possible, consistently with accuracy. This answers the double end of rendering their labors, in the highest degree, useful, and at the same time the best evidence is afforded of zeal and activity in the prosecution of the work.

The whole of our vast sea coast line has been divided into nine principal sections, in each of which the work is separately prosecuted by the several surveying parties. Of these the second section—from Point Judith to the Capes of the Delaware—is in general, completed, and the work is already in good progress in six others. The primary reconnaissance is first made, next follow the triangulations and astronomical observations—which prepare the way for the topographical and hydrographical parts of the work, so that the progress is one of increasing activity from the reconnaissance forward, until all the objects of the survey are embraced. It is easily seen that by this plan the survey of the whole coast may be completed within a very limited period of time, the number of sections under survey at the same time, determining the period of completion of the whole work. The publication of maps and charts goes on simultaneously, and the experience of the past two years shows that five or six sheets can be published within the year,—two or three sheets of general coast maps and three or four of harbor maps. The style of these maps is in all respects admirable, as all will agree who have had an opportunity of inspecting those which have been already published.

The hydrographical party under Lt. Commanding Davis, made the important discovery, during the past season, of an extensive shoal off the eastern end of Nantucket lying directly in the track of communication to and from Europe, and upon which, not improbably, the ill-fated "President" steamer stranded. This dangerous shoal has hitherto been quite unknown, except to the lost.

A melancholy interest is given to this Report by the loss of Lieutenant Commanding George M. Bache, and ten seamen from the surveying brig Washington, on the 8th of September. They were washed overboard during a terrific hurricane, with nearly all on deck, while the brig was knocked on her beam ends, dismasted: all but the commander and the ten unfortunate seamen succeeded in regaining the vessel.

Capt. Bache (who was a brother of the superintendent) was charged with a survey of the Gulf Stream, and had made three sections across it, between Barnegat and Cape Hatteras, determining with great exactness, its temperatures from the surface to great depths, (even in one case as deep as 1500 fathoms,) and investigating many other points of high scientific interest. We are left to deplore his loss as one of the most experienced and scientific naval officers in the service. He had passed nine years in the duties of the coast survey, and his name appears on every chart they have published, save one. A medal has been ordered by the Treasury Department commemorative of his heroism and of the sad disaster which removed him with his ten companions, from the scene of his usefulness. He perished nobly, in the able and faithful discharge of his duty; and the execution, after his loss, of the last order he gave at the moment he was washed off, insured the safety of the vessel, and of the surviving officers and crew.

The present report is accompanied by nine maps illustrating the progress of the work during the past season.

3. *Light Houses: Report of the Secretary of the Treasury on the Improvements in the Light House System and Collateral Aids to Navigation, embracing a Report from* Lieut. THORNTON A. JENKINS, U. S. N., *and* Lieut. RICHARD BACHE, U. S. N. Washington, 1846. 8vo. pp. 272, with a folio atlas of twenty-seven plates.—This Report embraces a full account of the light house systems of Europe, especially of England and France. The system of catopteric lights devised by the elder Fresnel and continued by his brother, is now universal on the French coast. Lts. Jenkins and Bache enjoyed the best advantages for becoming familiar with all the details of this perfect system of illumination, under the immediate auspices of Fresnel, now superintendent of light houses in France. This Report, it is to be hoped, will induce a great reform in this very important arm of our national service, which we are under the highest obligations of interest and philanthropy to maintain in the greatest possible perfection. We have read this Report with much interest, and regret that we have not space to make extracts from it.

4. *Journal of* Lieut. J. W. ABERT, *from Bent's Fort to St. Louis, in* 1845. 75 pp., 8vo, with maps and sketches. Ordered to be printed by the United States Senate.—The Expedition of Lieut. Abert commenced in the Rocky Mountains, in lat. 38°, and lon. 103° 30′, from which place he took charge, by the order of Capt. Frémont, of the survey of Purgatory creek, and the course of the Canadian, and False Washita. The party followed up Purgatory creek, and left its head waters for the source of the Canadian, down which they continued their survey and observations. Lieut. Abert's Journal contains much valuable information relative to the Camanche Indians, and many characteristic incidents are told of these wild warriors of the mountains. Many facts are also related regarding the natural history of the region. We gather from his pages that a soft brown sandstone, probably the

same observed to prevail so extensively farther north by Major Long, was the rock in the vicinity of Purgatory creek, and along the Canadian in latitude 36°. The beds were nearly horizontal and highly ferruginous, and occasionally much intersected by seams of iron. The rock forms high bluffs, bounding the valley of the Purgatory; numerous impassable ravines intersect it occupied usually by torrents dashing wildly over a succession of rocky ledges. The water of the region was in standing pools, generally impregnated with common salt and other salts, rendering it nauseous and bitter to the taste. From latitude 36½° to 36°, on the Canadian, there were bluffs of shale. Below this they passed to the soft brown sandstone again, and then to a red sandstone of a bright red color, which, in longitude 103°, was overlaid by a limestone. Pools of salt waters were here met with; and between the meridians of 98° and 102° there were beds of gypsum, besides handsome crystallizations of this mineral in the red clay banks. Near longitude 102° several petrified trees were observed, which were covered in part with quartz crystals; in some places the fibre had been replaced by pink colored agate, which gave a beautiful effect to the brilliant display of crystals above. The plains were strewed with coarse agates.

5. *Chloris Boreali-Americana*: Illustrations of new, rare, or otherwise interesting North American plants, selected chiefly from those recently brought into cultivation at the Botanic Garden of Harvard University; by Asa Gray, M. D., Fisher Professor of Natural History in Harvard University. Decade I. (From the Memoirs of the American Academy of Arts and Sciences, Vol. iii, New Series.) 56 pp. 4to, with colored plates. Cambridge, 1846.—This valuable memoir is the first of a series in the course of preparation, designed to illustrate the more obscure parts of North American Botany, by the description and illustration of new or imperfectly known species. A list of those described in this Decade is inserted in our last number, page 151. The descriptions are given with fullness, and with that discrimination and critical accuracy, which characterize all the botanical writings of Prof. Gray. The plates contain detailed dissections, and besides their scientific value they are exquisite specimens of art. The American Academy of Arts and Sciences falls behind none of the societies of Britain or Europe in the stile and merit of their recent memoirs.

6. *Nomenclator Zoologicus, continens Nomina Systematica Generum Animalium, tam viventium quam fossilium, etc.; Auctore* L. Agassiz. Fasc. 1–10, (Soleure, 1842–46,) 4to.—This great work, which must have cost an extraordinary amount of labor, is now almost completed. Trusting that some one of our able zoologists will duly give an account of a work which is indispensable to every votary of their science, we propose at this time merely to call attention to the preface, published last year with the 9th and 10th fasciculi, and to express unqualified admiration of the manner in which a subject of interest to all naturalists, that of nomenclature, is there treated. While botanists are enjoying the benefits of a sedulous adherence to the wholesome rules imposed by the father of natural history nomenclature, and of nearly unanimous agreement in the few changes which the progress of science and the multiplication of its objects have rendered needful, the zoologists on the

other hand, who have too generally allowed every one to do that which was right in his own eyes, are reaping in consequence a plentiful harvest of confusion. The difficulty of a reform increases with its necessity. It is much easier to state the evils than to relieve them; and the well-meant endeavors that have recently been made to this end are some of them likely, if adopted, to make "confusion worse confounded." Probably no living zoologist is so conversant as Prof. Agassiz, with the actual state of the nomenclature of the animal kingdom, and so well qualified to judge of the practical working of proposed rules, which often involve consequences that the propounders never dreamed of. Our author's views are therefore entitled to great weight. We are glad to perceive that they entirely concur with those quite unanimously adopted in the other great department of natural history, for which the Linnæan canons were originally framed. As these canons were the foundation of our nomenclature, Prof. Agassiz has very properly reproduced them, *totidem verbis*, from the *Philosophia Botanica*, adding now and then a short but pithy commentary. He then proceeds to examine the rules proposed by the Committee of the British Association, and shows that while some of them are mere iterations of the Linnæan canons, which should never have lost their authority, others are contrary to them, or threaten greater evils than they are intended to remedy. In most respects his criticisms concur with those already made by Dr. Gould in a former volume of this Journal, (xiv, p. 1.) We agree with Prof. Agassiz in thinking these English canons worthy of adoption only when they agree with the letter or spirit of the Linnæan rules, which indeed they generally do. Those which conflict with them have not received, and probably will not receive, the general assent even of British naturalists. Hence, in our opinion, the American Geological Association has too hastily reaffirmed them, while they have, indeed, improved their form in several respects. It may be well to notice the comments of Prof. Agassiz upon the more objectionable propositions.

Their first rule, "that the name given by the founder of a group or the [first] describer of a species should be permanently retained," cannot be too firmly insisted on; for upon it rests the stability which is the most essential requisite of nomenclature. Their second rule, that since "the binomial nomenclature originated with Linnæus, the law of priority is not to extend to the writings of antecedent authors," restricts the former too arbitrarily, and conflicts, as Prof. Agassiz states, both with the canons* and the example of Linnæus, not less than with the conscientious practice of good naturalists ever since. Linnæus was not the founder of *genera* or of *generic* nomenclature, and "far from making new names in every instance, he retained all names given by his predecessors, provided they could be received into his system." It is generally thought that Linnæus erred by adopting, not too many, but *too few* of the unobjectionable and well established generic names of his predecessors, such as Tournefort, &c. Now when, in the natural progress of the science, a Linnæan genus is resolved into two or more Tournefortian ones, for instance, are the names of Tournefort to be

* § 241. *Nomina generica Patrum Botanices, Græca vel Latina, si bona sint, retineri debent, ut etiam usitatissima et officinalia.*—Also vid. § 239.

excluded from use? In the breaking up of the Linnæan genus *Lonicera*, had not the Diervilla and Xylosteum (and if the division were to go farther, the Periclymenum and Caprifolium) of Tournefort, as well as the Symphoricarpos of Dillenius, an indisputable right to restoration? Indeed Linnæus was here plainly wrong in not adopting one of these prior names for the whole genus, instead of creating the new one. This, however, was to be submitted to; for, as Prof. Agassiz remarks, "the names sanctioned by Linnæus are to be held as established above all others. Linnæus, for instance, received very few genera of *Echinodermata*. Now-a-days this class numbers many, among which some of those founded by Klein, Link and Breynius, long anterior to Linnæus, hold their place with the modern ones of Lamarck, Müller, &c. But no one now prefers that new names should be made for such genera, rather than that such approved anterior ones should be brought into use again. I certainly see no cause why we may not call to life the names of former authors when we divide the genera of Linnæus." We think those naturalists blameworthy who do not.

The third, fourth and fifth, of the British canons are accordant with Linnæan rules, and are regularly followed in botany. The next four relate to matters which follow as a consequence of the law of priority; but as to what relates to the use of synonymous names, Prof. Agassiz intimates that their rule is perhaps too absolute, and even contradictory to the Linnæan canon, § 244. "*Nomina generica, quamdiu synonyma digna in promptu sunt, nova non effingenda.*"

The tenth rule, viz. "A name should be changed which has before been proposed for some other genus in zoology or botany, or for some other species in the same genus, when still retained for such genus or species," is not as well worded as the equivalent Linnæan canon, § 217, "*Nomen genericum unum idemque ad diversa designanda genera assumptum, altero loco excludendum erit.*" Mr. Agassiz remarks, greatly to our surprise, that the enforcement of this rule would demand the sacrifice of almost half the generic names made in recent times. In our opinion, while the same names *ought not* to be given both in zoology and botany, the time is passed when received names are to be changed on this account. While writers in the different departments of zoology alone, have doubly employed the same name "in ten thousand instances," we must see that cases of this sort between zoologists and botanists, occupying such widely separated fields, are inevitable, at least until as perfect lists of zoological names shall be compiled and kept up as is done in botany. Besides it is now utterly impossible for any single naturalist, or any joint committee of botanists and zoologists to determine, in half of the cases that arise, whether a particular genus is to be suppressed or retained in one department, so as to require or forbid a change of the posterior homonymous name in the other; hence the practical application of the Linnæan rule would now create tenfold more confusion than it can relieve. Each well founded change of the sort does no more than to obviate a possible inconvenience, while every needless one, in a genus of numerous species, draws after it a load of useless synomyms, which do not serve, like genuine synonyms, to tell the history of the genus and mark the progress of our knowledge. The whole subject is forcibly presented by Prof. Agassiz, in another section of his preface, (p. xxviii, *et seq.*,) where he states that he now knows three thousand generic names common to botany and zoology, which the Linnæan rule would require to be changed in one or the other department. But surely this number must comprise a host of synonyms long since fairly laid on the shelf, as well as names of somewhat different formation or termination, although of the same derivation. In this case a small matter should give them impunity. If these changes must be made, no one could do the work for zoology better than Mr. Agassiz; but he affirms it to be a task quite beyond his power, and justly concludes that, "in the present state of the science, generic names ought not to be changed solely on account of their being employed in both kingdoms of nature." To this conclusion the American Association evidently accede.

As to generic names doubly or triply* employed in the several classes of the animal kingdom, (which, we are astonished to learn, already number *nearly ten thousand!*) the necessity of applying the Linnæan canon is obvious, and would be imperative had not the evil reached such a height as to baffle the remedy. The *summum jus* which demands the immediate change of nearly a moiety of the received zoological names, would surely become *summa injuria* to the science, even if any naturalist were equal to the task of applying it. Justice must here be delayed, in order that it may be rightly administered, and, as our author recommends, the business of gradually bringing this part of nomenclature under the rule, must be left to monographers and future systematists. But let those upon whom the *cacöethes nominandi* is strong, obey our author's advice, desist from proposing new names in mere catalogues, and never attempt, while revising the genus which rightfully claims a particular name, to impose new names upon the homonymous genera in other classes, but leave that for their own respective monographers. It will be soon enough to give them new names, if such are needed, when the validity of these several genera is well made out.

Upon the 11th rule of the British Committee, namely, that "a name may be changed when it implies a false proposition which is likely to propagate important errors," Prof. Agassiz remarks that the less this liberty is used the better, lest it should lead to licentiousness.

The 12th rule ordains that "a name which has never been clearly defined in some published work should be changed for the earliest by which the object shall have been so defined." This law, our author remarks, "has become very necessary, since dealers in natural objects have begun to arrogate the authorship of books collected from catalogues, and demand that authors shall receive their names for dividing species. It is the same with names which remain unpublished in public or private collections, and to which the proprietors or curators sometimes lay claim. But priority is to be conceded only to publication in a work which is accessible to the learned throughout the world. Yet while we strictly press the observance of this law in respect to the publication by

---

* As a specimen of the carelessness of zoologists, the name *Cuviera* is employed as a genus not only in botany, (where it has priority and good taste in its favor,) but also among Medusæ, Echinodermata, Crustacea and Mollusca.

learned men of the results of their observations, so much the more must we brand with infamy those impudent parasites who prowl about museums to pick up materials for their *opuscula*, without mentioning the sources whence they have derived their spoil, and sometimes even furtively describing the species, the names of which they claim." The people alluded to well deserve this censure. On the other hand, not less blameworthy are those who purposely pass by, instead of courteously adopting, appropriate names under which naturalists often distribute their specimens in advance of publication. This felony is the more atrocious, because remediless, and to be prevented by no rule except that of courtesy; for the public good requires that priority should be conceded to actual publication alone.

The two remaining laws (13th and 14th) are agreeable to, or identical with, Linnæan canons, and are approved by all good naturalists.

The rules recommended by the British Committee, for the future improvement of nomenclature, are next considered; and as they are far the most commendable and in general use among good naturalists, we shall only notice those that Mr. Agassiz criticises, or we have occasion to comment upon. The writer of the British Report has chosen to enforce the direction, to avoid harsh and inelegant or sesquipedalian names, by citing as an example of the kind, the "*Enaliolimnosaurus crocodilocephaloides* of a German naturalist;" for which he is strongly censured by our author, who declares that no naturalist has ever proposed this name. Surely, if any one is inclined "to cast stones into his neighbor's garden," as our author says, there is no lack of legitimate opportunity, nor necessity for fabricating hard names.

The British Committee condemns the future employment of generic names which have been superseded by the rule of priority. But this is contrary to the canon, § 245—"Nomen genericum unius generis, *nisi supervacaneum*, in aliud transferri non debet," (and to *obs.* under § 244,) no less than to the practice of Linnæus and of subsequent naturalists. For instance, *Saururus* of Plumier became a synonym of *Piper*, but this did not debar Linnæus from the subsequent application of the name to a new genus. *Sisyrinchium* of Tournefort being included in *Iris*, Linnæus gave the name to a different genus; nor did he hesitate to adopt the genus which Ellis had dedicated to Hales, on account of an earlier *Halesia* of Browne, which had already sunk to a synonym. Why should a good name be forever *tabooed* in such cases, and why not, if occasion offers, allow it to be remarried to a new genus? We should be careful, however, not to re-produce names which are likely ever to be resuscitated in their former relation.

The British Committee objects to the practice of giving to a genus the name which it bore as a species of a former genus. But, as Prof. Agassiz justly remarks, when a species, which proves to be the type of a new genus, has a good proper name already, it seems quite as admissible to take that name for the genus and make a new one for the species, as to coin a new generic name, since either way a new name must be introduced: indeed it is preferable, because such Linnæan species frequently are found to comprise several, hitherto confounded, no one of which has a paramount claim to the specific name; e. g. *Cyprinus Gobio*, *C. Leuciscus*, *C. Barbus*, L. We go further, and maintain that *proper* specific names are, *cæteribus paribus*, always to be preferred for genera in these cases, not only because they are already familiar, but because they are most frequently old generic names which may claim under the law of priority. For example, *Lonicera Diervilla*, L.=*Diervilla*, Tourn.; *L. Symphoricarpos*, L.=*Symphoricarpos*, Dill.; *Rhamnus Paliurus*, L.=*Paliurus*, Dod.; *R. Zizyphus*, L.=*Zizyphus*, Dod.; *Rubus Dalibarda*, L.=*Dalibarda*, L.; and so of hundreds of proper specific names which have rightly resumed their generic rank.

The next proposition of the British Committee, namely, that specific names, even when substantive or borrowed from persons or places, should uniformly be written with a small (instead of capital) initial, is so contrary to long usage and offensive to good taste, that we are surprised it should anywhere find favor. Mr. Agassiz pointedly condemns it. The only reason assigned for the change is that some people might not be able to distinguish the specific from the generic name, without the aid of typography. But, as Dr. Gould has already remarked, in this Journal, such persons would be misled by almost anything; and the propounders of the rule should follow it consistently by writing their own cognomen with a small initial letter. We do not wonder that the Committee of the American Association refused to reaffirm this rule, as applied to proper names from persons; and we are quite sure that naturalists generally will not hesitate wholly to reject it. Surely the committee would not approve the practice of a late botanical author of this country, who reduced the proper specific names of Linnæus into adjective conformity, by writing "*Ranunculus flammulus*," instead of R. Flammula, "*Thymus serpyllus*" in place of Thymus Serpyllum, and so on.

Prof. Agassiz severely condemns the proposition to restrict the names of families to a uniform termination in *idæ*, and their subdivisions to *inæ*, without considering whether the words in question will receive that particular suffix kindly. This is quite too straight-laced, and gives rise to many awkward forms, or

> "Sesquipedalia verba
> Vel nocitura sono, guttur læsura loquentis,"

which it is not worth while to encounter *needlessly*, for the sake of mere technical uniformity, at least when they may be avoided by some liberty of choice in the mode of prolongation.

The proposition, D. of the British Committee, which directs that the name of the original propounder of a species should continue to adhere to it when transferred to a different genus, is warmly defended by some naturalists in England and, in a modified form, in our own country also. Few naturalists are now so well qualified to judge of the practical operation of this scheme, as Prof. Agassiz. He declares his opinion that, if received, "it will introduce horrible and remediless confusion," and that no possible multiplication of synonymy is likely to lead to so many difficulties, as this new practice. He therefore strenuously opposes it by arguments drawn from the precepts and practice of Linnæus, who meant the specific name to be subordinate to the generic, and never intended it to be inferred, that he who applied to a plant or animal a certain name, was therefore its discoverer, or even its first systematic describer. He affirms that Linnæus would have expressly rejected "*Tyrannus crinitus*, Linn. (*sp.*)," were the innovation proposed in his days, and have written *T. crinitus*, Swains., had he thought best to approve the division of his genus *Muscicapa*. On the other hand, if he disapproved the division, we may add, he would not have thanked a contemporary for making him seem to adopt it. The hardship is still greater when the question is not of the division of an old genus, but of the proper place of a species among admitted genera, when it is surely improper to cite an author as referring it to one genus, while he expressly maintains that it belongs to another. In fact, the remedy is much worse than the disease which the English doctors would cure. Linnæus maintains that he is the true naturalist who understands genera; but from the new practice it will inevitably follow, as Prof. Agassiz asserts, that the proper establishment and definition of genera, which demands the highest powers of the naturalist, will be less esteemed than the mere distinguishing of species; a result which, far from promoting science, will especially retard the progress of that part of zoology in which there is most to be done, and in which the science of the animal, is still far behind that of the vegetable kingdom. It is of the greatest importance that we should be able to thread our way back through entangled synonymy and mistaken references, to the original sources. Here our difficulties would be greatly multiplied, unless two sorts of synonyms are used. For who, as Mr. Agassiz says, can find out what Linnæus has said of *Muscicapa crinita*, without a direct reference to the genus in which Linnæus himself placed it? And when, as often happens, the Linnæan species is mistaken, so that the *Tyrannus crinitus*, Linn. (*sp.*) according to Swainson, is not the *T. crinitus*, Linn. (*sp.*) according to some other author, the confusion becomes inextricable, unless we encumber ourselves with two modes of annotation, the old for expressing synonymy, and the new for the names really adopted. "Then the two modes will not agree with each other, nor can one know whither to turn himself. Surely the authors of this new rule cannot have duly considered these inconveniences, else they would have themselves discarded it. Therefore I entreat and pray them, by all the interests of the science they wish to promote, to abandon their proposition, and not to introduce a new schism into natural history, but to return again to the system of Linnæus, the most simple of all, and least liable to errors and Babylonish confusion in nomenclature."

The Committee of the American Association more wisely adopted the mode, afterwards employed by Mr. Dana in his great work on zoophytes, namely, that of appending to the specific name the original authority for the species in brackets, and adding without brackets the name of the author who has first described the species under the later received genus. To this plan there can be no objection, except that it is rather cumbrous, if it is to be used in every brief mention of the species, and, in our opinion, quite superfluous in a systematic treatise, where the synonymy is given in proper historical order.

The recommendation to make sub-generic names agree in gender with that of the genus, Prof. Agassiz thinks is of no consequence, unless the new annotation, just animadverted upon, should come into use.

Besides it would often interfere with the rule of priority, which requires synonyms, when they exist, to be adopted for sectional names. But he strongly commends the rule, that the etymology of names should always be stated by the proposer.

Justly does Mr. Agassiz condemn the practice of those who change the authority of a genus, when they extend or narrow its bounds, or correct a faulty orthography. Thus he would write *Lepidosteus*, Lacep., although Lacepede wrote *Lepisosteus;* and especially would he write *Perca*, Linn. (Cuv.), not *Perca*, Cuv.

Hearty and just, also, is his censure of the custom of those French zoologists, who use vernacular appellations in scientific works, either to the exclusion of the systematic name, or in precedence of it.

Our author closes this part of his preface with some excellent reflections on the study of genera in the animal kingdom, and the need of a thorough re-investigation of the grounds upon which natural families are constituted; remarks which we would gladly copy, if our limits allowed. A. Gr.

7. *Beiträge zur Pflanzenkunde des Russischen Reiches; herausgegeben von der Kaiserl. Acad. der Wissenschaften.* (Contributions to the Botany of the Russian Empire, published by the Imperial Academy of Sciences.) St. Petersburg, 1845, 8vo.—The fascicles which we have received contain the following papers, by Dr. Ruprecht, viz: 1. *Flores Samojedorum Cisuralensium*, pp. 67, with six folio lithographic plates. The plants here described are the fruits of an exploring tour made by Dr. Ruprecht himself, in the summer of 1841, to the arctic coast and islands between the White sea and the northern extremity of the Ural mountains. They are particularly interesting for comparison with the arctic and subarctic vegetation of our own continent. When the ampler collections of Middendorf, who has largely explored the country of the Siberian Samoieds, come to be published, and which are said to resemble those of Melville Island, &c., though much more numerous in species, the botany of the arctic kingdom round the world may be said to be pretty well known. For the Linnæan *Arenaria peploides*, Ruprecht has restored the forgotten name of *Ammadenia*, conditionally proposed and perhaps sufficiently characterized by Gmelin nearly twenty years anterior to the uneuphoneous name of *Honckenya* of Ehrhart. Though it were to be wished, that Ehrhart had adopted this name, it is now too late to revive it.—2. *Distributio Cryptogamarum Vascularium in Imperio Rossico*, pp. 56. An interesting tract. It seems that the Siberian specimens of the Linnæan *Asplenium rhizophyllum*, belong to a new species of *Camptosorus;* and also that *Botrychium Virginicum* is a native of Russia proper. Dr. Ruprecht has added some new species of *Allosorus*, and given an arrangement of the genus under three subgenera; but his third group *Homopteris*, founded for *A. Stelleri* and *A. gracilis*, is probably not stable, for our *A. gracilis* certainly does not accord with the character "*Frondes omnes consimiles.*" Our author has also a good revision of *Woodsia.*—3. *In Historiam Stirpium Floræ Petropolitanæ Diatribæ* (pp. 93); a critical enumeration of the plants which grow around St. Petersburg; with a historical and interesting geographico-botanical preface. *Botrychium simplex* of Hitchcock, published in this Journal, or a plant extremely near it, has been detected near St. Petersburg. A. Gr.

8. *Report on the Trees and Shrubs growing naturally in the Forests of Massachusetts;* by GEO. B. EMERSON. Boston, 1846. pp. 534, large 8vo, with seventeen plates.—This volume worthily finishes the able series of Reports by the Commissioners on the Zoological and Botanical Survey of the State of Massachusetts. Our limits will not permit us to give here the detailed account which the work deserves. We can only say, that an attentive perusal has confirmed our impression that the work is a model for a popular, and yet truly scientific, treatise upon trees and shrubs. The volume is replete with the most valuable information, obtained by the protracted personal observation and research of a genuine lover of trees and plants, carefully digested, and presented in a form which, for the end in view, leaves nothing to be desired. A. GR.

9. *Botanical Magazine*, for January, 1847.—Sir WM. HOOKER has devoted this number entirely to the illustration of the *Victoria regia* of Central America, a gigantic water lily, and perhaps the most magnificent and wonderful vegetable production in the known world. One plate, taken chiefly from Schomburgk's "Views in British Guiana," is a reduced representation of the plants *in situ*, the enormous leaves and flowers covering the surface of a pool or placid lake, bordered by palm trees and other tropical plants. The next plate represents the flower of the natural size—a foot in diameter—from a specimen preserved in spirits, and brought from Bolivia by Mr. Bridges. Two other plates are devoted to dissections of the flower, which does not very essentially differ from that of Nymphæa, except in the higher cohesion of the floral envelops. Sir Wm. Hooker has not been able to examine the fruit. We are curious to know whether the seeds have an arillus, like Nymphæa, and regret that no analyses of the seed were made. Perhaps we ought not to regret that no seeds were sacrificed, however, since we are informed that those brought to England by Mr. Bridges have germinated in the conservatories of the Royal Botanic Gardens at Kew, and we may hope that Sir William may succeed in bringing the wonderful plant into flower. A. GR.

10. *A Treatise on Algebra, containing the latest Improvements; adapted to the use of Schools and Colleges;* by CHARLES W. HACKLEY, S. T. D., Professor of Mathematics and Astronomy in Columbia College, New York. 504 pp., 8vo. New York, Harper & Brothers. 1846.—Professor Hackley in the work before us, has presented the American public with the most complete Treatise on Algebra in the English language. The elementary principles are treated in a simple and easy style, and from these the student is conducted to the higher branches of the subject, in which all that is important is lucidly detailed. The author remarks in his preface, "the French treatises furnish excellent models of the theory of Algebra, the German of ingenuity and brevity of notation and exposition, the English of practical adaptation and variety of illustration and example; and from these, after a careful comparison of many authors in each language, demonstrations have been selected and introduced verbatim when they seemed incapable of improvement; but whenever the slightest alteration or amalgamation, or the entire remodeling of them, could give additional clearness or elegance, the *limæ labor* has not been spared." For the convenience of

the learner, a selection for a minimum course of Algebra, such as would ordinarily be advisable, is pointed out, and also a more extended course, such as is requisite for the prosecution of the higher mathematics; while the rest, the author states, may very well be reserved for reference, as the student's own discovery of his wants in the advanced stages of his mathematical pursuit shall call it into requisition.

11. *Organic Remains.*—Prof. BRONN of the University of Heidelberg, Germany, has in the press a systematical and geological catalogue of all fossilized organic bodies. The vegetables and zoophytes fill thirteen sheets (feuilles d'impression) closely printed, and include nearly 6000 species. The MS. for the nomenclature belonging to this part has also gone to press, and it is expected that the whole will be finished in about ten months from Oct. 23d, 1846, the date of a letter from the author.

12. *The Literary World: a Gazette for Authors, Readers and Publishers.* New York. No. I. Feb. 6, 1847. 24 pp. 4to. $3 per annum. —A new weekly Journal of superior character, recommending itself to all, scientific as well as literary, for its early announcements, registers, and reviews, of recent publications, foreign and domestic, and for its book advertisements from various houses of New York city and elsewhere.

D. P. GARDNER, M. D.: The Chemical Principles of the Rotation of Crops, pronounced before the American Agricultural Association, March 4, 1846. 29 pp. 4to, from the Transactions of the American Agricultural Association. 1846.

D. D. OWEN, M. D., and J. G. NORWOOD, M. D.: Researches among the Protozoic and Carboniferous rocks of Central Kentucky, made during the summer of 1846. 12 pp. 8vo., with a lithographic plate of fossils. *St. Louis.* 1847.

HENRY COLMAN: European Agriculture and Rural Economy, from Personal Observation; vol. ii, part viii. *Boston*, 1847.

Naturalist's Library, People's Edition, vol. xvi, Mammalia, Lions, Tigers, &c. 12mo. *London*, 1846. 4*s*. 6*d*.

J. I. GRIFFIN: Chemical Recreations, new ed., 18mo. *London*, 1846. 7*s*. 6*d*.

W. WHEWELL: History of the Inductive Sciences, 2d ed. *London*, 1846. 2*l*. 2*s*.

G. B. SOWERBY, F. L. S.: The Recent Brachiopoda, from the 6th and 7th parts of the Thesaurus Conchyliorum, with 7 colored plates. *London*, 1847. 15*s*.

Dr. C. G. SIEBEL: Paläozoologie; 23 sheets large 8vo. *Merseburg*, 1846. 1½ *Thlr.*

Wir leben in der Natur und müssen sie kennen; freie Unterhaltungen über vaterländische Natur und deren Diener mit Physiophilus; Erstes Bändchen. *Berlin*, 1846. 15*sgr*.

ARCANGELO SCACCHI: Lezioni di Geologia; 178 pp. 8vo, *Naples*, 1843.

———, Quadri Cristallografici e Distribuzione Sistematica dei Minerali; 70 pp. 8vo, with two plates. *Naples*, 1842.

HOMBRON ET JACQUINOT: Voyage au pôle sud et dans l'Océanie, sur les corvettes l'Astrolabe et Zélée, sous le commandement de M. Dumont Durville. Zoologie. Tomes i et ii, in 8vo. *Paris.*

R. D'HERICOURT: Second voyage sur les deux rives de la Mer Rouge, dans le pays des Adels et le Royaume de Choa. *Paris.* 1 vol. 8vo.

FREDERIK KLEE: Le Déluge; Considerations Géologiques et Historiques sur les derniers Cataclysmes du Globe. 1 vol. 18mo. *Copenhagen*, and *Paris.* 3*fr*. 50*c*.

P. JOIGNEAUX: Traité de Chimie Agricole. 1 vol. 12mo. *Paris*, 1846. 4*fr*.

Descriptions of the New Shells of the Exploring Expedition under Charles Wilkes, U. S. N., by A. A. Gould, M. D.; continued. (From the Proceedings of the Boston Society of Natural History.) One sheet containing 4 species of Helix, 6 of Vitrina, 16 of Succinea, and 7 of Bulimus.

PROCEEDINGS OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES, BOSTON, August, 1846.—p. 5. Moon culminations. observed at Cambridge Observatory, from Oct. 20, 1844, to June 14, 1846; *W. C. Bond.*—p. 14. Observations on the Transit of Mercury, May 8, 1845; *W. C. Bond.*—p. 17. Observations on the Comets of 1845 and 1846; *W. C. Bond.*—p. 19. Observations on the Solar Eclipse of May, 1845; *W. C. Bond.*—On the Solar Eclipse of April, 1846; *W. C. Bond.*—p. 21. Notes on Meteors, mostly of August, 1845 and 1846; *W. C. Bond.*—p. 23.

Observations on Phonotypy; *Emerson.*—p. 39. On De Vico's Fourth Comet; *Prof. Pierce.*—p. 44. Meteorological register kept at St. Michael's; *J. C. Hunt.*—p. 46. New genera and species of Compositæ; *Prof. A. Gray.* (This Journal, p. 274.)

PHILOSOPHICAL TRANSACTIONS OF THE ROY. SOC. OF LONDON, 1846. Part 2.—On the Blood Corpuscle; *T. W. Jones.*—On a point connected with the dispute between Keil and Leibnitz, about the invention of Fluxions; *A. de Morgan.*—On the action of the Rays of the Spectrum on Vegetable Juices; *Mrs. M. Somerville.*—On the use of the Barometric Thermometer for the Determination of Relative heights; *J. R. Christie.*—Investigation of an Extensive Class of Partial Differential Equations of the 2nd order; *G. W. Hearn.*—On Spontaneous Nitrification; *C. F. Schönbein.*—On the Viscous Theory of Glacier Motion; *J. D. Forbes.*—On the Nervous Ganglia of the Uterus; *R. Lee.*—On the Nerves of the Uterus; *T. S. Beck.* Part III. Contributions to Terrestrial Magnetism; *Lieut. Col. E. Sabine.*—Meteorological Observations made on board the Bark Pagoda, in 1845, between 20° and 68° S. Lat., and 0° and 120° E. Longitude; *Lieut. H. Clerk.*

LONDON JOURNAL OF BOTANY, for *December*, 1846.—Memoir of the life of Dr. J. R. Vogel.—Sur le genre Godoya et ses analogues; *Dr. Planchon.*—Botanical Information, viz: Letter of Dr. Leickhardt, from New Holland; Notice of Bloxam's British Rubi; Tomb of the Botanist Allan Cunningham, with a plate.

MEMOIRS OF THE GEOLOGICAL SOCIETY OF FRANCE, 2d Ser., 2d part of vol. i.—On the geology of the vicinity of Bayonne; *Thorent.*—Fossil Entomostraca of the cretaceous strata of La Haute Marne; *J. Cornuel.*—Journal of a Voyage in Turkey; *A. Viquesnel.*—Geology of the Mountains between the route of the Simplon and that of St. Gothard; *Studer.*—On the nummulite deposit of Les Corbières, and La Montagne Noire; *Leymerie.*

ANNALES DES SCIENCES NATURELLES. *July*, 1846.—On the embryogeny of the Gasteropodous Molluscs; *C. Vogt.*—On the successive development of the vegetable matter in the culture of wheat; *Boussingault.*—Note on the family of the Penæaceæ; *A. de Jussieu.*—Note on the Hypopitys multiflora, *Scop.; P. Duchartre.*—Extract of a Memoir on the nature and causes of the Potatoe disease in 1845; *P. Harting.*—Thirteenth notice on the Cryptogamous plants recently discovered in France; *J. B. H. J. Desmazières.*

August.—On the embryogeny of the Gasteropodous Molluscs (continued); *C. Vogt.*—On the development of the tissues in the Batrachians; *Kœlliker.*—On the movements of the heart; *de Martino.*—On the generation and development of the Biphori (Salpa); *Krohn.*—Hemipsilus, a new genus of Annelida; *de Quatrefages.*—Thirteenth notice on the Cryptogamous plants recently discovered in France; *J. B. H. J. Desmazières.*—On the motion of the sap in the interior of cellules; *Hugo Mohl.*—Monograph of the genus Pentarhaphia, and a new genus of the family Gesneriaceæ; *J. Decaisne.*—Flora of Sumatra; *W. H. de Vriese.*—On the Vanilla; *Desvaux.*—Description of a new genus of plants near Cliftonia, and observations on the affinities of Saurauja, Sarracenia and Stachyurus; *J. E. Planchon.*

COMPTES RENDUS; xxii, *Oct.* 12, 1846.—On a meteor of March 21, 1846, and calculations of its distance, &c.; *M. Petit.*—Human bones in Algiers in ancient tombs of unknown origin; *M. Serres.*—On the composition of the salts of antimony; *M. Peligot.* *Oct.* 19.—Comparison of observations on the new planet with the theory deduced from the perturbations of Uranus; *Le Verrier.* *Oct.* 26.—Physiological action of chlorid, bromid, and iodid of potassium; *Bouchardat* and *Stuart Cooper.*—New combinations of cyanid of mercury; *Poggiale.*—On the conversion of sulphuretted hydrogen into sulphuric acid; *Dumas.*—On the law of compressibility of elastic fluids; *Regnault.*—On xyloidine; *Pelouze.* On Isomeromorphism; *A. Laurent.*—Arsenic in mineral waters; *Figuier.* *Nov.* 2.—On the compressibility of liquids, and especially of mercury; *Regnault.*—On xyloidine; *Pelouze.* *Nov.* 9.—On xyloidine; *Pelouze.*—On the projectile force of gun-cotton; *Merin.* *Nov.* 16.—On xyloidine and pyroxyline; *Pelouze.*—On gun-cotton; *Robert, Payen, Seguier, Clerget, Combes* and *Flandin.*—On the temperature of the Geysers of Iceland; *Descloiseaux* and *Bunsen.*

PROCEEDINGS (BERICHT, &c.) OF THE BERLIN ACADEMY, Aug. 1846.—Description on new genus of Mammifera from Mozambique; *Peters.*—On the daily change of temperature of the atmosphere; *Dove.*

ARCHIV FÜR NATURGESCHICHTE, W. F. ERICHSON. No. 3, for 1846.—On the structure and relations of the Polygastric animalcules, &c.; *C. Eckhard.*—Development of the Limnæus stagnalis, ovatus and palustris; *A. F. F. Karsch.*—On the Geographical Botany of Texas; *F. Lindheimer.*—On the genus Oncodes; *W. F. Erichson.*—Review of the Works on Physiological Botany for the years 1844, 1845, (concluded); *H. F. Link.*

THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

Art. XXX.—*On the Relations which exist between the Phenomena of Erratic Blocks in Northern Europe and the Elevations of Scandinavia;* by M. Desor.*

There is a point in the phenomena of boulders not hitherto presented, which appears to me capable of throwing much light on the question that now engages our attention: it is the examination of the connection which subsists between the erratic blocks of Northern Europe and the elevation of Scandinavia. These relations are the more important, as they admirably explain some circumstances which are peculiar to the erratics of the north, and of which there is no example in Switzerland. These peculiarities are: 1, the occurrence of polished and grooved surfaces beneath the present level of the sea: 2, the existence of *marine shells* attached to the polished rocks at a height much above the *present* level of the sea: 3, the presence of marine shells in the midst of the diluvium even at an elevation of eight hundred feet: 4, the *osars*, or ridges of boulders and stones which contain the shells of the Baltic.

Among the phenomena which prove so fully the instability of the Scandinavian soil, there are some facts which indicate the elevation of the land, while others on the contrary attest its subsidence. Thus, we cannot have less equivocal proof of an elevation of a country, than the occurrence at a great height and at a considerable distance from the coast, of shells now inhabiting the adjacent seas, and whose perfect state of preservation leaves no doubt that they lived where they now occur: for had they

* Communicated by the author, through Prof. Agassiz, for this Journal. Translated from the French.

been transported by a current or any other violent agent, they would have been broken or at least much worn. But should we refuse to admit the evidence which these shells offer, we cannot deny the proof afforded by the serpulas of Christiania and the barnacles of Uddevalla, whose shells still adhere to the rocks far above the sea.

On the other hand, the fact that the striæ and furrows are continued *beneath the waters of the sea*, attests no less strongly that at a certain epoch the land must have been more elevated than now. In fact, it is a point on which the partizans of different hypotheses are nearly agreed, that the phenomena of erratics took place over a submerged country. Glaciers can advance only as far as the limits of the land: we learn from the observations of Mr. Martins, that even the glaciers of Spitzbergen do not project beneath the sea; for, as the temperature of the water is above that of the ice, it melts the glaciers by its contact, and a considerable space equal to the height of the tide, separates the glacier from the water.*

But if, as I believe I have sufficiently proved, the polished surfaces of the north have been occasioned by immense glaciers, which have transported from afar the erratic blocks of Scandinavia and furnished the materials of the diluvium and of the *osars*, it follows that the whole country which bears traces of scratches, must have been out of water when the glaciers produced this polishing and made the striæ and furrows which we now see there. If these striæ were exactly at the level of the sea, we might suppose that Scandinavia was then at the same elevation as at the present day. But we have seen numerous cases in that island in which the furrows are found *under* the sea, from which facts we must conclude according to the principles laid down, that the land at that epoch was as much above its present height as the striæ are now below the waters. These results although opposed, are not as they may at first appear, contradictory; and it is here that the observation of shells completes the study of erratic phenomena properly so called, by showing us the chronological order of these events. In fact, the barnacles of Uddevalla and the serpulas of Christiania which are found, the former at the height of two hundred, and the latter of one hundred and seventy feet above the sea, prove irresistibly that the coast has sunk in these places: the fact that these animals are adhering to striated rocks, shows not less certainly that

* In order that glaciers should advance upon the bottom of the sea, it is necessary that the temperature of the water should be below zero the year through; but such a climate would render the formation of glaciers impossible. A humid atmosphere rather than a severe temperature, is necessary to the existence of glaciers, and the former is incompatible with the temperature of a sea constantly below zero.

the rocks were dry before these animals were living there; whence I read this double conclusion: 1st, that the graving of the rocks was anterior to the epoch of the barnacles and serpulas, and 2d, that to receive these animals, the coasts of Uddevalla and Christiania must have sunk as far at least as would be equivalent to the actual height of these fossils.

But the barnacles and serpulas are not the only proofs of this subsidence. At a much greater height we find shells, over these polished and striated rocks, imbedded in the diluvium; and as the species are in general indigenous, and probably contemporaneous with the serpulas and barnacles, it follows of course that the submergence must have been considerable, and equal at least to the site of the highest shells of the diluvium, (eight hundred feet.) This submergence must consequently have taken place between the epoch of the furrowing and the stratification of the diluvium. At that time the glaciers having quitted the plain to retire to the interior mountains, the waters of the sea invaded all the low country of Scandinavia, surrounding the solid masonry of the Scandinavian mountains with an ocean to which we shall be able to fix some approximate limit when we are acquainted with the boundaries of the region of diluvial shells. In passing, I would remark, that the analogy of the erratic blocks of Finland with those of Scandinavia, allows us to believe that at that time the Gulf of Bothnia was not separated from the North Sea.

We have no means of determining the length of time which elapsed between the retiring of the glaciers, and that subsiding of the soil which led to the invasion of the sea. However, the perfect preservation of the polishing beneath the diluvium, would seem to prove that the period could not have been long. Nowhere are the grooves and scratches more distinct, than where they have been uncovered by removing the diluvium; they usually form a striking contrast with those rounded rocks whose surface has been for a long time exposed to the wearing effects of the atmosphere.* But as we have no reason to suppose that the action of the atmospheric agents was formerly less energetic than now, I am compelled to believe that the preservation of the polished surfaces under the diluvium, is owing to their having been exposed only a comparatively short time to wear from these agents. It is even probable that the invasion of the sea was one of the causes which have been active, if not decisive, in the destruction of the great glaciers. It explains at the same time the colder

* We may believe, that if after a new deluge the boulders which are at present exposed should be covered again with gravel, the geologists of future ages would have much more trouble in ascertaining the causes which have produced the effects, than we have at the present day, aided as we are by the preservation—frequently admirable—of the polishings, furrows, and fine striæ.

character of the diluvial fauna; for a mass of ice so considerable could not be melted without materially chilling the waters which bathed it. The cold having slowly disappeared, the temperature would have been gradually elevated, and the fauna of the waters would take by degrees the more temperate character which distinguishes it at the present day.

To this epoch of the invasion of Scandinavia by the waters of the sea, we should refer the arrangement in beds of the mud, sand, and gravel, which the great glacier has left in place in testimony of its ancient extent. The action of waves coming in upon this movable soil, has here overturned and heaped up the debris of marine life upon the shore, where the remains are found mingled with scratched rocks and pebbles. If such is really the origin of these deposits, there is no reason for surprise that the scratched pebbles should be so numerous. The waves in striking them against each other, would wear them more or less; and if blocks of a considerable size have generally better preserved their markings than the pebbles, it is because from their weight they were less exposed to being moved and rolled. It is very natural in Switzerland, where the action of the waters has been less manifest and less prolonged, that the striated pebbles should be more numerous. Thus you do not find there, or only occasionally, distinct beds in the properly glacial deposits. Those which are met with, ordinarily occur in the neighborhood of torrents.*

After this epoch of immersion, even the proximate duration of which it is impossible at present to ascertain, the country of Scandinavia was again elevated. The shores bordering the high central regions, the plains of Sweden, and those of Finland, were successively raised from the bosom of the waters, bringing back with them to the surface the same mud, the same diluvial gravel, which had been deposited by the glaciers and which had undergone no other change in the interval than that of being irregularly stratified and mingled with shells. The depressions of the soil alone remained covered with water, and formed the lakes of Sweden and Finland, as well as the Gulf of Bothnia. The last, isolated from the ocean by the elevation of the intermediate land, has lost by degrees its saltness; and this explains the character of its fauna, which is rather the fauna of brackish water than that of the sea. The interior lakes also were transformed completely into freshwater, and here and there may perhaps be found some indications of their ancient condition. It appears that certain fishes in particular have resisted these changes in the water, and according to researches of Scandinavian zoologists, especially of Mr. Esmark, the trout of Swedish lakes (*Salmo*

---

* Voy. Rod Blanchet, Terrain erratique alluvien du Cassin du Léman.

trutta, L.) is only a species of salmon, like the *Salmo salar*, L. But as the salmon of the coast does not ascend into the lakes, we are naturally led to the conclusion, that this fish has resisted the modifications that have occurred where it dwells. The immersion of land does not take place alike in all parts; the beautiful observations of Messrs. Keilhau and Bravais, upon the ancient marks of the level of the Scandinavian sea, teach us that there it was not uniform throughout. Finally, if it is true that the *osars*, which may be traced a long distance into the interior and whose mode of formation we have explained above, indicate successive sea shores, it follows that the Gulf of Bothnia was once much larger than at present. A large belt of coast now under cultivation, was then under water, and only gradually became elevated.

This successive retreat of the waters has taken place mostly during the present epoch, as undeniable traces of man* are found in the interior of the *osars*. It is probable that during this period of slow immersion, there lived in Scandinavia a primitive people, an entirely different race, as their osteology indicates, from that of recent Scandinavia, and whose skeletons are found in the peat beds mingled indiscriminately with those of animals, some of which have completely disappeared from the surface of the earth, such as the *Bos urus*, and others which are no longer known in the same countries, as the reindeer.†

Conclusion.—It follows from the preceding considerations, that whilst the upheavals of Scandinavia are of great importance in the study of erratic blocks, the latter furnish us in their turn with valuable hints as to the time and the geological bearing of these elevations. I have shown that the elevations are not confined to the historical epoch, but extend far back into the period of the diluvium. On the other hand we learn from the same examinations, that these elevations have not been continuous; that on the contrary they were intermitting and in sweeps, since the soil is successively raised and depressed. We have distinguished in this connection three principal points: 1st. An epoch when the land was higher than now, the epoch of the glaciers; 2d. A general sinking of the plains of Scandinavia, bringing with it an irruption of the sea; 3d. The rising of the same plains, which is even now in operation.

Each of these periods must have had a considerable duration. We can readily believe that while an agent is acting so slowly that a glacier might transport for hundreds of leagues the stones and gravel taken from the Norwegian mountains, a long time must have been required, whose minimum of years would be thousands, if the movements of glaciers in our day are regarded as a criterion.

---

* See Lyell, upon the proofs of a gradual elevation of the soil in certain parts of Sweden.

† I am indebted to the beautiful works of Messrs. Wilson and Eschricht for these details.

The second period must have been at least as long, if we consider the time required for the existence, propagation, and death of an entire fauna, whose numerous remains are found upon a land once submerged.

Finally, the third period comprehends the historical epoch, when the country was inhabited by the foreign race whose remains are discovered in the peat beds.

It follows therefore, that the glacier epoch is not merely an accident in the history of our globe, but that it embraces a long period, the more important to the geologist, that it is the connecting link between the antediluvial times and the historical era.

Art. XXXI.—*On the Analysis of the Oat;* by Prof. John Pitkin Norton, of Yale College.

(Continued from p. 236, this volume.)

3. *Of the Ash yielded by the Chaff.*—The chaff forms a very small and seemingly unimportant part of the plant; but it is in reality indispensable to its perfection, and a close examination shows that it is admirably adapted to its particular end.

1. The quantity of ash which it yields is greater than that left by any other part, and as in the other parts, this quantity varies with the soil and with the variety of oat.

The following table exhibits the per-centage of ash and water, in seven specimens of chaff.

Table XXI.

	Hopeton Oats.			Sandy Oats.	Dun Oats.	Potato Oats.		Mean of seven trials.
	No. 1.	No. 2.	No. 3.			No. 1.	No. 2.	
Per-centage of water, . . .	10·28	10·69	10·58	9·60	11·62	11·16	10·95	10·69
Do. of ash, calculated dry,	7·23	10·69	16·53	18·97	19·16	18·59	27·47	16·94

It is singular that the per-centage of water in the thin, dry, light chaff, should be fully equal to that in the straw.

The average of the above is nearly 17 per cent.; as this is higher than that of any other part, so no other exhibits so wide a range. The chaff of Potato oat, No. 2, has nearly four times as much ash as that of Hopeton oat, No. 1. This last-mentioned chaff is from the sample of oats I have noticed before, as grown on a poor mossy soil.

2. The quality of the ash from the chaff also varies greatly in different samples, and its composition suggests some interesting inquiries. As before, I will give an extended analysis first.

Composition of Ash from Chaff of Hopeton Oat, from Mr. Harbottle, Hexham, Northumberland.

TABLE XXII.

	Per-centage.
Sulphuric acid, ...	5·32
Chlorid of sodium, (common salt,)	5·11
Potash, ... } Soda, ... }	7·96
Phosphates of lime, magnesia, and iron, . . .	5·84
Lime, ...	4·55
Magnesia, ...	1·84
Soluble silica, ...	11·99
Insoluble silica, ...	56·05
	98·66

The quantity of silica in this ash amounts to nearly 70 per cent., being much greater than in any ash that I have before instanced. There is an extraordinary quantity of soluble silica in this chaff, and it may probably in this respect be considered an extreme case, for I have not found so much in any other sample.*

The office of the chaff seems to be to protect the oat during the earlier stages of its growth. For this reason fully one-sixth of its weight is ash, and of this ash 70 per cent. is silica. While the husk is yet soft and green, the chaff has arrived nearly at maturity, and closely envelops the tender seed with its flinty covering. As the husk gradually hardens, the chaff unfolds, and at last leaves the grain entirely to this its ultimate protector.

3. It now remains to show that the chaff varies in quality as well as quantity. The above single analysis must not be considered as a standard for the composition of the ash in other samples, it only indicates its leading features. The four following analyses, on a less extended scale, will be found to present variations equally extensive with those we have noticed in the other parts of the plant.

Composition of Ash from four specimens of Chaff.

TABLE XXIII.

	Hopeton Oats.		Potato Oats, Gravelly soil.	Dun Oats, Good loam.
	No. 1. Light Barley soil.	No. 2. Poor Moss.		
Salts soluble in water, chiefly sulphates and chlorids, ...	35·02	34·12	19·86	18·66
Phosphates of lime, magnesia and iron,	4·29	8·73	2·26	2·40
Lime and magnesia, ...	4·03	7·14	7·01	4·44
Silica, ...	56·65	50·01	70·86	74·50
	99·99	100·00	99·99	100·00

* I have taken many precautions in my determinations of soluble silica; in the above instance the quantity was so large, that I fused the substance obtained with carbonate of soda, and confirmed my previous result. I was at first accustomed to burn and weigh, before treating with acid, that portion of the watery solution which refused to redissolve after evaporation to dryness; but latterly, fearing that by burning, some alkaline silicates might be formed insoluble even in strong acid, I added the acid to the undissolved portion before burning.

The soluble silica, here included in the salts soluble in water, is to be added to the insoluble silica. With this addition, the silica in the last sample amounts to about 80 per cent. The Hopeton chaff, No. 2, is from the same mossy land which I have noticed in all the other parts as deficient in silica. In the chaff and leaf, however, this deficiency is not so great as in the straw; a subsequent table, No. 30, will show that the husk also has nearly its full proportion. This partiality, as it may be called, in the distribution of silica, I have noticed in several other analyses of the various parts. The leaf must have its framework to sustain it, while drawing food for the whole plant from the atmosphere; the chaff must have a large quantity of silica to form an effective covering for the tender oat; and the husk also must in its turn be fitted to protect the grain through all vicissitudes, until it is committed to the earth, and has commenced its growth. We find it actually the fact, that these parts are better supplied than the stalk, a part which can better perform its functions with a small supply than any other. Are we not then justified in supposing that some law exists by which those parts, where a particular substance is most needed, are supplied, even to the deprivation of other parts which can *exist* with a smaller quantity? Nature thus does all in her power towards the complete performance of her duties. She labors to perfect the leaf, the chaff, the husk, and through them finally the seed, upon which the future continuance of the species depends; if now the materials are exhausted, the straw must be weak and imperfect. *Nature* can do no more, the necessary substances are not within her reach, or she is prevented from obtaining them by the physical condition of the soil; the responsibility is thrown upon the cultivator, who has neglected his duty in the preparation of the soil, or in furnishing those substances which are essential to its fertility.

4 and 5. *Of the Ash yielded by the Husk and the Grain.*— In the consideration of the *quantity* of the inorganic constituents of the husk and of the grain, I shall separate them as I have done the other parts of the plant. In the first place, however, I shall draw attention to some points in which comparisons of the two parts are involved.

1. I have thought it of some importance to ascertain the relative proportions of husk and grain in different samples of oats, with the view of determining whether this might be an index of quality.

The following table gives these proportions in nine samples of oats.

Table XXIV.

	Hopeton Oats.				Potato Oats.	Dun Oats.	Victoria Oats.	Black Tartary Oats.	Sandy Oats.
	No. 1.	No. 2.	No. 3.	No. 4.					
Grain in 100 parts,	76·4	77·99	77·39	74·26	76·80	76·28	71·86	72·38	76·28
Husk in 100 parts,	23·42	22·0	22·61	25·55	23·20	23·66	28·22	27·62	23·68

An average of the above gives 75·54 as the usual proportion of grain, and 24·26 of husk. I am inclined to think that this separation cannot be considered a *certain* indication as to quality, because the above Victoria oat, which afforded the largest per-centage of husk, was sent as a sample of peculiar excellence, having yielded an extraordinary quantity of fine meal to the boll. The thinness of the skin, in this instance, was more than an equivalent for the thickness of the husk.

2. Of the water in the oat at ordinary temperatures, the annexed table gives the per-centage in five of the ordinary varieties.

TABLE XXV.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Per-centage of water, . .	13·02	13·59	11·02	11·50	11·90

The mean of the above gives about 12 lbs. of water in 100, or about 5 lbs. in a bushel of oats, as they are when kept in a dry place at the ordinary temperature. This is probably somewhat below the true average, as my determinations were made upon oats that had been kept for some time in small parcels.

I was next desirous to ascertain how much of this water was contained in the grain, and in the husk respectively, and accordingly made trials of each part separately. The following table contains my results.

TABLE XXVI.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
Per cent. of water in grain,	13·17	13·66	11·06	11·27	11·56	12·10
Do. do. in husk,	12·55	13·38	10·19	10·09	11·52	11·09

The difference is not great. It is singular that the husk should contain so very nearly the same per-centage as the grain, a body we should suppose so much more suited to absorb and retain water. The chaff, as we have seen, presents an analogous case.

3. The next inquiry relates to the quantity of ash, and is of much importance. I am now to show that in these two parts of the plant, the ash varies in quantity under different circumstances of growth, as we have found it to do in the parts already examined. I shall first give the husk and grain separately, and then the quantity yielded by the whole oat.

The annexed table gives the per-centage of ash in the dry husk and grain of different varieties of oats, grown on unlike soils.

TABLE XXVII.

	Hopeton, Light loam.	Hopeton, Poor moss.	Hopeton, Lime-sick land.	Hopeton, Reclaimed moss.	Potato, Thin gravel.	Dun, Good loam.	Sandy, Gravelly loam.	Mean of seven trials.
Ash in grain,	2·14	2·81	2·28	2·32	2·22	2·11	1·61	2·07
Ash in husk,	6·47	5·27	6·49	7·11	6·99	8·24	6·03	6·66

It appears from the mean of the above trials, that the husk contains three times as much ash as the grain. The variations of ash in the different samples of each are not so wide as in other parts of the plant, but there are no two even of the same variety alike.*

The following table gives the per-centage of ash in the whole oat.

TABLE XXVIII.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	Mean of eight trials.
Per cent. of ash in whole oat calculated dry,	3·17	3·32	3·37	3·25	3·56	2·58	2·66	3·65	3·19

If we take the above mean as near the true one, the bushel of 40 lbs. contains nearly 1¼ lbs. of ash; a crop of 60 bushels, therefore, carries off about 75 lbs. When the whole oat is burned, we find that the grain being in so much larger quantity, brings down the united per-centage of ash far below what is yielded by the husk alone.

Having now completed these preliminary inquiries, I turn to the consideration of the composition of the ash from the husk and the grain.

I shall now separate the two parts, and give the analysis of each in a distinct table.

1. *Composition of the Ash from the Husk.*—I have already shown that the ash of this part is three times greater in quantity than that of the grain, and that it constitutes about the third part of that which is taken from the land in the seed. In proceeding another step, and ascertaining its composition, I shall first direct attention to a table containing extended analyses of the ash from four specimens, grown in widely separated parts of the country, and of the two most common varieties, the Hopeton and the potato oats.†

TABLE XXIX.

	Potato Oats, Northumberland.	Hopeton. No. 1. Northumberland.	Hopeton. No. 2. Wigtonshire.	Hopeton. No. 3. Ayrshire.
Sulphuric acid,	4·30	9·61	5·01	4·90
Phosphoric acid,	0·66	1·04	2·65	1·80
Chlorid of sodium, (common salt,)	2·39	0·24		
Chlorid of potassium,	. .	. .	2·37	0·40
Potash,	2·23	3·93	5·55	5·30
Soda,	8·97	6·33		
Lime,	4·30	1·95	4·31	2·03
Magnesia,	2·35	0·38	1·01	0·64
Peroxid of iron,	0·32	1·58	1·61	1·80
Peroxid of manganese,	. .	0·92	0·86	0·72
Soluble silica,	5·79	4·46	2·91	1·61
Insoluble silica,	68·39	68·39	71·82	80·11
	99·80	98·83	98·10 F.	99·33 F.

* The grain burns with exceeding difficulty. The abundance of alkaline salts is so great that it is almost impossible to prevent their melting, and enveloping the carbonaceous matter. I have, in some instances, been compelled, after charring the grain, to dissolve out these phosphates, by boiling in successive portions of distilled water. The remaining ash then burns white. The alkaline solution is again added, and the whole evaporated to dryness. This method, *with care*, is perfectly accurate.

† The analyses marked F, are from Mr. Fromberg.

The very large per-centage of silica is one of the most striking features in this table. It amounts in every case to more than 70, and in Hopeton oats, No. 3, to more than 80 per cent, averaging considerably higher than in any other part of the plant. It is no doubt present in such quantity that the husk may be a proper covering to the grain. While the husk is yet green, the chaff, as I have stated, protects both it and the grain; but this is only until the husk arrives at maturity; it is then, by itself, admirably fitted to protect the grain, and the chaff is no longer necessary.

In the salts soluble in water, sulphuric acid still predominates; phosphoric acid is usually there also, but in minute quantities, and the phosphates in the acid solution seldom amount to more than 1 or 2 per cent. In two of these analyses there is no soda, neither is it found in the ash from the grain of the same oats. The two alkalies seem to fulfill the same purpose in the economy of the plant, and it appears to take one or both indifferently, as they are more or less abundant in the soil.

The above table has shown that the ash of the husk varies in its composition, but I have prepared another in a condensed form, which exhibits the fact more distinctly.

Composition of Ash from four samples of Oat Husk.

TABLE XXX.

	Hopeton Oats.		Potato oats, Gravelly soil.	Dun oats, Good loam.
	No. 1, Light sandy loam.	No. 2, Poor moss.		
Salts soluble in water, chiefly sulphates and chlorids,	22·92	33·84	23·14	19·96
Phosphates of lime, magnesia, and iron,	1·84	4·62	1·10	2·49
Lime and magnesia, ...	6·79	1·54	5·18	3·28
Silica, ...	68·55	60·00	70·57	74·25
	100·00	100·00	99·99	99·98

To the insoluble silica in each of the above, must be added 4 or 5 per cent. of soluble silica contained in the watery solution. The Hopeton oat husk, No. 2, on "poor moss," is the same to which I have referred before. It is less deficient in silica than any part of the plant to which it belongs. Its demands, as most imperative, seem to have been supplied first.

No part of the plant has so small a portion of salts soluble in water as the husk. From the instance of the Dun oat above, they may even be below 20 per cent. in a perfectly healthy sample, for this was inferior to none in general appearance and size.

2. *Composition of the Ash from the Grain.*—With this last part of the plant I shall follow the same plan as I have hitherto pursued, first giving extended analyses, and then directing attention to the differences caused by variety of soil, manure, &c.

TABLE XXXI.

	Potato Oats, Northumberland.	Hopeton Oats.		
		Northumberland.	Ayrshire.	Ayrshire.
Sulphuric acid,	. .	17·37		
Phosphoric acid,	49·19	38·48	46·26	50·44
Chlorid of sodium, (common salt,)	0·35	0·49		
Chlorid of potassium,	. .	. .	5·32	1·03
Potash, } Soda, }	31·56	20·96	16·27	20·65
Lime,	5·32	6·57	10·41	10·28
Magnesia,	8·69	11·00	9·98	7·82
Peroxid of iron,	0·88	0·38	5·08	3·85
Peroxid of manganese,	. .	. .	1·25	0·42
Soluble silica,	0·89	1·29		
Insoluble silica,	0·98	2·31	3·70	4·40
	97·86	98·85	98·27 F.	98·89 F.

In every part of the plant hitherto, we have found sulphuric acid in the watery solution of the ash; in the grain it seems to give way to phosphoric acid. In only one of the above analyses is it present; the grain was from a poor crop, grown on an exhausted soil, and it is possible that the sulphuric acid may have been present only because it was impossible to obtain a full supply of phosphoric acid.

The large quantity of this acid is remarkable; in nearly every case it constitutes almost or quite one-half of the ash. It is easy, therefore, to see how the addition of bones or guano should benefit the oat crop.

Silica, heretofore so prominent an ingredient in the ash, is here very small in quantity.

The second sample of Hopeton oats was grown on what is called lime-sick land, but it will be perceived that the proportion of lime is not larger than in some of the other ashes. This is in accordance with an opinion of Prof. Johnston, first suggested after an analysis of a lime-sick soil, that the defect does not consist in a superabundance of lime, but in a physical condition of the soil, produced originally by too large a dose of lime at once. The oats from this soil were very poor, the grain full sized but light. The quantity of chlorine is large compared with the others, as is that of the oxide of iron also, otherwise there are no very striking differences.

The grain constitutes three-fourths of the weight of the oat, and furnishes a little more than one-half of the ash; in which ash, if we consider 45 lbs. of phosphoric acid the average, a crop of 60 bushels will carry off about 68 lbs. of that acid, equivalent to about 300 lbs. of bones.

From the many analyses of grain that I have made, I will only select three, in addition to those which I have already given.

The three samples of oats to which the grain belonged were obtained through the kindness of my friend Mr. Simpson of Teawig, Beauly, Inverness. In accordance with my request, he selected specimens from the same neighborhood, grown on very unlike soils. They were of crop 1844.

"No. 1. *Sandy Oats.*—Grown on a stiff clay soil, which was much *baked* by the early summer's drought. They were after grass sown with wheat laid down after a crop of turnips, manured with farm-yard dung and a small quantity of bones. Crop, four quarters per acre."

"No. 2. *Hopeton Oats.*—Grown on a poor sandy soil, which also suffered much from the drought. The oats were after two years' grass, pastured, the grass sown down with barley, after a turnip crop (raised with bones), which was all eaten off on the ground by sheep. Produce, *three quarters* per acre."

"No. 3. *Hopeton Oats.*—Grown on a deep rich vegetable mould, one of the best soils in that part of the country. Managed in the same manner as No. 1. Produce, *eight quarters* per acre."

I will first give the per-centage of ash obtained from the grain of these oats, and then its composition.

Per-centage of Ash in Grain, from Mr. Simpson.

Table XXXII.

	No. 1.	No. 2.	No. 3.
Ash calculated dry, ...	1·80	1·48	2·48

The differences in this table are certainly very striking; after the above account of the soils, and amount of the crops, they scarcely need any explanation. The poorest crop has least ash. This is a very decisive proof of the absolute necessity of this small portion of inorganic matter to the grain. The scanty supply yielded by the soil of No. 2 seems to have made a difference of five quarters per acre in the crop.

We will now consider the composition of these ashes, as given in the following table.

Table XXXIII.

	No. 1.	No. 2.	No. 3.
Salts soluble in water, chiefly sulphates and chlorides,	68·52	70·96	72·96
Phosphates of lime, magnesia, and iron, . .	21·60	18·63	12·42
Lime and magnesia, ...	7·10	7·11	11·95
Silica, ...	2·78	3·30	2·67
	100·00	99·99	100·00

The chief differences in these ashes are in the lime and magnesia, and in the phosphates. It seems strange that the latter should be least in the ash of No. 3. This would perhaps be explained by some local circumstances, with which I am not acquainted.

The quantity of silica, in the ash of No. 2, from the sandy soil, is, as we should expect, somewhat larger than in the others.

On the whole, the differences between these ashes, are not very striking, and it would be hard to say from an inspection of the above, which had belonged to a poor crop. This fact is most worthy of attention, since, in so far as the present analyses go, they show that the plant will only produce as many *seeds* as it can bring to perfection, so far as the inorganic part is concerned. It may, and will, as we have seen, produce an imperfect straw, but the essential parts of the ash of the *grain* must always be present, and that too in the proper proportions.

Before closing my account of the inorganic part of the oat, I will introduce two tables, the first of which gives a comparative view of the per-centages of ash yielded by all the parts of the plant in different specimens, and the second an analysis of each of these parts united in one table, so as to give a comprehensive view of the whole.

1. *Comparative view of the quantity of Ash yielded by the different parts of the Plant. Calculated dry.*

TABLE XXXIV.

	Hopeton, Northumberland.	Hopeton, Fife.	Potato, Northumberland.	Dun, Edinburgh.	Sandy, Fife.	Mean of each part.
Grain, . .	2·14	1·81	2·22	2·11	1·67	2·00
Husk, . .	6·47	6·03	6·99	8·24	6·03	6·75
Chaff, . .	16·53	17·23	18·59	19·16	18·97	16·09
Leaf, . .	8 44	7·19	14·59	10·29	15·92	10·88
Top straw, .	4·95	5·44	9·22	8·25	11·01	7·77
Middle straw,	6·11	5·23	7·41	6·53	9·01	6·66
Bottom straw,	5·33	5·18	9·76	7 10	7·30	6·93

2. *Comparative view of the Composition of Ash from each of the above parts in Hopeton Oats, from Mr. Harbottle, Hexham, Northumberland.*

TABLE XXXV.

	Grain.	Husk.	Chaff.	Leaf.	Top straw	Middle straw.	Bottom straw.
Sulphuric acid, .	. .	9·61	5·32	14·80	16·33	18·45	13·29
Phosphoric acid, .	49·19	1·04					
Chlorid of sodium, .	0·35	0·24	5·11	2·29	3·13	3·03	15·36
Phosphates of lime, magnesia, and iron,	. .	. .	5·84	6·13	2·84	3·03	0·78
Potash, . . Soda, . .	31·56	10·26	7·96	14·89	19·09	21·80	43·17
Lime, . . .	5·32	1·95	4·53	6·99	7·02	7·23	6·06
Magnesia, . .	8·69	0·38	1·84	2 55	2·84	2·91	2·07
Peroxid of iron, .	0·88	1·58	0·24	. .	0·30	1·40	0·61
Peroxid of manganese,	. .	0 92					
Soluble silica, .	0·89	4·46	11·99	5·90	5·13	7·34	5·03
Insoluble silica, .	0·98	68 39	56·05	45·75	43·31	33·14	12·25
	97·86	98·83	98·90	99·30	99·99	98·33	98·35

Sprengel and Boussingault have published analyses of the grain of oats. Those of Sprengel are inserted in Prof. Johnston's Lectures, and those of Boussingault in his own works. As all the results hitherto presented in this paper are original, I merely refer to these without introducing them.

I have now finished the course that I at first marked out for the inorganic division of this chapter. The plant has been divided into seven parts, the top, middle, and bottom straws, the leaf, the chaff, the husk, and the grain. The leaf was again subdivided into a bottom and top part. Of each of these nine parts it has been shown—

1. That it varies from every other, both in the quantity of its ash, and the composition of that ash.

2. That variations also exist between the ash from different specimens of the same part, grown on different soils.

3. That in these variations, although often very great, the distinctive character of the part is always preserved; the composition of the ash from the husk, for instance, never being like that from the straw or leaf.

4. That the soil has a direct influence on the quality of the ash. This has been proved in several instances, and particular deficiencies pointed out.

5. That each part is furnished with an ash—in quantity and quality peculiarly adapted to the function which the part is designed to fulfill.

The silica, for instance, is in the straw so distributed as most effectually to strengthen those parts which need its supporting power; in the leaf it sustains an extended surface of pores in contact with the atmosphere; in the chaff it forms an impervious coating for the husk, until that part has also received a supply which enables it to protect the grain, upon which the perpetuation of the species depends.

Equally beautiful are the facts which we discover respecting the alkaline sulphates and phosphates. We find little of the latter in the whole length of the straw, in the leaf, or in the chaff. But when we arrive at the grain, the alkaline sulphates disappear, and the phosphates take their place; these have passed up the whole length of the stalk, avoiding the leaves and the chaff, and at last, by a law infinitely more unerring than any which human wisdom can devise, deposited themselves in the very place where phosphoric acid is most needed, in order that, as part of the food, it may build up the bones, the framework of the animal body.

These are only two of the many theoretical deductions that we have been enabled to draw during our gradual ascent.

But it is not only such theoretical and physiological questions that have been elucidated by these analyses; they indicate many facts of great importance to the practical man.

The composition of every part of the healthy plant being known, the means for obtaining a healthy crop are obvious. The inorganic part being entirely derived from the soil, to the soil must attention be directed in case of failure, and its deficiencies ascertained. With these results before him, any farmer may see that if his straw refuses to stand, the chief cause is probably a lack of soluble silica in the soil. In some of the alkaline silicates now manufactured for sale, he may find a ready means of remedying the defect.

The straw, it should be noticed, does not return to the soil all that the grain has taken from it, and thus even where all the straw is returned in the shape of manure with the greatest possible care, the land may ultimately become exhausted of the materials for the inorganic part of the grain, which is all carried away and sold. With these remarks I pass on to the second division.

II.—*Of the Organic part of the Ripe Plant.*

Under this division will come more especially the nutritive properties of oats. In the consideration of the inorganic part, attention was chiefly drawn to questions connected with the circulation of the plant, and with the best means of supplying those deficiencies which are invariably found when an imperfect crop is produced.

These inorganic substances, especially the phosphates, are indispensable to our food, but they form a small part of the whole grain, only 2 lbs. in 100. The remaining larger part merits our attentive consideration, particularly as it chiefly distinguishes the oat from other varieties of corn.

I speak here of the grain alone: that being the most important part, for its nutritive properties, I have confined my attention chiefly to it. I have also been able to make the husk the subject of a few researches. It would have been very interesting and useful to examine the straw also, but I was obliged reluctantly to conclude my observations, as the time for the delivery of this essay approached.

The proximate principles of the grain will first demand our attention, and it will be necessary, by way of preface, to give an account of the methods by which they were obtained.

The quantity of grain taken for analysis was from 75 to 100 grains.

1. This was rubbed thoroughly in a mortar, and successive portions of water added, until the starch, &c. was all washed away from the epidermis. The solution was allowed to stand in a cool place for twenty-four hours, and the liquid was then drawn off by a syphon. Fresh water was now added, and after some hours again drawn off; this was repeated until the liquid came away quite clear. The starch then remained pure, it was collected on a weighed filter and dried at 212°, until it ceased to lose weight.

2. To the solution drawn off from the starch, acetic acid was added, to throw down the casein or avenine. This was allowed to settle, and the liquid drawn off by a syphon of small bore. The precipitate was now transferred to a weighed filter. It is necessary to stop the washing while the water is still acid, otherwise a portion of the casein will be re-dissolved. It was now dried in the same way as the starch.*

3. The solution separated from the casein was evaporated to a very small bulk, and treated with strong alcohol to throw down the gum. After standing some hours the gum was collected on a filter, washed with alcohol, and dried as above.

For the remaining solution nothing more was determined.†

4. The epidermis, after separation from the starch as above, was collected in a retort, and boiled with acetic acid. On neutralizing the solution, a small precipitate of albumen fell. This was collected, and the epidermis boiled again in a very weak solution of caustic potash. On neutralizing the solution, another slight precipitate of some protein compound was obtained. This was so small in quantity that it was classed with the albumen. After this boiling with caustic potash the epidermis was collected, washed, dried, and weighed.

5. To determine the oil, sugar, and glutin, a fresh portion of grain, about the same weight as before, was taken and boiled with successive portions of alcohol, until a drop left no trace on evaporation. The solution was then carefully distilled to dryness in a small retort. The dry mass was treated with successive portions of pure ether to dissolve the oil; and this ethereal solution was carefully evaporated to dryness in a small weighed capsule.

---

* This substance has been called casein, because in many respects it resembles some of the kinds of casein found in other bodies; but as its exact composition has not yet been determined, I use for it the provisional name of *Avenine* proposed by Prof. Johnston.

From the casein of milk, it differs in some important properties. Rochleder describes the casein of milk as *soluble* in *weak acid*, but precipitated by more acid and weak alkalies. *Insoluble*, when free from acid or alkali, in *water*.

I have found the casein of oats to agree more nearly with the casein of beans, as described by Liebig. He says, "It is soluble in *cold water*, *does not* coagulate by *heating*, is precipitated by dilute acetic acid, and is *not soluble* in an *excess*.

The casein of oats is *very soluble* in pure water, being nearly all dissolved by the first water added to the bruised grain. *Weak* acetic acid causes an abundant precipitate, which an excess of acid does not seem to re-dissolve, as no precipitate fell from the liquid filtered and neutralized by carbonate of soda. Boiling a portion of the original solution did not coagulate the casein, but after cooling, on the addition of acetic acid, the precipitate fell more quickly than before. When this was filtered and neutralized by carbonate of soda, a slight precipitate fell, showing that the casein was slightly soluble in an excess of acetic acid by the aid of heat, or that there was a small quantity of albumen present.

† I made some experiments upon the legumin of almonds, to which also this casein seems to bear some resemblance. A copious precipitate of legumin falls on the addition of a little acetic acid, but a small portion of it re-dissolves in an excess. From the strongly acid solution filtered and neutralized by carbonate of soda a slight precipitate falls.

After weighing, it is safer to re-dissolve the oil, and evaporate again, as some of the sugar sometimes finds its way over with it.

6. The mass left in the retort is now treated with water to dissolve the sugar; this solution is also evaporated to dryness in a small weighed capsule. It is an impure sugar, always containing more or less of the soluble salts of the inorganic part.

7. The substance originally dissolved by alcohol and finally left undissolved by water in the retort, was considered analogous to the glutin of wheat, and was accordingly set down as such in the analyses. It was collected, dried, and weighed, either in a cup or on a filter.

Having now described the process employed, I will proceed to give the results obtained by it in four specimens of grain, the same four of which the full inorganic analysis of the ash was given.

The soluble salts of the ash are in these analyses distributed to some extent among nearly all the substances. It is impossible to say how much water dissolves when the grain is unburned, and an indefinite quantity of this undetermined portion is thrown away in the solution from which the starch, &c. are obtained. The quantities contained in the precipitates can only be determined by burning them all. I have, in the following analyses, considered the greater part of the loss as alkaline salts, and have made the sums up to 100.

Proximate Composition of the Organic part, in four samples of the Grain of Oats. Calculated dry.

TABLE XXXVI.

	Hopeton Oats, Northumberland.	Hopeton Oats, Ayrshire.	Hopeton Oats, Ayrshire.	Potato Oats, Northumberland.
Starch,	65·24	64·80	64·79	65·60
Sugar,	4·51	1·58	2·09	0·80
Gum,	2·10	2·41	2·12	2·28
Oil,	5·44	6·97	6·41	7·38
Casein, (avenine,)	15·76	16·26	17·72	16·29
Albumen,	0·46	1·29	1·76	2·17
Glutin,	2·47	1·46	1·33	1·45
Epidermis,	1·18	2·39	2·84	2·28
Alkaline salts and loss,	2·84	1·84	0·94	1·75
	100·00	100·00 F.	100·00 F.	100·00

In reference to the above table, we naturally turn our attention

1. *To the Starch.*—The four results are remarkably uniform. I am inclined to think, however, that the starch may be stated a little too low in this table, for reasons which will afterwards appear. As the table at present stands, the quantity of starch in the oat is nearest to that in barley.

2. *The Sugar.*—This, as I have said, is impure, and a little deduction should be made from its weight, especially in Hopeton oat, No. 1.

3. *The Gum.*—The quantities of this substance are nearly alike in the four trials: wheat contains a little more—about 3 or 4 per cent.

4. *The Oil.*—The quantities of *oil* given above are large, but I think correct. The earlier analyses of oats only give from three to four-tenths of a per cent. of oil. Both Boussingault and Johnston, however, have recently found from 6 to 8 per cent. This oil is of a beautiful pale yellow color, and its smell may be perceived on heating oatmeal cakes. The fattening qualities of the oat must be very great. The maize, or Indian corn, is celebrated for fattening animals; and Dumas gives only 9 per cent. as its maximum of fatty matters. Boussingault gives 7 per cent. as the average; while Leibig has denied that it contains more than 5 per cent. If we take 7 per cent. as the average, the meal of the oat, so far as the oil is concerned, should nearly equal that of the Indian corn.

5. *The Casein (avenine,) Albumen, and Glutin.*—These three I have grouped together as nitrogenous compounds. Their quantity is certainly very remarkable, being, in the potato oat above, a little more than 20 per cent. I have been led to think, however, that the quantities of all these compounds are a little overstated in the above analyses. Every one who has engaged in this kind of organic analysis knows the exceeding difficulty of obtaining the substances perfectly pure. I am somewhat suspicious that, in defiance of my precautions, my casein precipitates may have contained a little starch. I insert the above analyses, therefore, as open to correction.

In order to arrive at a more certain result as to the actual quantity of these nitrogenous compounds, I determined the nitrogen directly, by combustion in a number of specimens.*

The annexed table gives the result of nine of these combustions. Each burning was repeated two or three times.

TABLE XXXVII.

	Hopeton Oats.			Potato Oats.		Oats from Mr. Agnew, Ayrshire.			Imperial Oats, New York,
	No. 1.	No. 2.	No. 3.	No. 1.	No. 2.	No. 1.	No. 2.	No 3.	United States.
Of nitrogen, . .	2·19	2·35	2·28	2·76	2·82	2·89	5·51	2·49	3·00
Of protein compounds,	14·00	14·78	14·04	17·36	17·77	18·24	22·01	15·66	18·86

This table shows a range of no less than 8 per cent. in the nitrogenous compounds.

---

* The nitrogen was determined by combustion of the grain in a mixture of caustic soda and lime in the usual way. The method of such combustions is so well known among all chemists, and so universally inserted in all recent chemical works, that it seems quite unnecessary to enter into a lengthened description of it here. From the ammonia-salt thrown down by platinum, the nitrogen is determined, and from the nitrogen the amount of protein compounds calculated.

Nos. 1 and 2, from Mr. Vans Agnew, were the first crop, after very old grass. No. 1 was manured with two cwt. of guano per acre harrowed in with the seed. No. 2 was *without manure.* This result is a most surprising one, and although I have repeated my trials, I feel that it needs still further confirmation. The crop being after old grass, the land must have been in good condition, and therefore would mature a crop even without the addition of guano, though that manure undoubtedly increased the yield upon the part to which it was applied. It is possible that on such a good soil with a healthy plant, the more slow growth and maturing of a less luxuriant crop than that to which guano was added, may have been more favorable to the largest possible amount of nitrogenous compounds; so that, while the seed was less in quantity, it should be richer in quality. The opinion somewhat prevalent among farmers, that guano turnips or potatoes are less nutritious than others, seems to countenance this view.

The Potato oat, No. 2, was also from a very fine crop, as was the American imperial oat, which was remarkable for its weight. The three samples of Hopeton oats were all from rather inferior soils, and poor crops.

But even if we take the lowest per-centage of protein compounds, they amount to 4 per cent. more than is stated to be the average quantity in wheat. The mean may, probably, be safely taken as 16 or 17 per cent.

Before concluding the organic part of the grain, I wish to give some account of the organic part of the husk, and afterwards some determinations in which the two parts are united.

I did not make a complete analysis of the proximate principles of the husk, but determined the oil and sugar only, by boiling in alcohol and ether, as described under the analysis of the grain.

The following table gives the results in two samples of husks calculated dry:—

TABLE XXXVIII.

	Hopeton Oats, Hexham, Northumberland.	Potato Oats, Park End, Northumberland.
Of oil, ...	1·50	0·92
Of sugar and gum, . . .	0·47	0·75

Besides these substances, there was a considerable quantity of some nitrogenous compound left undissolved by water, somewhat analogous to glutin, and amounting in one instance to 1·28 per cent. The husk, then, is by no means without value for feeding. A determination of the nitrogen by combustion, shows that in addition to 1½ per cent. of oil, it contains at least 1½ per cent. more of protein compounds.

The following table gives the nitrogen in the husk and grain separately, and afterwards in the whole oat of the same sample. The results calculated dry:—

TABLE XXXIX.

	Husk.	Grain.	Whole Oats.
Of nitrogen, ...	0·30	2·82	2·18
Of protein compounds, . .	1·88	17·77	13·72

A proximate analysis of Boussingault's gives 13·7, as the amount of protein compounds in the whole oat, exactly coinciding with the above determination. We see, then, that even including the husk, the oat is superior to almost any other corn, in those ingredients which go directly to the production of muscle in the body. The strong muscular forms of the Scottish ploughmen have long been living witnesses to the good properties of their favorite and almost only food; and now that it has been shown what those properties really are, I feel sure that Dr. Johnson's definition of oats—"Food for men in Scotland, and for horses in England"—will be remembered only for its appropriate answer—"And where will you find such men and such horses?"

In conclusion, I may be permitted to say, that the extent of this investigation, and the many points which I have been compelled to leave undetermined, or doubtful, after eighteen months of constant labor, must convince those who entertain false ideas of the time and patience necessary for chemical researches of this kind, that they have erred in supposing the chemist able to do in a few days or weeks, what can only be effected by the labor and study of many successive years.

In presenting my results to the Society, it is with a consciousness of their imperfections, and a feeling that it would have been most desirable to extend them much further in every direction.

At the same time, I think that much *new* ground has been gone over, and that in many respects the bounds of our knowledge, with regard to the oat plant, have been considerably enlarged.

I have endeavored to condense rather than extend my conclusions and descriptions, which might have reached a very great length indeed, from the mass of tables and facts now presented.

Laboratory of the Agricultural Chemistry Association, October, 1845.

Art. XXXII.—*On Free Electricity;* by Robert Hare, M. D., Professor of Chemistry in the University of Pennsylvania.

Practically there is a striking difference between the excitement of an electrified insulated conductor, the prime conductor of an electrical machine for instance, and the charge of a coated pane or Leyden jar. In the one case diruptive discharge is productive of a comparatively short thick spark, in the other of a spark distinguished by comparative length and tenuity. The discharge from the pane or jar is productive, for equal surfaces, of a much greater shock than could result from a spark ten times as long, from the conductor of the machine by which the electricity is generated. And yet if the intensity be inversely as the square of the striking distance, it must be a hundred times as great in the case of the conductor, as in that of the coated surfaces.

Electricity, as it exists in the conductor, has been called free: as it exists about the coated pane, has been called simulated or disguised. Yet Faraday has alleged "that the charge upon an insulated conductor in the middle of a room, has the same relation to the walls of that room, as the charge upon the inner coating of a Leyden jar has to the outer coating of the same jar." "The one is not more dissimulated than the other." "As yet no means of communicating electricity to a conductor, so as to place its particles in relation to one electricity and not at the same time to the other, in an equal amount, has been discovered."

It seems to me that these opinions of Faraday have been judiciously criticized by Mr. Goodman in the London and Edinburgh Philosophical Magazine and Journal,. Vol. xxiv, p. 174.

It appears likewise that opinions harmonizing with those of Mr. Goodman, have been entertained by Charles V. Walker, Hon. Sec. L. C. S., as may be seen in the Proceedings, Dec. 20, 1842. Agreeably to Mr. Walker, lightning resembles the discharge from a prime conductor, not that which takes place between the surfaces of a coated pane or jar.

I will proceed to state the considerations which induce me to concur in opinion with Mr. Goodman and Mr. Walker.

If two sufficiently remote insulated metallic disks, such as usually enter into the construction of an electrophorus, by due communication with the rubber and collecting points, be made to serve, one as the positive, the other as the negative conductor of an electrical machine in operation, a diruptive discharge from either may be obtained, by the approximation of an uninsulated conducting body, or one communicating with one conductor while approximated to the other. When this discharge takes place from a small knob on the positive side, to a large one on the negative side, of the circuit, the resulting spark is comparatively long, and by its zigzag form represents lightning in miniature.

If, in the next place, a sufficiently large pane of glass being interposed, the disks be made to serve as a coating to the glass, the surfaces of the pane which they touch will become oppositely charged. If immediately after the charging is effected, both disks being insulated, the knuckle of the operator, or any other conducting body in communication with the earth, be approached to either disk, a spark will pass, and on contact, a certain portion of electricity will be discharged. This is what I would call free electricity: but on making a conducting communication between the disks acting as coatings, a much larger discharge of electricity will take place. This is what I would call neutralized or dissimulated electricity. But the ratio in quantity of the latter to the former, varies evidently with the thickness of the pane or panes which may be interposed; so as to be inversely as the square of the distances of the charged surfaces. If a stratum of air perform the part allotted as above to the panes, the same law must hold good. But when instead of flat disks, corresponding in size and shape, we substitute a cylindrical or globular metallic mass, such as is generally used for the prime conductor of an electrical machine, on the one side, and on the other side the walls, floor, and ceiling of a room, for the other surface, evidently the ratio of the free electricity to that which can be neutralized, must be enormously great. Supposing the glass pane to be one-tenth of an inch in thickness, the distance between the surfaces of the conductor and the parietes of the room to be ten feet, the quantity of electricity neutralized in the case of the pane will be to that neutralized in the case of the conductor as the square of one to the square of twelve hundred inversely; or in other words nearly as a million and a half to one. It follows that in the phenommena of discharges from a prime conductor the neutralizing or dissimulating influence of the conducting superficies opposed to it must be too small to be regarded.

The allegation of Faraday, that no mode has been discovered by which to place the particles of a conductor in relation to one electricity, and not at the same time to the other, is verified, as Mr. Goodman has observed, when the friction between the rubber and glass takes place. The glass becomes positive to precisely the same extent as the rubber becomes negative; but when the vitreous surface thus excited moves away from the rubber, the compensating electricity of the rubber being no longer at hand, that upon the glass cannot realize Faraday's idea, excepting so far as it may be competent to act upon the walls, ceiling, and floor of the apartment, as electricity on the inner surface of a Leyden jar acts upon the outer surface. But in the case in point, the electric interposed is so enormously thick, compared with the glass in a Leyden jar, that very little of the inductive influence can avail to produce an opposite state tending to neutralize the electrical excitement "to an equal amount."

Just so far as it can produce an equivalent opposite state, it becomes dissimulated or neutralized; so far as it does not, it is free, or, in other words, exercises that uncompensated activity which has, in my opinion, justified the distinction made between free, and dissimulated, neutralized, or latent electricity.

It will be perceived that I concur with Mr. Walker in the opinion, that on account of the distance of thunder clouds from the earth, the electricity which they may acquire is too remote from the terrestrial surface to induce in this an opposite electrical state, capable of neutralizing the electricity of the cloud beyond a minute proportion.

There seems to be an obvious means of discrimination between free and neutralized electricity, in the fact, that the one is associated with the surface of a conductor, so as to accompany it when moved, while the neutralized electricity is inseparable from the superficies of the electric, through the intervention of which it exists. It is well known that the coatings of a pane or jar may be removed without disturbing the charge which may have been imparted by their presence. Yet if removed after the pane is fully saturated, each coating will hold a charge which it will give out in a spark to any uninsulated body, without any reference to the other coating which may meanwhile be remote and insulated from all communication with it. The spark thus yielded has the characteristics of free electricity. Having served as a part of the conductor, with which it had communicated, the coating is surcharged in proportion to its capacity, and gives up the redundancy on communicating with the earth, without any reference to the other coating. The spark thus given I conceive to have the characteristics of free electricity.

In the case of electric accumulations in the atmosphere, there can be no substitute for the service performed by glass in Leyden charges but that which air can render; and it can hardly be conceived that while agitated, as it is during thunder gusts, a stratum of that fluid can perform the part of a glass pane.

ART. XXXIII.—*On Zoöphytes*, No. V.; by JAMES D. DANA.

CLASSIFICATION OF ZOÖPHYTES.

General Remarks on Classification.—It has often been justly said, that there can be but one strictly natural classification in either of the organic kingdoms. Yet if we look upon any system presented in the usual order on paper, as correctly and completely *the* natural system, we greatly mistake nature; for the various affinities cannot be fully expressed on a plane surface. The lines are so many, and so interlaced, that to be understood, they must be conceived of as ramifying in space. The mind, proceeding properly to its work, determines first upon those qualities which are physiologically of the most fundamental importance: it follows out the variations of structure under the grand divisions thus ascertained, fixing its attention successively upon qualities of a less and less general character; it traces the species through the various modifications in these several particulars, marking out the lines of gradation in affinities, observing some, it may be, partly isolated and terminating abruptly, others graduating into the different series by frequent blendings or anastomosings, and often between different lines detecting a serial parallelism: in this way the network is finally completed to the mind's eye.

When the relations are fully understood, we are ready to divide off into classes, orders, and the smaller subdivisions, cutting the threads here and there, as shall best exhibit the general character of the whole, remembering to make the corresponding divisions of equivalent importance and character. The institution of these various groups is not properly classifying; for the classification is completed when the branchings and interlinkings of affinities are made out. Subdivisions with appropriate names are, however, necessary, to aid the memory and convey this knowledge in words. Genera are convenient artificial sections, based on natural affinities; and very commonly they shade almost imperceptibly into one another. Whoever has attempted to lay out classes and their families and genera, has perceived the interlinkings, and felt the perplexity they produced. It may often have seemed vexatious to the systematist to have had a *well characterized* family or genus spoiled in its characteristic, and *exceptions* introduced, by the discovery of new species which blend it with another group, before considered quite distinct. But such perplexities will not be perceived, if we follow nature with docility, and make it our aim to bring out prominently the various shadings between subdivisions. The true object of classification is not to dissect the departments of life into as many distinct parts as possible for display like anatomical preparations; but to illustrate the system of nature in its unity, and exhibit the myriad parts blended in one concordant whole.

The modifications of structure in living beings evidently proceed, to a great extent, from the nature of the world we inhabit, and the general laws and necessities of life. There are air, earth, and water, and these have their varieties of condition. Plants and animals offer other sites for living beings. The same circumstances may be said to call for the variety of size which exists in nature, for otherwise there would be possible conditions for existence unoccupied. The general nature of life, and its modes of exhibition, with the primary systems of structure, being determined upon in infinite wisdom, we need attribute no other plan to creative power than that of the simple adaptation of life, as thus constituted, to the conditions the world affords. Circles and numerical relations may amuse the imagination: but we have no evidence that the hand which made, was confined by such prescribed courses. We cannot fail to see, however, that in the primary plan of structure in living beings, certain organs or their parts, through extended groups, have been limited by fixed numbers: and this is so distinct in some classes, that it becomes an interesting study to trace out the sources of variations from the typical number.* We see the boundless resources of nature's Author displayed with greater force, the fewer the types from which an infinite variety might proceed; but not in any limiting of the number of species constituting groups.

Among the organs upon which the range of characters in the animal kingdom depends, the nervous system takes necessarily the precedence, for, as has been said with much propriety, this system is itself *the species;* since upon its characters, in connection with the general laws of organic growth, depends in a very great degree the nature of the individual. Next to this, come those organs which are intimately connected with the sustaining of life, *primarily*, those pertaining to respiration and circulation, and *secondarily*, those adapted to the receiving and digesting of food; and next, or of parallel value with the last, the provision for the continuation of the species. The means of locomotion and the associated structure, constitute a characteristic intimately

* Milne Edwards has well illustrated the fact, that *seven* is a normal number in Crustacea, the cephalic, thoracic and abdominal parts, each consisting normally of this number of segments, and variations taking place by a union of two or more segments, or by subdivisions; and this same law extends even to the joints of the legs and antennæ. The prevalence of such a law through so large a class, affords a sufficient ground for belief that specific numbers have not been entirely disregarded in any branch of nature; though the actual exhibition of them has been obscured in ways not understood. We cannot disbelieve, therefore, that numerical relations were involved in the plan of creation; yet, while admitting them as regards the *nature* of organic structures, we do not admit that the *number* of structures made on any particular type, had reference to any similar ratio.

connected with the causes just mentioned. Under the several grand divisions to which we are led by the above considerations, there are subordinate variations arising from the adaptation of life to minor differences in the conditions of existence around us:— such as minor differences of soil, (if we may extend this word to all those varieties of sites, afforded by the air, earth, water, vegetable and animal structures, variously modified by temperature, light and pressure); differences in the modes of taking prey or food of whatever kind, and in some peculiarities of the organs of digestion; certain differences depending on the sexual relations, and the means of preserving and developing the young, varying with the modes of existence alluded to; modifications of the provisions for self-preservation against enemies. These minor differences are exhibited in two ways: either particular organs retaining the *same* functions, undergo modifications in form and structure; or with other modifications, they subserve the purposes of *different* functions. When adaptations to different circumstances or purposes take place by variations in corresponding sets of organs or parts of organs, the relations produced are termed *homological;* and the relations are *analogical*, when they depend on a similarity of function, however produced.*

As the several families or classes of animals are exposed, in some respects more or less general, to the same circumstances, they would naturally undergo, in many instances, either *homological* or *analogical* modifications, occasioning that serial parallelism alluded to on a preceding page. And again, as the animals of the same class may be fitted to many different circumstances in nature, other parallelisms should exist, of a wider character.

The order in which the above sources of distinctions in the animal kingdom are mentioned, may be in the main nearly that

---

* Prof. R. Owen, the eminent comparative anatomist of England, mentions three kinds of homology, viz: "general," "serial," and "special." "General homology is the relation in which a part or series of parts stands to the ideal or fundamental type; and thus, when the basilar process of the occipital bone in Anthropotomy is said to be the 'centrum' or 'body of the last cranial vertebra,' its *general* homology is enunciated. When it is said to repeat, in its vertebra or natural segment of the skeleton, the body of the sphenoid bone, the body of the atlas, and the succeeding vertebral bodies or centrums, its *serial* homology is indicated. When the essential correspondence of the basilar process of the occipital bone in Man, with the distinct bone called 'basi-occipital,' in a crocodile or a fish is shown, its *special* homology is determined."—*Phil. Mag.*, xxviii, iii ser., 526, June, Sup. 1846.

We refer the reader also to a very excellent paper "on the Structural Relations of Organized Beings," by H. E. Strickland, F. G. S., Phil. Mag., xxviii, iii ser., 354, in which the subject of affinities in organic beings, is presented in a clear and philosophical light. In addition to the terms *homology* and *analogy*, Mr. Strickland proposes the word *iconism*, to express *resemblance of form without a similarity of structure or function;* for example, the resemblance of the flower of the pea to a butterfly, or the shell Haliotis to an ear; and it includes also resemblances between species arising from accidental coincidence of color; while *analogy* includes such resemblances as depend upon a similarity of function.

of their relative importance. Yet it is well known that a set of characters valuable in one group is worth nothing in another: and this holds true in some cases even with those characteristics that are in general fundamental. It seems at first a violation of all propriety, to arrange together animals having gills, and those that have none; those that have a heart, and those that are destitute of even a vestige of one beyond a distant valve or two in the circulating system; those that have distinct arteries, and those whose arteries are only the lacunal passages among the muscles and other organs. Still this may be in accordance with a philosophical classification. The class Crustacea actually illustrates each of the three anomalies just stated. If the singular Amphioxus is truly a fish, as many ichthyologists affirm, we may have a vertebrate animal without a brain, and without a sense to raise it above the Polyp. In such cases, the system of structure typical of a group, is ascertained by a general study of the species, and then an acquaintance with this structure assists in tracing out transitions, and determining how far one and another organ may fail without requiring an entire separation of an individual from the group.

To classify, requires therefore the widest possible range of knowledge of organic beings, and the nicest balancing of affinities: and we remark again that it consists rather in expressing the various chains of affinities or homologies direct and parallel, with their shadings and blendings, than in searching for certain inviolable characteristics for distinguishing groups of species.

Classification of Zoophytes.—In view of the foregoing principles, any classification of Zoophytes made out without reference to the structure of the animals must necessarily be faulty. There have been several of this kind in the department of corals; and as the subject has been little understood till within a few years past, their errors were to be expected. They subserved, for the time, the purpose of systematizing the facts known, and afforded a means of characterizing species: so far, they were good. But at the present day, to make out a classification based on the corals alone and the easiest method of distinguishing them, would partake of times of past ignorance: they can no more be properly arranged without reference to their animals, than shells without regard to their molluscs. The zoological relations of the species should be first studied, and afterwards such characters laid down for the corals, as belong to the orders and families thus deduced.

The first classification of Zoophytes in which the animals received attention, was offered by Blainville.* Lamarck had led

* Manuel d'Actinologie ou de Zoophytologie, par H. M. D. de Blainville. 644 pp. 8vo, with an atlas of 100 plates. Paris, 1834. (The printing began in 1830.)

the way with a discriminating study of the corals. Blainville availed himself of the observations of Quoy and Gaymard, besides the few investigations of older authors, and with great acumen, made out an arrangement, which in its general features was highly natural. He divided Zoophytes, *including the Actiniæ*, into the groups *Zoantharia, Polypiaria, and Zoophytaria ;* and if we strike out from Polypiaria a few species that belong with the first division, and others that are Bryozoa, we have the groups Zoantharia and Zoophytaria corresponding to the groups *Actinaria* and *Alcyonaria*, of the classification by the writer, and Polypiaria nearly to the *Hydroidea*. The only other change of importance which the writer has proposed in these primary subdivisions, is the union of the Actinaria and Alcyonaria into a single group, *Actinoidea*, equivalent in importance to Hydroidea. Blainville was the first author who actually introduced coral zoophytes fairly into the animal kingdom by his mode of describing and arranging them. He did not call the department a branch of zoology, and then describe corals as if they were *porous, stelligerous stones*, which is even now in many instances the case.* Still he speaks of the cells as *containing* the polyps, which is the reverse of the fact.

Ehrenberg in 1834,† after a more thorough acquaintance with coral animals obtained by investigations in the Red Sea, made some important improvements in the minor subdivisions; but his grand divisions were unfortunate. He separated in many cases the attached from the unattached species, and again, the simple from the compound, and thus broke up the natural assemblages which Blainville had made out. Even the natural group Alcyonaria, (Blainville's Zoophytaria,) is subdivided by him, and the parts widely separated. His system, notwithstanding some anomalies, exhibits great reach of mind and searching investigation. He removed correctly the Bryozoa from other Zoophytes, and first suggested the relation of the Millepores and Favosites to the Madreporacea. He pointed out the true nature of coral secretions, and described the mode of reproduction by spontaneous subdivision, which had not before been noticed. The modes of growth were also to a considerable extent described by him, and important use made of them, though not always correctly, in the classification of Zoophytes.

Milne Edwards, whose acquaintance with Zoophytes had been extended by a personal examination of many species, and by a thorough study of the labors of others, besides a comprehensive

* In descriptions of corals, (the *internal* or *basal* secretions of Zoophytes,) those characters which belong to the Zoophyte ought to be first stated, such as the general form, mode of growth, &c ; and afterwards, separately, whatever, not already stated, may require mention with respect to the coral itself.

† Abhandl. der Königl. Akad. der Wissensch. zu Berlin, for 1832, pp. 225–438.

knowledge of nature, proposed, in 1837, a brief outline of a classification, which as far as detailed, exceeded those preceding it, in philosophical character. The Hydroidea, ("Sertulariens,") the Actinaria, ("Zoanthaires,") and the Alcyonaria, ("Alcyoniens,") are laid down as the grand divisions, and without the striking violations of affinities which appear in Blainville's order Polypiaria. We only observe that the Favosites are separated from the Madreporacea, with which group they were placed by Ehrenberg, and where they beyond doubt belong.

These are the principal authors since Lamarck, who have undertaken a general arrangement of the class of Zoophytes. The "Stony Corals" have quite recently been arranged mostly from the corals alone by Mr. J. E. Gray, of London.* We may express the belief, without entering into any criticisms on his classification, that with a more extended study of the animals and their corals, he would not have separated the *Milleporæ* and *Helioporæ* so widely from the *Pocilloporæ;* the *Stylastridæ* from the *Sideroporæ;* the *Montiporæ* from a part of Lamarck's *Porites;* the *Fungiæ* from the *Pavoniæ:* nor united into a single group the *Pavoniæ* and many *Astræœ;* nor the *Fungiæ*, *Flabella*, and *Meandrinæ:*—in the last case giving an unreal importance to the oblong shape of the Flabella, and implying a relation which is wholly without foundation between the oblong cell of the Meandrinæ, Flabella, and Fungiæ, for in the *first*, the form arises from budding, in the *second*, it is the shape of the polyp's disk, and in the *third*, the cell is only a depression *at the center of the disk*, and the form has not even generic importance.

Before giving a general view of the classification of Zoophytes, to which the writer has been led by the study of coral animals,† the importance of different characters as a basis of classification may be briefly considered.

Owing to the simplicity of polyps, there are few organs or functions to afford distinctive characters. They are as follows: I. The digestive system; II. The ovarian; III. The modes of budding and growth; IV. The tentacles and general character of the exterior; V. The secretion of coral and its nature.

I. The *Digestive System.*—In this system the stomach varies (1) in length as compared with the internal or visceral cavity

* An outline of an Arrangement of Stony Corals, by J. E. Gray, F. R. S., &c. Annals and Magazine of Natural History, xix, 120, Feb. 1847.

† As it may be of some importance to those interested in the department of Zoophytes, the writer here states that the animals of more than sixty species of coral animals, exclusive of Alcyonaria and Hydroidea, and pertaining nearly to every genus, have been figured by him, from living specimens obtained in the Pacific and East Indies, and these figures will appear along with others of different corals whose animals were not obtained, in the forthcoming Atlas to accompany the Report on Zoophytes.

below, and (2) in the character of the parts below and around it. In the *first* particular, the difference is one of less general importance than has been allowed; the relative length in the *Actiniæ* and most Actinoid corals, is between *four-fifths* and *one-third;* in the *Zoanthidæ* it is between *one-third* and *one-sixth;* in the *Alcyonaria*, between *one-third* and *one-twentieth;* in the *Hydroidea* the stomach is sometimes much shorter in proportion than in many Alcyonaria, though often far longer. In the *second* particular the difference is wide, the Actinoidea having the stomach suspended within the visceral cavity, and attached to the sides of the polyp by a radiating series of vertical fleshy lamellæ, which are wanting in the Hydroidea. The visceral cavity is a simple tube in the latter, and is radiated with vertical lamellæ in the former: but these peculiarities are also connected with the modes of reproduction. We omit other less obvious points of difference.

II. *Ovarian System.*—In this system, ranking in importance with the digestive, the absence of special organs with spermatic and ovarian functions, distinguishes the Hydroidea, and the existence of such organs, the Actinoidea. No character can be of higher value, or more marked in its attending peculiarities.

Among the Actinoidea, there is a great variation in the number of genital lamellæ, and in the relative position of the two kinds, the spermatic and ovarian. In the *Alcyonaria* there are uniformly *eight* in all; in the *Actinaria*, either *six*, *twelve*, or *more.** In many of the latter division if not in all, the two kinds of lamellæ, (spermatic and ovarian,) are distinct: in some of the former, the same lamella is ovarian above, and spermatic below, or two are spermatic and the rest ovarian; or perhaps other conditions may exist. There is good reason for separating the *Alcyonaria* from the *Actinaria*, but not for making each division equivalent in rank to that of Hydroidea.

III. *Process of Budding and Growth.*—1. We find that the fact of species *budding* or *not budding*, is not connected in Zoophytes with any peculiarity of structure that can be detected, and farther, the transitions are gradual and frequent. This character, therefore, as it indicates no difference of concentration in the ner-

---

* A passage of the Actiniæ into the Alcyonaria may perhaps be observed in the *Lucernariæ*, which have a four or eight-lobed summit; and other Actiniæ approximate to this lobed character. These lobes bear a number of tentacles, or correspond to a number; and hence analogy suggests that possibly in the Alcyonaria each tentacle properly corresponds to two tentacles or more, or to a lobe in the Actiniæ alluded to. This view is borne out by finding in the larger Alcyonaria, the tentacles having a size wholly incompatible with the structure of the Actinaria; for the writer has shown in another place that in the Actinaria there are limits to the relation between the number of tentacles, as well as the width of interval between the genital lamellæ, and the size of the animal. Whether the analogy holds or not, the facts show striking differences between the Actinaria and Alcyonaria. See further, Report on Zoophytes, pp. 34, 123, and this volume, p. 7.

vous system, is entitled to little consideration as a means of distinction in the classification of these animals:—it is no more important here than in botany, where a plant consisting of a single individual bud, may be placed along side of one which consists of several. It may sometimes however be used to distinguish genera: yet in the genus Fungia, there are a few species that increase until they consist of two or three individuals; and there is thence a passage to the *Herpetolithi*, Eschsch. (Haliglossæ, *Ehr.*) and *Polyphylliæ*, Q. and G. The simple and compound Cyathophylla are other examples of the difficulty of this separation.

2. But the *modes of budding and growth* are of higher character; especially the distinction of *superior* and *inferior* gemmation, in the former the buds being terminal or at summit, and in the latter lateral or basal. It is of little importance whether the summit-widening, which accompanies superior gemmation, takes place in the disks, or just exterior to the disks. In either case, the visceral lamellæ are prolonged at top beneath the upper surface, by the process of growth, and hence such species have the upper surface of the corallum lamello-striate.

3. In superior gemmation, when the disks widen and bud, they sometimes subdivide as each new mouth opens, and sometimes not till several mouths have opened. This difference (distinguishing the genera Astræa and Meandrina) is of small importance. There are Astrææ in which the disks become 2 or 3-compound before they subdivide; and thus the two genera graduate into one another. There are simple and meandrine *Mussæ*, Oken, (Lobophylliæ, *Bl.*) between which no line of separation can be drawn, and they have been always retained in the same genus. The Monticulariæ, in the same manner, are related to the Meandrinæ.*

4. There is a group of species having superior gemmation, in which the disks have no proper limits; and in the compound species, the surface is a single disk with many mouths and scattered tentacles, (the latter often obsolescent.) The *Fungiæ* are examples of simple species of this kind; and the *Polyphylliæ*, *Pavoniæ*, &c., (including the *Astræa siderea*,) are compound species. The coralla of compound species are characterized by the continuation of the lamellæ of the stars from centre to centre, without interruption along a medial line; and they have no cells except it arise from a prominence of the intervals between the polyp-mouths. They thus differ from the *Astrææ;* for the cells in the *Astrææ* correspond to the visceral cavities of the polyps.

---

* See on this subject Report on Zoophytes, pp. 76, 77, and this volume, p. 19.

5. Growing *free* or *attached* is a character of minor importance. It is sometimes a convenient *generic* distinction, as with the *Fungidæ*, but in other cases cannot be appealed to. All species, as is well known, are attached in the young state; and the time of becoming free varies with the species, some earlier and some later. The *Flabella* thus pass so gradually to attached species, and the animals in the two cases are so completely identical, that the separation can be sustained only on the ground of convenience in a distribution. We add that in this last mentioned case, the simple species pass as gradually into the compound, and they are closely connected with the group *Euphyllia*, D. (a part of *Lobophyllia*, Bl., having entire lamellæ.)

6. Growing *massive*, or *calicularly branched*, (aggregate or segregate,) is sometimes a good generic distinction. But polyps in contact grow together so readily that it can be of importance only when supported by other characters. In the group *Manicina*, no line can be drawn between the segregate and coalescing species; and the *Cyathophylla* are other examples. Difficulties in the way of characterizing groups thus arise, which must be fairly met and not denied nor overlooked.

7. The *forms of growth*, whether branching, massive or explanate, afford good distinctions for species, but seldom generic characters. We find *explanate* and *massive* Gemmiporæ and Porites; *explanate*, *massive*, and *branching* Porites and Manoporæ; and *explanate* and *branching* Merulinæ and Echinoporæ. No more unfortunate generic character can be laid down than one drawn from this source: it may, however, be occasionally used, when sustained by other characters. The genus *Explanaria* of Lamarck is an agglomerate of species of several genera.

We have elsewhere shown that the sizes of branches, the frequency of branching, and the width of intervals in groups between branches, are good trivial characters within certain limits. But in all cases in instituting species, the specimens examined should be good and full grown, and not fragments.

8. Growth by budding from an apical polyp, or from serial budding, are points that may afford good generic distinctions.

IV. *Tentacles and General Character of the Exterior.*—In many genera, the tentacles are too short to take any part in the prehension of food, and apparently subserve only the purpose of aeration. As the whole body takes part in this function, the size of the tentacles must necessarily be unimportant as a family character. Hence we find, even in the same genus, (*Fungia*, *Porites*,) species with comparatively long tentacles, and others in which they are almost obsolete. The species of the genus *Actinia*, are almost as various in the sizes of the tentacles. Among the *Astrææ*, one species was observed by the writer, in which the place of tentacles was supplied by numerous spine-like processes over the surface between the disks; and the same is true of the *Echinoporæ*, or at least partly so, for the writer observed no tentacles in the two species he examined. The same reason shows that the moss-like subdivision of tentacles, observed in some Actinidæ, is a character only of generic importance, for it takes place generally in such species as live more or less buried in the sand or mud, which fact seems to require an extension of the aerating surface, such as this delicate branching affords.

The *number* of tentacles appears to have a relation to two distinct series; in one the number is *six*, *twelve* or *more*, with the alternate usually unequal when exceeding six, (and always so, when over twelve:) in the other, *eight* simply, and all equal. The *character* of the tentacles is different in the two series, the former (the Actinaria) having them naked; the latter (Alcyonaria) having them fringed with perforate papillæ. A large number of species of Actinaria are characterized by *twelve* tentacles, and have been separated to form the group Madreporacea; but notwithstanding this point of resemblance, the several genera are as closely related to species having a greater number of tentacles.

The occurrence of suctorial vesicles on the lateral surface or disk, is a character of only generic importance.

Color is seldom of much importance, even for trivial distinctions. Yet the mode of arrangement of colors may be characteristic of species. A mutual dependence or relation of certain colors may possibly be hereafter ascertained, by which a knowledge of one will determine the others that may be possible in a species; and in such a case, the character may have a value which cannot now be allowed it.

V. *Secretion of Coral.*—1. The *secretion* or *non-secretion of coral internally*, is at the best no more than a family distinction; and among the *Alcyonaria* it is only generic. This is an admitted truth with regard to calcareous secretions among Molluscs; and Olivi and Blainville long since acknowledged it with reference to zoophytes.

2. The *secretion of coral at base, distinct from internal secretions*, is a characteristic of much value; it produces the structure of the *Gorgoniæ* and allied zoophytes, and also of the *Antipathi*.

3. The *nature of coral secretions* sometimes affords generic distinctions, and with other characters, in some instances, distinguishes the higher divisions of zoophytes. The *Hydroidea*, as far as known, never form any but membranous or horny coralla. The *Astræacea*, *Caryophyllacea* and *Madreporacea*, secrete only calcareous coralla, excepting a few marine Actinidæ, (*Actinectæ*,) which form a cellular membranous float at base to keep them at the surface. The *Antipathi* form only basal horny secretions, and therefore have a horny axis. The *Alcyonaria* are more various in this character, the different genera having their peculiar-

ities; the *internal* secretions are always calcareous and in *grains* or *spiculæ*, and in this last particular they differ from the calcareous of the Actinaria; these grains are sometimes so abundant as to unite into solid tubes, (*Tubiporæ.*) The *basal* secretions are either horny, (*Gorgoninæ*,) calcareous, (*Corallium*,) or siliceous, (*Hyalonema;*) and in some instances, from a mixture of membranous tissue with the earthy matter they resemble cork.

4. Among the calcareous corals, the texture or density of the coral is often of little importance, as it may vary in different parts of the same specimen, according to their full exposure to the free ocean waters or not.

In species with stellate cells, there is always a definite number of rays to the *adult* cell, excepting among those that bud in the disks, and this number is some multiple of four or six, and usually of both. The characters of the cells, whether immersed or occupying a prominent calicle; and, *internally*, deep and open at bottom, or transversely septate, or spongy cellular, or solid,—are important; also the peculiarities of the lamellæ, whether entire or not, equal or irregular, exsert or included.

In transverse sections of the stellate cells, the number of rays, (when adult,) the diameter, and the character of the centre, and of the interstices, are generally good characteristics for species.

The corals of *Alcyonaria* never have rays to their cells or tubes; the *Madreporacea* have never more than *twelve* rays; the *Caryophyllacea* and *Astræacea* have always more than twelve; and the last order is distinguished by having the interval between the cells lamello-striate (see p. 344, III, 2) *internally*, with few exceptions, as well as *externally*.

This brief review of the characteristics of zoophytes, has prepared the way for an exposition of the classification into which the species naturally fall.

Art. XXXIV.—*Notices of Koordistan.—Hot Sulphur Spring—Manna—Mines of Lead—Sulphur and Orpiment—Rock Salt and Saline Springs—Ruins, &c., derived chiefly from the letters of Rev. A. H. Wright, M. D., of the Mission of the A. B. C. F. M., at Oroomiah,* Persia;* communicated by Oliver P. Hubbard, M. D., Prof. Chem., &c., Dartmouth College.

The Nestorians of the mountains of Koordistan, which lie to the west, in the limits of Turkey, have recently suffered severely

* This Mission is situated among the Nestorians, at Oroomiah, in Persia, by the salt lake of the same name. This lake is about 1400 yards above the sea, about eighty-nine miles in length from north to south, and in breadth about thirty-two miles. The governor of this district is Yahyah Khan.

in two campaigns against them by Badr Khân Bey, chief of Buhtan, who resides near Jesireh, on the Tigris—which disturbances have rendered the passage of the mountains unsafe and even dangerous for all travellers.

B. K. Bey, however, needed medical advice, and made an urgent request, through his neighbor Noor Ali Khan, the Hakkary chief, residing at Julamerk, and directly through the Governor of Oroomiah, that Dr. Wright should make him a professional visit, assuring him of "every practicable means for his security on the journey."

Accordingly, on the 4th of May last, accompanied by Mr. Breath, of the Mission, two native assistants and a guide, Dr. Wright commenced his journey, and lodged at night in an encampment of Koords, by the roadside. The next day, the 5th, they came to the fort of Ali Aga, a Koordish chief, who resides on the frontiers of Koordistan, and who hospitably entertained them; and when they left on the following morning, he gave them a London thermometer. Having crossed a high range of mountains, they reached Hoshgan, a small Koordish village, on the 6th. The 7th being rainy, they rode but two hours to a place called "the Four Churches," and on the 8th, spent the night at Kermè. The next day, the 9th, about noon, they arrived at the castle of the chief, at Julamerk.

Here "they were detained thirteen days, it being reported that the mountains beyond were still covered with snow, and that it would be impossible to pass them for some time to come." The chief was "enlarging and ornamenting his castle, and as iron is dear in Koordistan, great quantities of the guns, daggers and other weapons taken in war from the Nestorians, were used up in making nails." They left Julamerk on the 21st of May, and soon ascended a high range of mountains lying west of Julamerk, and on reaching the summit, had an extensive view of the surrounding country. On the east and south, rose the lofty mountains of Diss, Jeloo, Tehoma and Tiyary; in the west, far in the distance, were the mountains of Buhtan; and on the north, lay a wild region, reaching to Lake Van, which is some 1800 yards above the sea.

In the course of the day, they passed through the districts of Sillah and Leewin. Next morning they ascended another mountain, (range,) the higher portions of which they found covered with snow, but so frozen on the surface as not seriously to impede them. In the forenoon, they passed a Nestorian village of fifteen houses, situated on a plain, surrounded by the mountains which contain the sources of the Khabour, a branch of the Tigris. From Julamerk to this point, the course had been "about west. They now turned to the south, taking the western bank of the Khabour."

Hot Sulphur Spring.—"On the 23d of May," says Dr. Wright, "just before noon, we came to a hot sulphur spring, where we stopped some hours. Though we had heard much of it on the way, as a natural curiosity, our expectations were more than realized. The water rushes out of a crevice in a high rock, which is a spur of a still higher mountain, in a bold, rapid current, sufficient to carry a grist mill of ordinary size, and after passing some twenty feet, the stream becomes a branch of the Khabour. Just as the water issues from the crevice, the rock projects above and beyond, in such a manner as to form a small apartment, quite sheltered from the wind; thus affording an unequalled hot bath in this wild region, so destitute of the ordinary comforts of life. The water is clear as crystal, and of a temperature of 105° Fah., and very remarkable for its quantity, purity and temperature. I have seen most of the Virginia springs, all of which appear quite insignificant in comparison with this. I have visited the baths in Constantinople, Erzeroom, Tabreez and Oroomiah, which are fitted up with every thing to please; but weary and worn as we were in crossing mountain heights and snow-capped peaks, it was a greater, an inexpressible luxury to throw ourselves into this beautiful water and bathe our aching limbs. We wished to carry away with us some of the water for the purpose of analysis, but as our loads were thrown down some precipitous bank every little while, breaking every thing that could be broken, we were not disposed to add to them.

"The place is much frequented by the people living in these parts, both Koords and Nestorians; and many a poor traveller, crossing these snowy regions in the winter, finds here a delightful shelter for the night, from the cold mountain blasts."

After leaving the spring, the road was exceedingly rough and precipitous; and on the 25th of May, they left the Khabour and travelled nearly west, and after crossing an elevated range of mountains, their course lay along the base of immense rocky palisades. On the 26th, the course was southwest; and a ride of seven hours on the 27th, over an uneven and barren country, brought them to Dergulè, the residence of Badr Khân Bey,—a small town of a few hundred houses, built of stone and mud, and twelve miles east of Jezireh. The castle of this chief stands near the village, on the brow of a hill, overlooking a small stream, which flows into the Tigris. The chief was about removing, on account of the heat, to more elevated and cooler regions, and Dr. Wright and Mr. Breath accompanied him in his migrations from place to place, during four weeks: the former was engaged professionally every day, more or less, among the sick in the Emir's family and retinue, and successfully introduced vaccination among them.

These gentlemen commenced their return to Oroomiah on June 24th, by an easier route, farther to the north, by Bashkallah, which they reached in six days travel, and on the 3d July, arrived at Oroomiah, after an absence of two months.

Dr. Wright thus speaks of the country :—

"*Physical Features.*—Our route to Dergulè, led us across central Koordistan, and through a region of almost unequalled interest, in a physical point of view. Mountains, valleys, precipices, gorges, rivers, &c., combined to form the most attractive scenery ; and such was the variety of rock and minerals, that the geologist and mineralogist would find it a region of rare interest. No man devoted to natural science has ever been through these regions. Some twelve or fifteen years ago, Prof. Schultz, of a German University, made the attempt, with purely scientific objects in view. His motives were mistaken, and he was murdered by order of the Koordish chief of Julamerk. We have now formed such an acquaintance with that chief and others having power in the mountains, that I think we can ensure one a safe passage through any part of the country. The Emir, B. K. Bey, prides himself on being a man of '*one word*,' and pledged himself as our '*friend.*' "

The peculiarities of the different routes are thus referred to. Dr. W. says of his return route :—

"The country over which we passed was elevated and mountainous ; but the mountains were not heaped up in regular ranges or chains, as on the Julamerk route ; they seemed rather to have been thrown together in a confused manner, resembling the surface of the ocean, when lashed into commotion by contrary winds." "During the first day and part of the second, we passed over a district covered with a stunted growth of oak and gall-nut trees, &c., but from that time until we reached Salmas, we did not see trees or shrubbery of any kind. The mountains and hills were not barren, however, but covered with grass to their summits, affording a grazing district equal to any in the world. In the winter they are a waste, being enveloped in snow, and no dweller or traveller is ever seen among them." The flocks of sheep from the plains of Mesopotamia, are driven here by a gradual ascent, as the season advances in the spring, and retire before the early snows, from the summits to the champaign below, for winter quarters. Thousands of sheep, with their keepers, were seen on the hills at this time.

Dr. W. describes a substance he met with, under the name of *Manna.* We found "in one part of the mountains (probably on the return route) great quantities of a sweet substance, formed on the leaves of certain trees, generally the oak and gall-nut tree, and which is called *gezza* in Koordish, and *manna* in Syriac, and perhaps *honey-dew* in English. It forms on the leaves in such abundance, that when they are dried and pounded, it comes off in scales, and is collected and used as an article of food. When melted and strained, in order to separate the crumbled leaves, it is very delicious, and is eaten by the people often in preference to honey. In the summer, it is collected in large quantity and put up for winter use. Often, as we were riding along among the trees loaded with it, we found it pleasant to break off the branches and lick the leaves, which were so coated with it that in a very few minutes our appetites were satisfied. There is a species of willow growing on the water courses in Persia, on which this article is sometimes found; but we have never seen it there in such abundance as in the Koordish mountains."

The term *manna* ordinarily refers to the well known product of several species of Fraxinus, "that grow spontaneously in Italy and Sicily, and very probably in all the oriental Mediterranean region," and which is used for medicinal purposes. Substances which resemble this in form, or taste, or mode of production, are also called by the same term, which, in every case, therefore needs defining. The *gezza* was observed in June, and from Dr. W.'s account, we infer it was a semi-fluid exudation upon the leaves of certain trees. This has been mentioned by writers in other parts of Asia; and as it differs so entirely from other forms of *manna*, which occur under peculiar circumstances, a few facts from various authors may here be cited.

Wellsted,* in his journey from Tór to Mount Sinai, September, 1836, "found in the Wádí Hibron, fifteen miles from the sea, and at an elevation of about two thousand feet, the tree which produces the *manna*. This remarkable substance is secreted by several trees, and in various countries in the East. In some parts of Persia, it is believed to be an insect secretion, and is collected from a shrub called *gavan*, about two feet high, bearing a striking resemblance to the broom. In the hilly district of Looristan, (southeast from Koordistan,) as in Mesopotamia, we find it on several species of oak, which there, however, are of more stunted growth than in England. From these, the manna is collected on cloths spread beneath them at night, and it then bears the form of large crystal drops of dew, such as we see on plants in England, in the early part of the morning. Burckhardt observes that at Erzrūm, a substance resembling manna in taste and consistence, distils from the tree which bears galls, and with the inhabitants of the country forms one of the principal articles of their food."

In the Horticulturist, No. 7, January, 1847, is an article translated from the Révue Horticole, from which we extract the following notice of what appears to be the same (or similar) thing with the *gezza*.

---

* Travels in Arabia, vol. ii, pp. 47, 48.

"Ehrenberg and Bové described the '*Manna Tamarisk,*' which is abundant throughout Arabia, and even found on Sinai, nine hundred feet above the sea. The women and children collect this, which flowed from the branches of these trees. The Arabs clarify the manna by dissolving it in warm water, and making a syrup, the taste of which is equal to that of the best honey."

Under the word "*manna,*" in the Dict. Univ. d'Hist. Nat., Paris, 1846, is mentioned "a stunted, spinous shrub—Hedysarum alhagi, *Linn.*, Alhagi Maurorum, *Tourn.*—as growing in the deserts of Arabia and Persia, upon which is gathered a white, concrete juice, which is called *manna alhagi.* Olivier, on his return from Turkey, brought to France several pounds of this substance, which, according to Niebuhr, is used in Persia instead of sugar in pastry, &c."

"Mr. Lindley* has recently pointed out an oak, *Quercus mannifera*, from the leaves of which also drops a sweet substance, which seems to have been mentioned under the name *chelber*, by Olivier. This name, which is applied by the hordes of Korassan and Little Tartary, to a nutritious substance which falls on the ground, it is easy to see approaches very nearly to that of *Semljenoi-chleb*, by which name the nations of the Kirghiz designate the *Lecanora esculenta.*"

"Several occurrences of what is called a fall of *manna*, are attributable to the accumulation of this Lichen, Lecanora esculenta. Aucher-eloi† observed it in Persia in layers of nearly four inches (0 *m.* ·12 to 0 *m.* ·13) in thickness. He sent specimens, with the following note, to France. 'In 1829, during the war between Persia and Russia, there was a great famine in Oroomiah, southwest of the Caspian. One day, during a violent wind, the surface of the country was covered by a lichen, which *fell from heaven.* The sheep immediately attacked and devoured it eagerly, which suggested to the inhabitants the idea of reducing it to flour and making bread of it, which was found to be good and nourishing. The country people affirm that they had never seen this lichen before nor after that time.'" "During the siege of Herat, (which is about eight hundred and seventy-six feet above the sea,) more recently the papers mentioned a hail of *manna*, which fell upon the city, and served as food for the inhabitants." "A rain of manna occurred April, 1846, in the district of Jenischehir—the government of Wilna—on the grounds of M. Tizenhauz, and formed a layer three or four inches in thickness. It was of a greyish-white color, rather hard, and irregular in form, inodorous and insipid."

---

* Révue Hort., as already cited.

† Relat. d'un Voy. en Orient, vol. ii, p. 399.

"Pallas observed it in the mountainous, arid and calcareous portions of the great desert of Tartary. M. Eversham collected it in the steppe of the Kirghiz, to the north of the Caspian Sea, where it is called *semljenoi-chleb.* M. Ledebour has observed it in the same countries, but chiefly those which border on Altaï; and Bilezikdgi saw it also in Anatolia, in 1845. Dr. Léveillé gathered it in Crimea, and Dr. Guyon recently in Algeria."

"It is found in irregular shaped bodies, varying in size from that of a pin's head to a pea or small nut, and when seen in its proper sites, has never been found attached to any support whatever. An analysis of the Lecanora shows that there is no fecula in its composition."

Wellsted, p. 49, "learned from a Jewish Rabbi, that on his journey through the desert contiguous to Damascus, far removed from trees or vegetation of any kind, a substance was deposited, which, from his description, in appearance, size and flavor, accurately resembled the manna of the Scriptures. Similar testimony was derived from several Bedouins."

It may be remarked, in passing, that several writers have not hesitated to identify some of these species with the manna miraculously supplied to the Israelites, in the wilderness. They were obviously acquainted with manna of some kind, from the fact that they named the new substance from its resemblance to it. Dr. Wright describes, also,—

"*Mines of Lead, Sulphur and Orpiment,* which exist in the mountains, and are worked by the natives there. The lead mines are found mainly in the Nestorian country, where they are worked chiefly to furnish balls for rifles. *Sulphur* is found in many localities, and is obtained for the purpose of making powder. In many cases, a man makes what he wants for his own use, and may sell a little to his neighbors. The *Orpiment* mine is owned by the chief of the Hakkary Koords, Noor Ali Khan. It is worked extensively, and has been for many years. About twenty Koords are employed, day and night, in digging the ore and bringing it out to the surface. The ore occurs in veins, which run, in various directions, into the body of a high mountain. The mineral is exported to every part of Persia and Turkey, where it is largely used in making a composition with which Mussulmân's remove the hair growing on their bodies, when frequenting the baths; for hair is an abomination to them, except on the face, and a lock or two on the head. Orpiment is also used by them as a pigment." Mr. J. D. Dana informs me he has purchased specimens of orpiment in Smyrna, which were probably derived from this locality.

"*Salt and Saline Springs.*—There are some salt springs on the west side of the mountains, near the Tigris, which are very useful in furnishing salt, by solar evaporation of the water. Most of the salt, used in Eastern Koordistan, however, is carried from the lake of Oroomiah, 'the saltest water in the world,' on the shore of which it is found in great abundance. Porter says of the lake, as seen from the hills on the east, that 'its waters now appeared of the deepest blue, and most singularly hemmed in by a broad belt of salt, looking at a distance like a violent surf.' 'In many places it lies more than a foot thick, and where the bed of the lake slopes gently from the land, the salt left by evaporation in summer often exceeds a breadth of three or four miles down to the verge of the waves.' '*Rock salt* is found in some localities in this vicinity, and is a very good article.' "*

After these mineralogical notices, Dr. Wright mentions some

Remarkable Ruins.—"We found in great numbers, scattered over the country, a mysterious species of ruins, which puzzled us extremely in endeavoring to satisfy our minds as to their history. They consisted of collections of stones, many of them very large, which were once built up in the form of a regular structure, usually oblong. We heard of some still standing, built up some ten or fifteen feet high, without door, window or roof. The Koords have the idea, as we learned upon inquiry, that they are the work of DEEVS,† whom they regard as spiritual beings, who were engaged in a war with the human race, and who built these structures for their strongholds in the conflict. My companion, Mr. Breath, conjectures they may be the remains of the works of the Fire Worshippers, who formerly occupied these parts, though it is difficult to imagine what object they could have had in constructing them. On the plain of Oroomiah, there are numerous remains, which it is altogether probable are the relics of the ancient Fire Worshippers. The indications of their character are much more obvious than those of the mountains."

ART. XXXV.—*Caricography;* by Prof. C. DEWEY, M. D.

(Appendix, continued from this volume, p. 173.)

No. 209. *C. oxylepis*, Torrey. Mon. N. Am. Cyp., p. 409.

Spicis 4–6 longo-cylindraceis sublaxifloris erectis exsertè pedunculatis, inferioribus subremotis basi distantifloris, superiore inferne staminiferis; fructibus *tristigmaticis* oblongis utrinque acutis subtriquetris glabris ore vix bilobatis, squama ovata oblonga margine hyalina cuspidata paulo longioribus; culmis inferne foliatis.

---

* V. Am. Jour., vol. xxxvii, p. 350, *et seq.*

† Sir R. K. Porter, in his Travels in Persia, describes a mound with massive marble structures upon it, in the plain of Morgaub, near Persepolis, called "the Court of the Deevs, or Devils," and in many places the temples of the Fire Worshippers.

Culm erect, slender, 15 inches high, with shortish leafy bracts; leaves flat, lanceolate, acute, striate, originating towards the root, and shorter than the culm, slightly pilose on the under side; spikes 4–6, erect, pedunculate, bracteate, lower ones sheathed and very loosely flowered at the lower part, the upper spike staminate below, with long and lanceolate staminate scales; stigmas three; fruit oblong, tapering to each end, smooth, subtriquetrous, dark brown, rather loose, orifice nearly entire; pistillate scales ovate, oblong cuspidate, white and membranous on the edges, shorter than the fruit; plant pale green.

Texas—*Torrey;* Florida—*Dr. A. W. Chapman*, author of the *List of Plants near Quincy, Florida;* Louisiana—*Dr. Hale.*

Related to *C. formosa* and *C. æstivalis*, though far different. Specimens from Florida and Louisiana are fine and beautiful.

No. 210. *C. Baltzellii*, Chapman. *List of Florida Plants*, 1845.

Spica staminifera unica perlongo-pedunculata, squamis oblongis obovatis obtusis vel subemarginatis brevimucronatis; spicis pistilliferis 3–4, oblongis erectis laxifloris subradicalis pedunculatis, suprema interdum apice staminifera; fructibus tristigmaticis oblongis obovatis obtusis triquetris brevi-rostratis ore integris subpubescentibus vel scabris nervosis, squamam similem staminiferæ subæquantibus; foliis radicalibus subpubescentibus.

Culm 6–10 inches high, slender, triquetrous, terminated by a cylindric and clubform staminate spike, as if supported by a nearly radical peduncle; leaves radical, flat, striate, lanceolate, much surpassing the culm, and slightly pubescent; pistillate spikes 3–4, subradical, pedunculate, approximate, cylindric, loosely flowered, the highest often continued into a short staminate spike; stigmas three; fruit oblong, obovate, obtuse, short rostrate, subscabrous, entire at the mouth, sometimes distinctly triquetrous, nerved; pistillate scale, like the staminate, oblong, obovate, obtuse or slightly emarginate, mucronate, and often slightly surpassing the fruit, deep reddish-brown on the edges, and green on the keel; whole plant rather light green.

Florida—*Chapman;* a singular and beautiful species, closely allied, as Dr. Chapman remarked, to *C. pedunculata.*

No. 211. *C. polymorpha*, Muh. Gram. Muh., p. 239.

Spicis staminiferis 1–2, raròque 3, oblongis cylindraceis erectis, superiore pedunculata, ceteris sessilibus; spicis pistilliferis 2, longo-cylindraceis erectis incluse pedunculatis bracteatis dnsifloris *tristigmaticis*, superiore apicem staminifera; fructibus ovatis acuminatis vix rostratis ore bifidis nervosis glabris, squama ovata fusca duplo longioribus; foliis lanceolatis inferne abbreviatis.

Culm 14–20 inches high, erect, with leafy bracts; leaves lanceolate, striate, shorter below and shorter than the culm; staminate spikes 1–3, erect, cylindric, often more than an inch long, with ovate and oblong short acute scales, upper one pedunculate; pistillate spikes 2, oblong, cylindric, closely jointed, erect, upper one often staminate at the apex, all with enclosed peduncles, upper nearly sessile; fruit ovate, acuminate, bilobate, scarcely rostrate, striate, longer than the ovate and tawny scale.

Penn.—*Muh.*;—New Jersey—*Torrey;* Florida—*Chapman.*

All the varieties noticed by Muhlenberg, have not been found by later botanists. Perhaps one of them is *C. Halseyana*, which is, however, too different in various respects. In *C. Halseyana*, the staminate scale is more obtuse, and the fruit is distictly rostrate, or more nearly ovate-globose, and continued into a distinct beak, two-toothed, much less glabrous, and the spikes less closely flowered. All the Carices in Muhlenberg's Gram., are ascertained.

No. 212. *C. turgescens*, Tor. Mon. Am. Cyp., p. 419.

Spica staminifera solitaria oblonga erecta pedunculata; spicis pistilliferis 2–3, ovatis paucifloris erectis subsessilibus folio-bracteatis *tristigmaticis*, infima nunc remota nunc subapproximata exserte pedunculata; fructibus ovatis inflatis conico-longo-rostratis striatis divergentibus ore bifidis, squama ovata magis duplo longioribus.

Culm 15–30 inches high, erect, with long and leafy bracts; leaves linear-lanceolate, striate, shorter towards the root, and all surpassed by the culm; staminate spike long cylindric, pedunculate, and small bracteate; pistillate spikes 2–3, ovate, few flowered, erect, mostly sessile, except the lowest, which is often remote and long pedunculate; stigmas three; fruit ovate, inflated, long-conic, and thus rostrate, two-toothed, with prominent or raised striæ, diverging, glabrous, more than twice longer than the ovate scale; light green.

This is *C. folliculata*, Elliott, (not of Lin.,) found in South Carolina; also in Louisiana—*Torrey;* Florida—*Chapman.*

Related to *C. folliculata*, Lin., and *C. intumescens*, Rudge, the *C. folliculata*, Schk. Dr. Torrey saw the difference and properly gave the species a name. Its fruit is far more inflated than that of *C. folliculata*, L., and far more tapering and conic than that of *C. intumescens*, Rudge.

Art. XXXVI.—*On a New Metal, Pelopium, contained in the Bavarian Tantalite; by* Prof. H. Rose.*

In a former paper,† on the composition of the so-called tantalic acid which occurs in the columbite of Bodenmais in Bavaria, I showed that it consisted of two acids, one of which differs so decidedly from all known metallic oxyds, that I did not hesitate to regard it as the oxyd of a new metal, which I named niobium. I did not then enter into a description of the second acid, which occurs in company with the niobic acid, but merely observed that it possessed great similarity to the tantalic acid procured from the Finland tantalites.

The separation of the two acids according to the method I formerly described, was exceedingly troublesome and tedious. After I had suspected a peculiar substance in the so-called tantalic acid from columbite, and had vainly attempted in various ways to isolate it, I succeeded in effecting this only approximatively on converting the acid into chlorid, by mixing it with charcoal and passing a current of chlorine over the heated mixture. I obtained a yellow, readily fusible and very volatile chlorid, and a white, infusible, less volatile chlorid. Both were converted by water into metallic acids, which were not dissolved by the hydrochloric acid formed, but separated on boiling, and could easily be freed by washing with water from every trace of acid; but when the acid from the white infusible chlorid, after I had separated it as well as possible from the yellow one, was again mixed with charcoal, and treated with chlorine, I constantly obtained yellow and white chlorid; less, it is true, of the first than when the mixture of the two acids as they occur in the mineral was employed; but even when the operation was very frequently repeated with the acid from the white chlorid, it was not possible to obtain by this method a pure white chlorid free from yellow. I observed, however, that the white chlorid was only partially sublimed. When it was separated as much as possible from the yellow chlorid, and by sublimation also from a white non-volatile residue, it at last afforded an acid, which, on treatment with charcoal and chlorine, yielded a tolerably pure, white, wholly volatile chlorid, the chlorid of niobium. The white fixed residue yielded with charcoal and chlorine a large quantity of yellow chlorid; and after removing this by sublimation, again left a white non-volatile residue, which, on being again subjected to a similar treatment, afforded the same products.

---

* Neber ein zweites im Tantalit, (Columbit,) von Baiern enthaltenes neues Metall; von Heinrich Rose. Poggend. Annal.; cited from Chem. Gazette, September 15, 1846.

† Poggend. Annal. Bd. 63, S. 317.

On comparing this behavior of the yellow chlorid with that observed on treating a mixture of pure tantalic acid and charcoal with chlorine, I obtained a perfectly similar yellow chlorid and a white non-volatile residue; but the quantity was far smaller, and its production could be entirely avoided, if, in the preparation of the chlorid of tantalium, every trace of humidity and atmospheric air had been carefully excluded. Moreover, the sublimed yellow chlorid from the Bavarian mineral, very much resembled the chlorid of tantalium. This similarity likewise extended to the acids prepared from the two chlorids; they behaved so much alike, that it was only after long-continued investigation that properties were discovered by which they might be separated.

In the preparation of chlorid of tantalium from the tantalic acid from the Finland tantalite, and especially in that of the yellow chlorid from the Bavarian mineral, I frequently obtained considerable quantities of a red chlorid, which was still more volatile than the yellow one, and proved on examination to be the chlorid of tungsten. When the chlorids are exposed for some time to the air, the tungsten can be removed by digestion with ammonia, as soluble tungstate of ammonia.

Sometimes chlorid of tin and chlorid of titanium were obtained in preparing the chlorid; they could be readily distinguished, by their fluid state of aggregation, from the other chlorids.

The formation of the chlorids of tungsten and tin appears remarkable, inasmuch as the acids from which the chlorids were prepared had been kept in a moist condition for a long time in contact with sulphuret of ammonium. I draw especial attention to this circumstance, because, unless perfectly freed from these impurities, the chlorids and the acids prepared from them are obtained with very different properties.

The yellow chlorid from the Bavarian mineral differs, therefore, principally from the chlorid of tantalium by its leaving a white non-volatile residue on its production, or rather on its volatilization, at a high temperature. This residue consists principally of the acid which may be obtained from the yellow chlorid by decomposition with water.

In the preparation of the yellow chlorid from the columbite of Bodenmais, there is formed along with it an oxychlorid, which is decomposed by heat into chlorid and acid, just like the tungstate of the chlorid of tungsten. The formation of the oxychlorid can be prevented by placing a long layer of charcoal in the anterior portion of the glass tube, in which the mixture of acid and charcoal is to be treated with chlorine. While the chlorine is passing through the tube, this charcoal is first raised to a strong red heat, and then the mixture.

The acid of the yellow chlorid from the Bodenmais mineral, which is contained in it along with the niobic acid, I have named

Pelopic acid, and the metal *Pelopium*, from Pelops, the son of Tantalus, and the brother of Niobe; to point out, at the same time, by this name, not only its simultaneous occurrence with the oxyd of niobium, but more particularly the very great resemblance of pelopic acid to the tantalic acid from the Finland tantalites. This similarity is indeed more perfect than exists between the combinations of any other two simple metals; it is so great, that it was only after a long-continued and most minute investigation that I could decide upon publishing the results I had obtained. The combinations of niobium are, on the contrary, very different from those of pelopium or tantalium.

I will here describe the most important properties by which the compounds of tantalium differ from the corresponding compounds of pelopium, and at the same time enumerate those of niobium.

In its properties, pelopic acid is intermediate between tantalic and niobic acids, just as strontia is between baryta and lime. And in the same way as we are able to explain many properties of strontia, by assuming it to be a mixture of the two last-mentioned earths, we are able to determine *à priori* most of the properties of pelopic acid, by admitting it to be a mixture of a large proportion of tantalic acid, with a small quantity of niobic acid; and as was the case with bromine, which, on its discovery, was considered to be a combination of chlorine and iodine, I myself was long of opinion that the pelopic acid was nothing more than tantalic acid, still contaminated by a certain quantity of niobic acid, which I had not succeeded in separating. It was only by an uninterrupted investigation of this subject for several years that I became convinced of the distinctness of pelopic acid.

The chlorids of the three metals dissolve in cold concentrated sulphuric acid without any evolution of heat, but with disengagement of hydrochloric acid; but if the solution of the chlorid of tantalium and pelopium is boiled, it solidifies to a jelly. Water then does not dissolve any of the tantalic acid, but a large quantity of the pelopic acid. The solution of the chlorid of niobium by sulphuric acid is not rendered turbid by boiling; it even remains clear on dilution with water, but if it be now boiled, the whole of the niobic acid is precipitated from the solution.

Chlorid of tantalium dissolves in hydrochloric acid in the cold to a turbid liquid, which after some length of time forms an opaline jelly, from which water both cold and boiling dissolve only traces of tantalic acid.—But if chlorid of tantalium is treated with boiling hydrochloric acid, it does not dissolve entirely, and on cooling it does not form a jelly, but water now dissolves the whole of it to an opaline liquid, which is not rendered more turbid by boiling. Sulphuric acid produces in it, after some time, a voluminous precipitate even in the cold. The chlorid of pelopium behaves in a similar manner, except that sulphuric acid does not produce a precipitate in the cold, in the solution obtained by boiling and diluted with water, but only on boiling. Chlorid of niobium does not dissolve in cold hydrochloric acid, and scarcely anything is dissolved on the addition of water: when, however, chlorid of niobium is boiled with hydrochloric acid, though not dissolving at first, on diluting with water the whole dissolves, and the niobic acid is not even precipitated from the solution by boiling. When sulphuric acid is added, a turbidness results even in the cold, and the whole of the niobic acid is precipitated by boiling. On the other hand, when but a small quantity of hydrochloric acid is placed in contact with the hydrates of the acids, the result is quite a different one. The same is the case when the chlorids of the three metals are treated with much water. The niobic acid is then completely separated on boiling from the chlorid of niobium, and also the pelopic acid from the chlorid of pelopium; but tantalic acid does not separate quite so completely from the chlorid of tantalium.

Chlorid of tantalium, heated with a solution of hydrate of potash, is partly dissolved; but a solution of carbonate of potash does not dissolve any tantalic acid even on boiling. Chlorid of pelopium is dissolved in large quantity by a solution of caustic potash, and even carbonate of potash dissolves it in tolerable abundance on boiling. Chlorid of niobium is dissolved even in the cold by a solution of potash, and also by boiling in a solution of carbonate of potash.

Tantalic acid remains white on being heated to redness; pelopic acid is rendered slightly yellowish; niobic acid, dark yellow. On cooling, both again become as white as before ignition.

All three acids exhibit, when their hydrates are heated very strongly, the phenomenon of phosphorescence. This, however, is not the case when the compounds with sulphuric acid are treated with ammonia, and then heated to redness.

Tantalic acid, exposed in a current of hydrogen to a strong red heat, remains white; pelopic and niobic acids become black; but the reduction which these acids undergo is quite inconsiderable, for very doubtful traces of water are perceptible, and the blackened acids quickly become white when heated with access of air, without experiencing any perceptible increase in weight. When tantalic acid is heated to redness in a current of gaseous ammonia by a brisk charcoal fire, it is turned gray, with the formation of but slight traces of water. Pelopic and niobic acids become black, and are reduced, with the production of a considerable quantity of water.

When tantalic acid is heated in a brisk charcoal fire, and sulphuretted hydrogen gas passed over it, it becomes slightly gray, but no trace of water is perceptible. Pelopic and niobic acids are converted by the same treatment slowly but entirely into sulphurets, with formation of water and separation of sulphur.

Metallic pelopium can be prepared from the chlorid by treatment with ammonia, in the same way as the metals from the chlorid of tantalium and chlorid of niobium. It has the greatest resemblance to tantalium.

When the ignited acids, which are insoluble in almost all reagents in the moist way, are fused in a silver crucible with hydrate of potash, they are dissolved. The fused mass is soluble in water. Hydrate of soda behaves in a different manner. When the ignited acids are melted with it, the fused masses obtained are not clear; but an insoluble sediment is formed, which does not dissolve in any excess of the alkali. If the fused mass be treated with a moderate quantity of water, the excess of soda is removed, and a white insoluble mass remains. If, after removing the free soda, a large portion of water be poured over the insoluble mass, it dissolves, and most completely when niobic acid has been employed.

The insolubility of the three acids in excess of soda, while the potash compounds are soluble in excess of potash, essentially characterizes them. In this they differ from similar acids, especially from tungstic acid. When the solutions of the soda salts are mixed with concentrated solutions of hydrate of soda, they immediately become turbid; if the mixture be made very slowly and carefully, all three soda salts may be obtained in crystals, which are deposited on the sides of the vessel. But crystals only of the niobate of soda can be easily obtained of any size. I succeeded in obtaining them half an inch and more in size, but in general they are much smaller. They are sparingly soluble in cold water, more readily soluble in hot; the solution may be boiled without becoming turbid; it can be evaporated, and the niobate of soda deprived of its water of crystallization without being decomposed. The salt is only rendered insoluble in water by being heated to redness.

The pelopate, and especially the tantalate of soda, are less stable; when their solutions are boiled, an insoluble white precipitate separates, which is an acid salt of soda.

When the niobate of soda is exposed to a red heat, and a current of dry sulphuretted hydrogen passed over it, a dark black crystalline mass is obtained, from which water removes hydrosulphated sulphuret of sodium, while crystalline sulphuret of niobium remains undissolved.

When pelopate of soda is treated in the same manner, there is no sulphosalt formed, but only sulphuret of pelopium. The tantalate of soda remains white on treatment with sulphuretted hydrogen, but its soda is converted into sulphuret of hydrogen and sodium.

When niobic acid is fused with an excess of carbonate of soda until the fused mass no longer decreases in weight, the amount of oxygen in the expelled carbonic acid is twice that in the niobic acid employed. The results obtained on fusing pelopic and tantalic acids with carbonate of soda did not agree. By long-continued fusion of tantalic acid with carbonate of soda, so much carbonic acid is expelled that its amount of oxygen was equal to that of the tantalic acid employed, and finally exceeded it. But nevertheless this basic salt does not dissolve undecomposed in water, but leaves a considerable residue of acid tantalate of soda. Something similar takes place with pelopic acid, only the basic pelopate of soda formed dissolves entirely in water.

When the three acids are fused with carbonate of potash, they exhibit similar properties; but the potash salts are as soluble in the excess of carbonate of potash as in hydrate of potash. In this way we obtain compounds which are soluble in water and crystallize; but they contain carbonate of potash, which cannot be separated in any manner.

The combinations of tantalic acid with the alkalies, are characterized by their passing on all occasions into insoluble acid salts, especially on boiling and evaporating their solutions. The solutions of the alkaline pelopates exhibit this property in a far less degree, those of the niobates not at all. Insoluble acid niobates of potash or soda can only be produced by not fusing the acid a sufficient time with the carbonates.

Tantalic acid is soon and entirely precipitated from its alkaline solutions by carbonic acid as an acid salt; the same is the case with pelopic acid, but with greater difficulty and far more slowly. It is owing to this that the neutral solution of tantalite of soda becomes turbid even by exposure to the air, while that of the pelopate of soda does not become turbid even after long exposure, which is characteristic of it. Carbonic acid produces a precipitate in the solution of alkaline niobate only after a considerable length of time, which, however, is again dissolved by much water.

When the solutions of the alkaline tantalates and pelopates are treated with an excess of hydrochloric acid, the eliminated acids dissolve to faintly opaline liquids. Sulphuric acid produces in these solutions precipitates, and separates the acids on boiling; however, only the pelopic acid entirely, and but partly the tantalic acid. Hydrochloric acid precipitates the acid from the solutions of the alkaline niobates in the cold, and still more so on boiling; an excess of hydrochloric acid merely dissolves slight traces. This behavior is interesting, since we have seen that under other circumstances niobic acid may be wholly soluble in hydrochloric acid. Sulphuric acid precipitates niobic acid from its alkaline solutions even in the cold.

From the solutions of the alkaline tantalates the acid is entirely precipitated, without the assistance of heat, by chlorid of ammonium, pelopic acid less perfectly, and niobic acid still less.

When the solutions of the alkaline tantalates are rendered acid with hydrochloric or sulphuric acid, a pale yellow precipitate is produced in them by tincture of galls. An orange-yellow precipitate is formed, under similar circumstances, in solutions of the pelopates, and a dark orange-red in those of the niobates.

Ferrocyanid of potassium produces in solutions of the tantalates of the alkalies, when they have been rendered slightly acid, a yellow precipitate; in those of the pelopates, a brownish-red; and in those of the niobates, a red one.

When the three acids are fused with bisulphate of potash, they dissolve in it. Niobic acid alone solidifies with it to a crystalline mass. Water removes sulphate of potash from the fused masses, and leaves compounds of sulphuric acid with the metallic acids, from which, however, the sulphuric acid can be removed by very long treatment with water.

When hydrochloric or sulphuric acid is added to the solution of the niobate of potash or soda, and then a bar of zinc immersed in it, the separated niobic acid soon assumes a very beautiful pure blue color. It gradually becomes dirtier, and finally brown. The blue color is produced, in the solutions of the alkaline pelopates, only on the addition of sulphuric acid; but not even then is a blue color produced in the alkaline tantalates, which, however, takes place when the solution of the chlorid of tantalium in sulphuric acid is treated with water and zinc.

Tantalic acid yields before the blowpipe, with the fluxes, colorless beads, even in the inner flame; pelopic acid gives with the microcosmic salt in the outer flame a colorless, in the inner one a brown bead. Niobic acid colors the microcosmic salt in the inner flame of a beautiful blue; the bead can be easily blown colorless in the outer flame.

These are the most important differences between pelopic acid and tantalic acid on the one hand, and niobic acid on the other. To ascertain accurately the behavior of these acids and their combinations, is a most difficult task, as all three acids frequently exhibit highly anomalous properties. We have seen, for instance, that the niobic acid is readily dissolved, under certain circumstances, by hydrochloric acid, when separated from its combinations, while under not very dissimilar circumstances it is almost entirely precipitated by it. This is owing to the acid assuming different isomeric modifications.

The three acids resemble in this respect silicic acid, the behavior of which towards reagents is frequently remarkable, and only excites less surprise from our having been long acquainted with this acid, and its properties having been thoroughly examined.

This tendency of the three acids to assume different isomeric modifications is connected with the great variability which they exhibit with respect to their specific gravity. My experiments on this subject have led me to the most unexpected results; although I have not terminated my investigations, I will nevertheless communicate at present some of the most important.

Some time ago I drew attention to the fact, that in the artificially prepared titanic acid the specific gravity gradually increases by long-continued ignition, until it attains that of rutile. In the same way the modifications of titanic acid which occur in nature, anatase and Brookite, may be converted by continued ignition into rutile. I thought that the publication of these facts would have induced chemists to examine the specific gravity of other oxyds at different temperatures, since these changes have an important influence on the atomic volume. This, however, has not happened, with the exception of a very interesting investigation of Count Schafgotsch, on the specific gravity of silicic acid, in which he has shown that opal, before heating to redness, has so low a specific gravity, that it floats on oil of vitriol; but that the specific gravity is so increased by heating to redness, that it equals that of chemically prepared silicic acid (2·2), but which is still considerably lighter than quartz and rock-crystal (2·6).

The changes which the three metallic acids under consideration experience by heating to redness are far more remarkable. When the hydrate of pelopic acid is deprived of its water by a gentle red heat over a spirit-lamp, just sufficient to produce the phenomenon of incandescence, and then exposed to a strong red heat in a charcoal fire, its specific gravity is considerably increased. If we examine the ignited acid under the microscope, we see that it consists for the greater part, of amorphous granules, in which some small crystals are perceptible. The ignited acid was then exposed to the most intense, and at the same time continuous heat, that a platinum crucible is capable of bearing, that of the porcelain furnace of the Berlin Royal manufactory. The acid was not melted by it, but was converted into a coarse sandy powder, which, examined under the microscope, consisted of perfect crystals. The specific gravity of the acid, however, was thereby considerably diminished; curious enough, it had become still lower than that which the acid possessed after the hydrate had been exposed to a gentle heat over a spirit-lamp, in order to expel its water.

On repeating this experiment, the specific gravity of the crystallized acid, which had been ignited in the porcelain furnace, was found to be constant, while by no other temperature could the acid be brought to a constant specific gravity.

These experiments are in so far remarkable as they prove precisely the contrary of what has hitherto been frequently admitted. Crystalline bodies, such as idocrase, epidote, and garnet, fuse at a high temperature, become amorphous, but of lower specific gravity. It is evident that what applies to these substances cannot be advanced as a general rule.

Niobic acid has a far lower specific gravity than pelopic acid. It exhibits a similar behavior. The acid, exposed to the temperature of the porcelain furnace, appears under the microscope perfectly crystalline.

Tantalic acid behaves very different from the other two acids. It is the heaviest of all, and, by heating to redness in a charcoal fire, increases considerably in specific gravity, from 7·0 or 7·1 to 8·2. In the fire of the porcelain furnace it is likewise converted into a coarse powder, but which does not appear distinctly crystalline under the microscope. Its specific gravity is thereby only slightly lessened.

In all these experiments no alteration in the absolute weight was perceptible.

Art. XXXVII.—*Termination of the Palæozoic Period, and Commencement of the Mesozoic;* by D. D. Owen, M. D.

Some of the most distinguished and experienced geologists seem, from their recent publications, disposed to include the Permian system, in the Palæozoic division of the fossiliferous strata, regarding it as the terminating group of that period. Their arguments in support of this view, are—

The corals of this system are considered to have a palæozoic type.

From ten to thirty species* of brachiopodous mollusca are common to the Carboniferous and Permian systems.

The genera *Productus* and *Spirifer* are continued into it.

The *Chonetes sarcinulata* is common to the Silurian, Devonian and Carboniferous strata, and penetrates, according to M. de Verneuil, into the gypsum and marl deposits of Bakhmout, which are believed to belong to the Permian system.

The analogy which exists between the plants of the Permian and those of the Carboniferous system.

In estimating the value of the above arguments, the following facts must not be overlooked.

"Of all the corals of the Permian system which have come under the observation of Lonsdale, he has not yet detected one species† that is identical with any found in the inferior systems;‡ and the only corals which occur in profusion, pertain to genera

---

* The tables only show nine species.

† The table gives *Fenestella antiqua* (*Gorgonia antiqua*, Goldf.) as common to the Permian, Devonian and Silurian systems; and *Fenestella dubia*.

‡ See note Sur les equivalents du system Permien, par M. de Verneuil, p. 8.

analogous in structure to the *Fenestella*, *Retepora* and *Gorgonia*. But these reticulated corallines are by no means confined to the palæozoic strata. Six species of *Retepora* are given by Goldfuss, as occurring in the cretaceous system of Maestricht, and two species in particular, viz: *R. fenestrata*, Goldf., and *R. vibicata*, Goldf., are remarkably analogous in structure to forms occurring in the Silurian and Devonian rocks, whilst the genus *Gorgonia* is still living in the ocean.

As yet but one single species has been established as common to the Silurian, Devonian, Carboniferous and Permian systems, viz: *Chonetes sarcinulata*, (*O. striatella*, Dal. *L. lata*, v. B.;) since the *Spirifer hystericus* is given in the tables as only problematical in the Permian system, and but one, besides the preceding, is common to the Permian and Devonian, viz: *Terebratula concentrica*.

The only other four species of brachiopods noted in the table above referred to, *not peculiar* to the Permian system, are—*Lingula mytiloides*, *Productus Cancrini*, *Spirifer cristatus*, *Terebratula Rossyi*. These are given as common to the Permian and Carboniferous systems.

It appears from the above, that the force of the argument in favor of placing the Permian system in the palæozoic period, proves chiefly an analogy between it and the Carboniferous system; for when we examine the evidence to show that the Devonian and Silurian systems belong to the same era, the proof is feeble, resting on but two instances of specific identity.

Reflecting on the above, and other facts which are about to be enumerated, I have been led to differ from the writers alluded to, or at least to doubt the propriety of a classification which throws the Permian and Carboniferous systems into the palæozoic period, high as the authority is from which the proposed classification emanated.

Before proceeding to give the arguments in favor of a different arrangement, let us see what ought to be our most important guide in determining the great division of rocks.

These divisions are, in one sense, arbitrary. Geological eras cannot be considered as separated by abrupt transitions: where the series are complete, there is a blending of one system into the other; especially a gradual dying off of orders, genera and species of fossil forms, rendering it difficult, sometimes impossible, to draw broad and well defined lines of separation. Still, taken as a whole, the best guides in defining their limits seem to be the evidence of a more or less complete change in the physical condition of our planet; the termination of one great class of phenomena and the beginning of another; the extinction of races and the development of new tribes; the proofs of the elevation and disruption of formations and the unconformability of stratification; the evidence of a change in the relative position of land and sea.

Let us consider, then, in the first place, what is the evidence of such phenomena about the termination of the Permian system and the commencement of the Triassic.

In every country where these systems exist, so far from there being any evidence of disturbance or unconformability about the termination of the one and the beginning of the other, there is so complete a blending of adjacent strata, that it is only since the geological examination of Russia, by Murchison, Verneuil and Keyserling, that the Permian beds have been distinguished from the variegated marls and sandstones of the trias; indeed, even at this day it is hardly decided where the dividing line ought to be drawn.

It is true that a few genera of Brachiopoda and Gasteropoda, which occur in the Silurian and Devonian systems, are continued into the Permian, and here, perhaps, become extinct. But is this to be considered of as much importance as the extinction of a whole tribe? Is it of as much moment as the commencement of a luxuriant tropical vegetation? Is it to be compared to the apparent coming in of a new order of terrestrial animals?

If we except the small and rather insignificant genera of *Griffithedes* and *Phillipsia*, which occur in the limestone on which the coal measures rest, does it not appear that the entire race of trilobites becomes extinct at the termination of the Devonian period. Just at the time when this remarkable family of crustaceans passes away, have we not the strongest proof of a most extensive accession of dry land in the luxuriant and extra-tropical vegetation of the carboniferous epoch. Before this period, with one or two rare examples, no trace of land plants has been discovered. If, during the Silurian and Devonian periods, a suitable climate had prevailed, capable of supporting a terrestrial vegetation, and dry land had existed in a proper position, we should certainly, long ere this, have obtained marks of its presence.

In the Permian system, there have been discovered in Europe, at least twelve species of Sauroid reptiles, an order of animals which may be regarded as singularly characteristic of the mesozoic period, and imprinting, more than any other race, a peculiar type to the mesozoic fauna. If the footmarks observed by Dr. King, in the coal measures of Pennsylvania, should prove, as at present suggested, to be referable to some reptile, then the commencement of air-breathing reptiles is just coeval with the grand carboniferous flora.

These are certainly strong arguments in favor of placing, not only the Permian, but also the Carboniferous group in the mesozoic period, and terminating the palæozoic division with the commencement of the coal measures.

The previous remark with regard to the blending of adjacent strata, and the prevalence of some characteristics of one era in the nearest members of the next, applies, to a certain extent, to the systems in question. Indeed, the Carboniferous and Permian systems may be regarded as transition groups, connecting the palæozoic and mesozoic periods. But, take them as a whole, if we are to include them in one or the other of these periods, there is, to my mind, far more reason for grouping them with the mesozoic than with the palæozoic deposits.

Besides the arguments just brought forward in support of the above classification, I invite attention to the following.

Hardly a vestige exists in the Permian system, of the numerous Cephalopods so conspicuous in the Silurian and Devonian. The only specimens of this order of mollusca recorded, are: *Nautilus Freislebeni*, a nondescript *Nautilus*, and a problematical fragment of an *Ammonite*. So far, therefore, as the Cephalopoda are concerned, analogy connects the Permian species with the mesozoic strata.

Only a single fossil fish is known common to the Permian and inferior systems, and that not lower than the Carboniferous; i. e. *Palæoniscus Freislebeni*, which occurs both in the Permian and Carboniferous systems, but not in the Devonian and Silurian.

But three Gasteropoda are cited as common to the Permian and inferior systems, and two of these are problematical; i. e. *Loxonema Urii* and *L. rugifera;* the former, *perhaps*, common to the Permian and Devonian systems. The third, the *Pleurotomaria carinata*, is given as common to the Permian and Carboniferous systems.

Only one of the Monomyaria, i. e. *Avicula antiqua*, is common to the Permian and inferior systems, being found also in the Carboniferous.

All the species of Dimyaria are peculiar to the Permian. On the whole, therefore, very few even of the mollusca are common to the Permian, Devonian and Silurian; and when we recollect that this class of animals is capable of surviving very great vicissitudes, it cannot be considered extraordinary that a few may have escaped and outlived even a great change of temperature, or some sudden catastrophe.

In addition to the above arguments in support of the views here taken of the classification of rocks, the reader may be reminded that the Permian system of Russia, according to M. de Verneuil, rests unconformably on the upturned edges of the Carboniferous group, whilst a similar want of conformity ("*pareille discordante*") is very rare between the Permian and Triassic.

Art. XXXVIII.—*Glycocoll (Gelatine Sugar) and some of its Products of Decomposition;* by E. N. Horsford.

(Read before the Albany Institute, September, 1846.*)

As there are laws in physics, whose evolution, carefully traced, would constitute a general history of this department of science, so there are bodies in chemistry, whose career, if we may employ such an expression, accurately followed out, would acquaint us with the prominent periods through which this science has passed. The history of *sulphuric acid*, for example, may almost be said to be the history of *technical* chemistry, as that of *hydrosulphuric acid* and *ammonia* is of *analytical;* or, as that of *oxygen* is of *theoretical* chemistry.

Among the bodies belonging to organic chemistry, perhaps no one presents itself, whose history, fairly exhibited from the time of its discovery down to this date, contains more obvious and lasting impressions of the periods through which this branch of chemical science has passed, than the sugar of gelatine. It bears the stamp of a period when an organic analysis had scarcely been made; of a time when the substance was not obtained pure; then of a time when, from the perfection of methods and apparatus, analyses enjoyed the whole confidence of the chemist, and it was only necessary that formulæ should coincide with them, in order to their being considered correct; and finally, of a time in which the relations to other substances came in to share in the solution of the problem of the constitution of an organic body. These circumstances may justify a glance at the history of this interesting body.

Braconnot,† in 1820, by treating isinglass with sulphuric acid, obtained a body of sweet taste, ready solubility in water, difficult solubility in alcohol, capable of uniting with nitric acid, and in this state of combination uniting with alkalies and alkaline earths; to which substance he gave the name of sugar of gelatine, (*sucre de gelatine.*)

Boussingault,‡ to whom we are indebted for the first analysis of this body, gave it the formula $C_{12}H_{31}N_6O_{11}$, which, expressed in equivalents, is $C_{12}H_{15\frac{1}{2}}N_3O_{11}$.

From this body he obtained a crystallizable compound, with the protoxyd of lead, which, upon analysis, yielded the formula $C_{12}H_{13\frac{1}{2}}N_3O_7+3PbO$. Three atoms of protoxyd of lead had taken the place of two atoms of water.

* Published in Liebig and Wöhler's Annalen, 1846; and translated for this Journal by the author.

† Annal. de Chim. et de Phys., T. xiii, p. 113.

‡ L'Institut, No. 245. Phar. Cent. Blatt, No. 50, 1838.

If this be regarded neutral, Boussingault remarks, the body without water would be $C_4 H_{4\frac{1}{2}} NO_3$.

The investigation undertaken at this period (1838) was resumed in 1840, '41,* when, from the same chemist, a new formula, obviously based upon a conscientious trust in the results of analysis, was produced.

Meanwhile, Mulder† had obtained the same body with Leucin, by treating glue with caustic potash. His analysis led him to the formula $C_8 H_9 N_2 O_7$. With protoxyd of lead it lost two atoms of water. Its composition would then have been $C_8 H_7 N_2 O_5 + 2HO$, the two atoms of water being replaceable by two atoms of protoxyd of lead. This formula differs from that of Boussingault, chiefly in that it is about two-thirds as large. In that of Boussingault, an equal loss of water was, however, replaced by three atoms of protoxyd of lead, instead of two.

With the gelatine-sugar-nitric acid, (*acide-nitro-saccharique; leim-zucker-salpetersaure,*) Mulder obtained a compound with baryta, of unusual constitution, which he expressed by the following formula—

$$(BaO, C_8 H_7 N_2 O_5) + 2(BaO, NO_5).$$

His formula for gelatine-sugar-nitric acid, is

$$C_8 H_{11} N_4 O_{19} = C_8 H_9 N_2 O_7 + 2NO_5 + 2HO,$$

while that of Boussingault, for this compound, was

$$C_4 H_{6\frac{1}{2}} N_2 O_{10} = C_4 H_{4\frac{1}{2}} NO_3 + NO_5 + 2HO.$$

These differ from each other in the relative and absolute quantities of hydrogen and oxygen, and yet not so widely but that the want of correspondence might be attributed to slight impurity of substance.

Boussingault analyzed a compound of this acid with oxyd of copper, of the following constitution:—

$$C_4 H_{6\frac{1}{2}} N_2 O_{10} + 2CuO =$$
$$(C_4 H_{4\frac{1}{2}} NO_3, NO_5) + (2CuO, HO).$$

At a temperature of 165° C., [329° F.] this compound lost 17·71 per cent. of water, leaving

$$C_4 H_{2\frac{1}{2}} NO, NO_5 + 2CuO.$$

Deducting the two atoms of oxide of copper, there remains a body— $C_4 H_{2\frac{1}{2}} NO$.

In this condition of the question, as to the constitution of glycocoll, the investigation was resumed by Boussingault. He analyzed the body itself, and several most interesting compounds of it with oxyds of copper, lead and silver, nitric acid and nitrates of metallic oxyds. From these he derived the formula

$$C_{16} H_{15} N_4 O_{11} + 3HO,$$

---

* Ann. de Chim. et de Phys., 3d Ser., T. i, p. 257–270.

† Nat. en Scheik. archief, 1838, p. 146.

in which the three atoms of water were replaced with four atoms of metallic oxyd.

The gelatine-sugar-nitric acid he found to be

$$C_{16}H_{15}N_4O_{11}, 4NO_5+9HO,$$

and its compounds with bases to be

$$C_{16}H_{15}N_4O_{11}+4NO_5+4(8)MO+2aq.$$

This exceedingly complicated formula, and its high atomic weight, together with the fact that the several formulæ for gelatine sugar, enumerated above, though differing absolutely from each other, are nevertheless but slight modifications from once, twice, three and four times the following formula,

$$C_4H_4NO_3,$$

led naturally to the conclusion that the differences might be attributed partly to the impurity of the substances analyzed, and partly to the imperfect atomic weights at that time in use.

Beyond the description and analysis of the body itself, and the few salts above enumerated, gelatine sugar had met with no detailed examinations. These considerations gave occasion to the investigation which follows. It is scarcely necessary to add to the statement of its having been conducted at Giessen, that the counsel and coöperation there enjoyed, have united with the recollections of this labor, some of the most grateful memories of a life.

Formula of Glycocoll.

Finding it impossible to obtain as large a per-centage of carbon by the combustion of gelatine sugar, either in chromate of lead or oxyd of copper, as had been found by both Mulder and Boussingault, no conclusion remained, but that the analyses they had recorded, and those we had made, were of different bodies. After the analyses of several compounds of this body with hydrochloric, sulphuric and nitric acids, oxyd of copper, nitrate of silver, and bisulphate of potash, the conviction was established that its constitution was $C_4H_4NO_3$,

to which in crystallized gelatine sugar, an atom of water is united.*

Upon comparing the per-centages derived from this formula with the results of analysis in Boussingault's last investigation, the differences will be seen to be scarcely greater than frequently occur in a series of the best determinations.

The body analyzed by Boussingault, was dried at 120° C., [248° F.] That analyzed by us lost nothing in weight at 150° C.,

---

* For the anhydrous body, we have adopted the already proposed name GLYCOCOLL. The inappropriateness of the name *sugar*, has been noticed by Dessaigne. The attribute of sweetness it shares with AqO, S_2O_2, oxide of glyceryle and nitrous ether, and beside, it is incapable of fermentation.

We submit the symbol Gl., as least likely to lead to confusion. G. might confound with Glycium, (Glucinum, Beryllium,) and Gly. is already appropriated to *Glycerile.*

[304° F.] When exposed upon a watch crystal to the heat of a lamp, with a metallic screen between, and at such distance that the escape of vapor is barely discernible, a part of the mass in contact with the glass becomes browned, while another portion melts and shoots into crystals. These continue to form even after other portions have become charred. Rubbed together with finely pulverized hydrate of baryta, it becomes almost instantly fluid, the whole dissolving readily in water, from which, in process of time, crystals containing baryta and glycocoll deposit themselves. Here, in the act of combination, the water from one or both the ingredients was given up.

The above circumstances, and others yet to be noted, induced the opinion that at a certain temperature, a lower one longer continued, an atom of water from one half of the hydrated glycocoll might be given up, and the remaining half take its place. This would give almost precisely the analytical results of both Mulder and Boussingault, and yield from the formula determined on by us, precisely the composition given by Mulder.

$$2(C_4\,H_4\,NO_3,\,HO)—HO=C_8\,H_9\,N_2\,O_7.$$

Below, follow the estimated per cent. constitution, according to the above formula, and the average of a series of analyses by Boussingault and Mulder.

	Estimate.	Bous.	Mulder.
8 equiv. Carbon, - - - -	34·04	33·79	34·17
9 " Hydrogen, - - -	6·38	6·44	6·49
2 " Nitrogen, - - -	19·85	19·90	19·84
7 " Oxygen, - - - -	39·73	39·70	39·50
	100·00	100·00	100·00

The effort to expel this half atom of water was unsuccessful. A temperature of 150° C. [302° F.] produced scarcely a perceptive diminution in weight. At 170° C. [338° F.] it began to brown with the escape of gaseous products of decomposition. At 190° C. [374° F.] though portions had become quite charred, others had merely melted and crystallized anew.

The support which the analyses of Boussingault give to the formula $C_4\,H_4\,NO_3,\,HO,$ will justify the following juxtaposition of the estimated per cents. and the actual results.

Glycocoll and Oxyd of Silver; dried at 110° C. [230° F.]

	Boussingault. $C_{16}H_{15}N_4O_{11}+4AgO.$			Horsford. $C_4H_4NO_3+AgO.$	
	Equiv.	Estimate.	Result.	Equiv.	Estimate.
Carbon, . . .	16 = 96	13·35	13·62	4 = 24	13·18
Hydrogen, . .	15 = 15	2·08	2·21	4 = 4	2·19
Nitrogen, . .	4 = 56	7·78	8·07	1 = 14	7·69
Oxygen, . .	11 = 88	12·26	12·35	3 = 24	13·21
Ox. silver, . .	4 = 464	64·53	63·75	1 = 116	63·73
	719	100·00	100·00	182	100·00

Glycocoll and Oxyd of Copper; dried at 120° C. [248° F.]

	Boussingault.			Horsford.	
	$C_{16}H_{15}N_4O_{11}+CuO$.			$C_4H_4NO_3+CuO$.	
	Equiv.	Estimate.	Result.	Equiv.	Estimate.
Carbon, . . .	16 = 96	23·19	23·57	4 = 24	22·68
Hydrogen, . .	15 = 15	3·62	3·75	4 = 4	3·77
Nitrogen, . .	4 = 56	13·53	. .	1 = 14	13·24
Oxygen, . .	11 = 88	21·29	. .	3 = 24	22·70
Ox. copper, . .	4 = 158·8	38·37	37·60	1 = 39·7	37·61
	413·8	101·00		105·7	100·00

Glycocoll and Oxyd of Lead; dried at 120°. [248° F.]

	Boussingault.			Horsford.	
	$C_{16}H_{15}N_4O_{11}+4PbO$.			$C_4H_4NO_3+PbO$.	
	Equiv.	Estimate.	Result.	Equiv.	Estimate.
Carbon, . . .	16 = 96	13·67	13·58	4 = 24	13·48
Hydrogen, . .	15 = 15	2·13	2·12	4 = 4	2·24
Nitrogen, . .	4 = 56	7·97	7·78	1 = 14	7·86
Oxygen, . .	11 = 88	12·57	11·62	3 = 24	13·50
Ox. lead, . .	4 = 446·8	63·66	64·90	1 = 111·7	62·92
	701·8	100·00	100·00	177·7	100·00

Glycocoll and Nitric Acid, dried in vacuo by ordinary temperature.

	Boussingault.			Horsford.	
	$C_{16}H_{15}N_4O_{11}+4NO_5+9HO$.			$C_4H_4NO_3$, $HO+NO_5$, HO.	
	Equiv.	Estimate.	Result.	Equiv.	Estimate.
Carbon, .	16 = 96	17·39	17·32	4 = 24	17·39
Hydrogen, .	24 = 24	4·34	4·53	6 = 6	4·34
Nitrogen, .	8 = 112	20·29	20·23	2 = 28	20·29
Oxygen, .	40 = 320	57·98	57·92	10 = 80	57·98
	552	100·00	100·00	138	100·00

At 100° C. [212° F.] this salt lost 9·18 per cent., and at 110° C. [230° F.] 4·5 per cent. more, with which it began to brown. This loss, 13·68 per cent., corresponds nearly with 13·77 per cent., the water in the salt. Its formula would then be

$$C_4H_4NO_3, NO_5.$$

Glycocoll and Nitrate of Silver.

	Boussingault.			Horsford.	
	$C_{16}H_{15}N_4O_{11}+2HO+4(AgO, NO_5)$.			$C_4H_4NO_3+AgO$, NO_5.	
	Equiv.	Estimate.	Result.	Equiv.	Estimate.
Carbon, .	16 = 96	10·07	10·09	4 = 24	10·16
Hydrogen, .	17 = 17	1·78	1·84	4 = 4	1·69
Nitrogen, .	8 = 112	11·75	11·50	2 = 28	11·87
Oxygen, .	33 = 264	27·72	27·87	8 = 64	26·75
Ox. silver, .	4 = 464	48·68	48·70	1 = 116	49·53
	953	100·00	100·00	236	100·00

Glycocoll and Nitrate of Potash.

	Boussingault.			Horsford.	
	$C_{16}H_{15}N_4O_{11}+2HO+4(KO, NO_5)$.			$C_4H_4NO_3KO$, NO_5.	
	Equiv.	Estimate.	Result.	Equiv.	Estimate.
Carbon, .	16 = 96	14·14	14·26	4 = 24	14·35
Hydrogen, .	17 = 17	2·55	2·42	4 = 4	2·39
Nitrogen, .	8 = 112	16·50	. .	2 = 28	16·78
Oxygen, .	33 = 264	38·86	. .	8 = 64	38·21
Potash, .	4 = 189·6	27·95	27·49	1 = 49·4	28·27
	678·6	100·00		167·4	100·00

Glycocoll and Nitrate of Copper.

	Boussingault.			Horsford.	
	$C_{16}H_{15}N_4O_{11}+4NO_5+8CuO+9HO$.			$C_4H_4NO_3, HO \left\{ \begin{matrix} CuO, HO \\ CuO, NO_5 \end{matrix} \right.$	
	Equiv.	Estimate.	Result.	Equiv.	Estimate.
Carbon, .	16 = 96	11·02	11·04	4 = 24	11·02
Hydrogen,	24 = 24	2·75	2·89	6 = 6	2·75
Nitrogen, .	8 = 112	12·86	12·08	2 = 28	12·86
Oxygen, .	40 = 320	36·79	37·45	10 = 80	36·79
Ox. copper,	8 = 317·6	36·58	36·54	2 = 79·4	36·58
	869·6	100·00	100·00	217·4	100·00

If we review the estimates from the two systems of formulæ, and the results of analysis recorded above, it will be seen—

1st. That the analyses of the compounds with nitrate of silver, more nearly correspond with the estimates from Boussingault's formula.

2d. That the analyses of the compounds with nitric acid, nitrate of potash and nitrate of copper, are suited equally well to either formula. And

3d. That the analyses of the remaining compounds, viz: with the oxyds of silver, copper and lead, correspond more nearly with the simpler formula.

As additional reasons for adopting the simpler formula, the following, drawn from our investigation, may be recorded.

4th. The analyses give this constitution: as the average of four combustions for carbon and hydrogen, and two for nitrogen, will show, placed side by side with the estimates from the formula

$$C_4 H_4 NO_3, HO.$$

		Theory.	Experiment.
Carbon, - - - - -	4 equiv. = 24	32·00	31·98
Hydrogen, - - - -	5 " = 5	6·67	6·87
Nitrogen, - - - -	1 " = 14	18·67	18·79
Oxygen, - - - -	4 " = 32	42·66	42·36
	75	100·00	100·00

5th. It forms a compound in which sulphuric acid replaces the atom of water: $C_4 H_4 NO_3, SO_3$
corresponding with Boussingault's nitrate, dried at 110° C. [230° F.]: $C_4 H_4 NO_3, NO_5$.

6th. It forms a compound with oxyd of copper, of this formula:

$$C_4 H_4 NO_3, CuO, HO,$$

which, at 100° C., [212° F.] loses an atom of water.

7th. It forms a compound in which the atom of water is replaced by an atom of nitrate of silver:

$$C_4 H_4 NO_3; AgO, NO_5.$$

8th. It forms, when long digested with sulphuric acid, a salt of this constitution:

$$\left. \begin{matrix} C_4 H_4 NO_3, SO_3 HO \\ H_4 NO, SO_3 HO. \end{matrix} \right\}$$

The ammonia is taken from the hydrated glycocoll, which may be considered as fumarate of ammonia:

$$C_4 H_4 NO_3, HO = H_4 NO, C_4 HO_3.$$

9th. It decomposes when subjected to the action of the galvanic battery; an acid (fumaric?) and oxygen appearing at one pole, and an alkali (ammonia) and hydrogen appearing at the other.

10th. It may be derived from hippuric acid by treatment with a mineral acid, in which case a neutral salt of glycocoll is formed and benzoic acid set free: or by treatment with potash, in which case benzoate of potash is formed and glycocoll is set free.

Hippuric acid, - -	$C_{18} H_9 NO_6$
Benzoic acid, - - -	$C_{14} H_5 O_3$
Glycocoll, - - -	$C_4 H_4 NO_3$

We may add also that the formulæ of Boussingault and Mulder have not the advantage of so great simplicity.

Preparation of Glycocoll.

The recent brilliant discovery of Dessaigne,* that by boiling hippuric acid with sulphuric, hydrochloric or any of the stronger acids, this body separates into benzoic acid and a salt of glycocoll, rendered the preparation of the latter, in purity, a task of no difficulty. It was, of course, necessary first of all to obtain a quantity of *hippuric acid.*

This acid was prepared according to the method proposed by Dr. Bensch,† by evaporating in a water bath, the morning urine of stall-fed horses, to from one-eighth to one-tenth of its volume; adding hydrochloric acid till all effervescence ceased; setting aside, in a cool place, for the perfect separation of the hippuric acid; filtering through linen, and pressing; dissolving in freshly prepared solution of hydrate of lime, with addition of boiling water; filtering, as before, and pressing; heating the filtrate to boiling, acidifying with solution of alum, cooling to 40° C. [104° F.], adding solution of bicarbonate of soda till no farther precipitation takes place; filtering and pressing; and precipitation of the filtrate with hydrochloric acid. After washing, filtering and pressing the precipitate of hippuric acid, it was again dissolved in boiling water, and blood coal added in the proportion of half an ounce to a pound of moist acid, again filtered at boiling heat through paper, and set aside to crystallize. By this method prismatic crystals are obtained of the most perfect whiteness, an inch in length, and from one to two lines in diameter.

* Compt. Rend., xxi, p. 1224–1227. Liebig's Annalen, Bd., lviii, S. 322.
† Liebig's Annalen, Bd., lviii, S. 267.

From three to four ounces of hippuric acid were digested in a flask of one litre* capacity, over a spirit lamp, in four times their weight of concentrated hydrochloric acid, until entirely dissolved. A larger quantity is less manageable, and the subsequent treatment less expeditious. It is well to continue a gentle heat, with the addition of water half an hour after the solution is completed. In this time a part of the benzoic acid gathers into oily drops and sinks to the bottom, becoming, as the whole cools, a solid crystalline mass, not easily removed from the flask. The presence of water retains the hydrochlorate of glycocoll in solution. After the whole mass has become cool, the benzoic acid having for the most part crystallized out, the contents of the flask are poured upon the filter and washed till the filtrate no longer tastes sour. The filtrate is then evaporated in an open porcelain basin over a water bath, nearly to dryness,—by which process the excess of hydrochloric acid and benzoic acid are, for the most part, removed. Redissolving and again evaporating two or three times repeated, at length give the hydrochlorate of glycocoll quite pure. Ammonia is then added to the syrup till it yields an alkaline reaction. Absolute alcohol being then added, the remaining traces of benzoic acid and the salammoniac are dissolved, while the glycocoll is thrown down in the form of a white precipitate, consisting of myriads of minute prismatic crystals. As the body is slightly soluble in alcohol, and more so in alcohol containing salammoniac, it is well to let the fluid stand a few hours. The precipitate is then brought upon a filter and washed with absolute alcohol, till the filtrate no longer gives a precipitate with nitrate of silver.

Properties of Glycocoll.

Thus obtained, hydrate of glycocoll tastes sweet, though less so than cane sugar,—has neither acid nor alkaline reaction; dissolves in from 4·24 to 4·35 parts of water; is more soluble in hot than in cold spirits of wine; is quite insoluble in ether, and scarcely less in absolute alcohol.

When heated with a concentrated solution of caustic potash, in excess, it assumes, with the evolution of ammonia, a fine brilliant red color. If the heat be continued, the color gradually disappears.

Heated with hydrate of baryta or oxyd of lead, the same brilliant color is produced.

With sulphate of copper, a trace of glycocoll prevents the precipitation by potash, and the solution assumes a characteristic blue color. Boiled with oxyd of copper or its hydrate, it yields the same blue solution, which, if concentrated, crystallizes in fine needles.

* = 0·2201 English gallon.

With nitrate of suboxyd of mercury, it gives a precipitate of metallic mercury.

From a concentrated solution in diluted spirits of wine or in water, in process of time large prismatic crystals are formed, which apparently belong to the monoclinate system, of the combination ∞ P. 0P. + P. ∞ P∞. Prof. Kopp, to whom I am indebted for an examination of these crystals and of several others of salts of glycocoll, obtained from crystals prepared by Prof. v. Liebig, an admeasurement of the sharper angles of ∞ P, (through which the orthodiagonal passes,) giving 66¼°.

The combustions for carbon and hydrogen were made with chromate of lead; those for nitrogen, according to the method of Varrentrapp and Will,—

I. 0·6770 grm.	gave 0·7940	carbonic acid and	0·4170	water.
II. 0·5576 "	" 0·6607	" " "	0·3474	"
III. 0·4670 "	" 0·5455	" " "	0·2882	"
IV. 0·4003 "	" 0·4686	" " "	0·2478	"
V. 0·1338 "	" 0·4100	platin-salammoniac.		
VI. 0·1937 "	" 0·5646	" "		

These determinations correspond in per cent. with

	I.	II.	III.	IV.	V.	VI.
Carbon,	31·89	32·31	31·81	31·92	. .	. .
Hydrogen,	6·84	6·92	6·85	6·87	. .	. .
Nitrogen,	. .	. .	. .	. .	19·24	18·36

From these may be derived the formula,

$$C_4\,H_4\,NO_3,HO,$$

as will be seen by comparing the estimated and average actual per cents. of the several elements.

		Theory.	Experiment.
Carbon, - - -	4 equiv. = 24	32·00	31·98
Hydrogen, - - -	5 " = 5	6·66	6·87
Nitrogen, - - -	1 " = 14	18·66	18·79
Oxygen, - - -	4 " = 32	42·68	42·36
	75	100·00	100·00

The atomic weight of glycocoll is, with the above constitution, 66.

Glycocoll and Hydrochloric Acid.

Neutral Hydrochlorate of Glycocoll.

Gl HCl HO.

This is the product of boiling hippuric acid with concentrated hydrochloric acid, as already described. If the filtrate, page 376, be carefully evaporated to syrup consistence, and suffered quietly to cool, the whole mass becomes filled with groups of long, flat prisms, perfectly transparent, and of the greatest brilliancy. The mother liquor poured off, and the crystals washed with spirits of wine, gives the salt in the utmost purity. A second and third portion of crystals may be obtained by concentrating the mother liquor and similar treatment.

This salt slowly absorbs moisture from the air and deliquesces: over sulphuric acid, the crystals retain their form and constitution any length of time. It tastes sour, and slightly but positively stiptic; reacts acid: dissolves readily in water; in hot spirits of wine, and slightly in absolute alcohol.

The substance dried over sulphuric acid, on combustion with chromate of lead,

I. 0·2368 grm. gave 0·1833 carbonic acid and 0·1272 water.
II. 0·3218 " " 0·2555 " " " 0·1711 "
III. 0·2853 " " 0·5698 platin-salammoniac.
IV. 1·5920 " " 2·0562 chlorid of silver.
V. 1·0008 " " 1·2961 " "
VI. 1·5300 " " 1·9300 " "

Expressed in per cents., the above determination correspond with

	I.	II.	III.	IV.	V.	VI.
Carbon,	21·11	21·28	. .	. .	. .	. .
Hydrogen,	5·96	5·95	. .	. .	. .	. .
Nitrogen,	. .	. .	12·57	. .	. .	. .
Chlorine,	. .	. .	. .	31·91	31·99	31·99

With these numbers, the following formula is in accordance:

$$C_4H_4NO_3, HCl, HO,$$

as the annexed comparison will show.

		Theory.	Experiment.
Carbon, - - -	4 equiv. = 24	21·42	21·20
Hydrogen, - - -	6 " = 6	5·35	5·95
Nitrogen, - - -	1 " = 14	12·56	12·57
Oxygen, - - -	4 " = 32	28·53	28·40
Chlorine, - - -	1 " = 35·4	32·14	31·94
	111·4	100·00	100 00

Basic Hydrochlorate of Glycocoll.

(a.) 2Gl, HCl, HO.

This salt is formed by adding hydrochloric acid to a cold concentrated solution of glycocoll in water, and then pouring in alcohol till the solution becomes slightly turbid. Crystals of the utmost transparency and regularity commence forming immediately. To continue the crystallization, alcohol is added drop by drop, at intervals. It is perhaps better to let the solution in water slowly evaporate over sulphuric acid. In this way larger crystals, of surpassing beauty, were obtained. They are rhombic prisms of 87° and 93°. They do not deliquesce like those of the neutral salt, upon exposure to the air. The salt has a pleasant sour, and at the same time sweet taste, reminding one of fine fresh pippins.

The solution reddens litmus with chromate of lead.

I. 0·3505 grm. gave 0·3550 carbonic acid and 0·1743 water.
II. 0·2758 " " 0·6729 platin-salammoniac.
III. 1·5050 " " 1·1940 chlorid of silver.

These determinations expressed in per cents.:

	I.	II.	III.
Carbon,	27·59	. .	. .
Hydrogen,	5·52	. .	. .
Nitrogen,	. .	15·37	. .
Chlorine,	. .	. .	19·58

Correspond with the formula

$$C_4\ H_4\ NO_3,\ HCl + C_4\ H_4\ NO_3,\ HO,$$

which, calculated, gives:

		Theory.	Experiment.
Carbon, - - -	8 equiv. = 48	27·05	27·59
Hydrogen, - - -	10 " = 10	5·63	5·52
Nitrogen, - - -	2 " = 28	15·78	15·37
Oxygen, - - -	7 " = 56	31·59	31·94
Chlorine, - - -	1 " = 35·4	19·95	19·58
	177·4	100·00	100·00

Basic Hydrochlorate of Glycocoll.

(b.) 2(Gl, HO)+HCl.

This salt was obtained by dissolving glycocoll in hydrochloric acid and leaving the solution to a quiet crystallization. The exact proportions of acid and base necessary to procuring it have not been determined. Indeed, it will appear obvious, after the accounts of the hydrochloric and sulphuric acid compounds, that the task of accurately fixing the temperature, concentration and quantity of the several ingredients necessary to the formation of a given compound of acid, glycocoll and water, will be exceedingly difficult.

Combustion with chromate of lead gave the following results:

I. 1·0290 grm. gave 0·9840 carbonic acid and 0·5580 water.
II. 1·0890 " " 0·8180 chlorid of silver.
III. 0.9760 " " 0·7305 " "
IV. 0·9710 " " 0·7290 " "

In per cents. expressed,	I.	II.	III.	IV.
Carbon,	26·08	. .	. .	. .
Hydrogen,	6·02	. .	. .	. .
Chlorine,	. .	18·53	18·46	18·41

These numbers conduct to the formula,

$$2(C_4\ H_4\ NO_3,\ HO) + HCl,$$

the estimated per cents. of which with the results of analysis are here placed side by side.

		Theory.	Experiment.
Carbon, - - -	8 equiv. = 48	26·46	26·08
Hydrogen, - -	11 " = 11	6·06	6·02
Nitrogen, - -	2 " = 28	15·43	. .
Oxygen, - -	8 " = 64	33·12	. .
Chlorine, - -	1 " = 35·4	18·91	18·47
	186·4	100·00	100·00

The rational constitution of this salt may be considered as one atom of hydrated glycocoll, united to one atom of hydrochlorate of hydrated glycocoll, thus, Gl, HO+Gl, HCl, HO.

Basic Hydrochlorate of Glycocoll.

(c.) 3Gl, 2HCl, 2HO.

This salt was prepared in the same manner as the last; a simple solution of glycocoll in hydrochloric acid, set aside to crystallize. The acid was, however, in excess.

It was also prepared by passing dry hydrochloric acid gas over melted hydrate of glycocoll. For this purpose, a gramme and a half of substance was distributed along the bottom of a Liebig's drying apparatus, and carefully heated with a spirit lamp; at the same time conducting over it hydrochloric acid gas. At a temperature of between 150° C. and 170° C. [between 302° F. and 338° F.] as determined in an oil bath, the glycocoll melts in the acid atmosphere. It was found better, however, to employ the simple lamp. With the latter the apparatus could be readily inclined or half inverted, to spread the molten substance over the interior of the tube, and thus facilitate absorption.

The absorption is attended with the escape of aqueous vapor. The process was continued until no further increase in weight was observed. At each interval the hydrochloric acid was thoroughly removed by long continued passing of dry air through the tube before weighing. At the end of the absorption, the glycocoll usually became slightly green, owing doubtless to a trace of decomposition and separation of carbon.

From an analysis of crystals obtained by the first method,

I. 1·2560 grm. of substance, gave 1·2520 grm. chlorid of silver.

By the other method,

II. 1·9727 grm. of hydrated glycocoll, increased in weight to 2·4580 grm. Precipitated with silver, this gave 2·3855 grm. chlorid of silver. The increase in weight was 24·60 per cent. The per centages of chlorine, I. 24·59; II. 24·23.

These numbers correspond to the formula,

$$3(C_4\ H_4\ NO_3)+HCl+2HO,$$

which requires 24·51 per cent. of chlorine.

Basic Hydrochlorate of Glycocoll.

(d.) 3Gl, 2HCl, HO.

This salt is prepared precisely as the last mentioned, both by crystallization from the acid solution and by leading dry hydrochloric acid gas over fused hydrate of glycocoll.

The notice of this salt would scarcely have been ventured upon, had not a precisely corresponding compound with sulphuric acid been analyzed. It will contribute to show how multifarious may be the relations of a body, that combines as a salt, and yet possesses both acid and basic properties.

From crystals of the salt prepared as above mentioned,

I. 1·2864 grm. gave 1·3203 grm. chlorid of silver.

II. By leading dry hydrochloric acid gas over glycocoll in the manner already described, a compound was formed, of which,

1·1370 grm. gave 1·1845 grm. chlorid silver.

In per cent. expressed, these determinations give,

$$3(C_4\ H_4\ NO_3)+2HCl+HO,$$

which requires 25·30 per cent. of chlorine. As the probable rational constitution of the above salt the following is submitted,

$$(Gl\ HCl+Gl,\ HO)+Gl\ HCl.$$

Anhydrous Hydrochlorate of Glycocoll.

Having found a basic hydrochlorate, which might be regarded as a double salt of one atom of hydrate of glycocoll, with one atom of anhydrous hydrochlorate of glycocoll:

$$C_4\ H_4\ NO_3,\ HO+C_4\ H_4\ NO_3,\ HCl,$$

and especially having found as will be seen below, an anhydrous *sulphate* of glycocoll, it was natural to suppose that the anhydrous hydrochlorate might be obtained by itself, viz. $C_4\ H_4\ NO_3,\ HCl$.

To this end absolute alcohol was saturated with hydrochloric acid gas, and this added to a solution of glycocoll in hot spirits of wine. Upon evaporating the liquid, delicate prismatic crystals appeared which deliquesced with the greatest rapidity. They even dissolved in absolute alcohol. This latter circumstance led to the supposition that the crystals might have been a double salt of hydrate of glycocoll with hydrochlorate of oxide of ethyle. This supposition was further strengthened from an analysis of a sulphate of corresponding constitution soon to be noticed.

(To be continued.)

Art. XXXIX.—*Origin of the Grand Outline Features of the Earth;* by James D. Dana.

The traveller who follows along the indented shores of a continent, or, traversing the ocean, touches here and there at an island, is likely to become strongly impressed with the common idea that the land has every where the utmost irregularity of form, and that islands are "scattered dots" over the wide seas. Such must be the conclusion of any one who should judge from his own casual observations. Were there a system in the world's physiognomy, it could not become apparent till explorations had traced accurately the varying outlines and elevations of continents, and the positions of islands. A good map or globe is a register of the thousand observations of voyagers and surveyors upon these points. It is a miniature of the world within the grasp of our view, and may be properly appealed to with reference to the earth's features. The evidence has not been overlooked by the philosophers of the day, and is more or less fully discussed by Humboldt, Malte Brun, L. A. Necker, Elie de Beaumont, Boué, and other geographers and geologists. Yet it has failed of fixing general attention. It is proposed to pass briefly in review the principal facts, and consider the causes to which the existing features of the earth are attributable.

The remarks which follow will be hardly intelligible to the reader without a globe before him, or a Mercator's chart of the world: and the latter, though the best kind of map for the purpose, is somewhat erroneous in consequence of the parallelism of the meridians.

Trends of Coasts and other Features of Continents.—1. On the continent of America, the reader will observe the nearly straight coast line from the Gulf of Mexico along by Newfoundland and Greenland, a distance of 5000 miles; the near parallelism of this line with the southeast coast of South America, 4000 miles in length; also with the line of Lakes Ontario and Erie, and the river St. Lawrence; also with the coast on the northwest of Hudson's Bay, and that by Prince Regent's inlet. These parallelisms are too striking not to be at once obvious. They are instances of a *northeast* and *southwest* trend; and the distance between these great parallel lines are respectively about 3000 miles, 250 miles, 1400, and 380 miles.

Again: look at the west coast of the same continent, from Darien to Russian America, and laying down a rule, mark the near parallelism of the course with the line of great lakes, from Erie through Michigan, Superior, Winnipeg, Slave and Bear, to the coast by the mouth of the Mackenzie; also with the southwest side of Hudson Bay; with the coast on the west of Davis Strait and Baffin Bay, and that also on the east. Here the uniformity is even more remarkable. These are instances of a *northwest* and *southeast trend.* To one of the two lines correspond the greater part of all the grand features of the continent. The apparent exceptions will be hereafter considered. The distances separating these *northwest* lines average respectively 1000 miles, 350, 700, and 400 miles.

2. Compare the sides of the Atlantic Ocean. The southeast coast of South America, from Magellan to St. Roque, is almost an exact continuation of the western line of the opposite continent, by western Africa, Spain, and Norway or the Baltic; and the break in the line made by the Atlantic, is partly filled by the islands Fernando Noronha, St. Paul and the Cape Verds. It will be shown hereafter that the northeast coast of South America belongs to the northwest system of trends, and extends by Guatemala and California northward; and if we cross the ocean,

we find the Cape Palmas coast of Africa, or rather the Kong mountains adjoining, and the Pyrenees between Spain and France, having the same trend as the northeast of South America.

3. In the eastern continent, the western coast of Europe and eastern of Africa have a striking parallelism, in which the north coast of Asia, from the Obo Gulf to the northeast cape, partakes; and so also the east coast of Asia, the east coast of Hindostan, and also the island of Madagascar. These are *northeast* trends. Again, we observe that the Red Sea, Adriatic and British isles, the Persian Gulf, Western Hindostan, and the coast from Calcutta by Malacca, are nearly parallel lines, having the *northwest* trend. Whatever may be said of the exceptions and irregularities, there are evidently too many coincidences to be set aside as mere accident; and the two courses have accordingly been considered by Humboldt, the great geographical lines of the globe.

We might pursue the same course with the mountains. But the general parallelism of the chains with the coast lines, is so obvious that we barely allude to them in this brief outline of the subject under discussion. The fact is plainly true with respect to the great chains of America: and some particulars, soon to be stated, will bring into one system what appears irregular in Europe and Asia. We observe only that Tchihatchef, a Russian traveller, has pointed out the conformity of the main range of the Altai to the course of the east coast of Africa and the island of Madagascar, while there is also a northeast range in the same chain, parallel with the Persian Gulf and Red Sea: the highest point of the Altai mountains occurs at the intersection of the two ranges.*

Trends of Groups of Islands.—We proceed to a few remarks on the islands of the ocean; and they are the more satisfactory, as islands are the culminant peaks of submerged mountain chains, and therefore mark correctly the proper outline features of the earth's surface. The fact that the islands range in lines was long since pointed out; and Malte Brun remarks on the regularity of these lines in the Pacific Ocean. Compare the line in which lie New Ireland, the Salomon group and the New Hebrides, with the Sandwich or Hawaiian range, extending to the northwest through a number of small islets 2000 miles, from longitude 155° W., beyond 180°. Though 3500 miles apart, the lines are nearly parallel; and parallel also with New Caledonia, and with northeast New Holland, on one side, and nearly also with the coast of California and Guatimala on the other; and moreover, these lines are

---

* Comptes Rendus, May 12, 1845. Tchihatchef observes that the occidental chain runs N. W. and S. E., and the other or oriental, N. E. and S. W. He mentions that a similar system exists in the Alps; but as the identity of direction is not exact, he considers the two systems different.

parallel with the several intermediate chains of islands, as is apparent on the largest charts: the details which are highly interesting will be given by the writer in his Geological Report on the Pacific. Here, then, is an approximate parallelism in ranges over more than a quarter of the circumference of the globe; and nearly all correspond to the *northwest* trend. New Zealand and the Tonga group, and the Ladrones, are examples of the transverse or *northeasterly* trend. The latter trend, (approaching N. N. E.,) characterizes a part of New Holland, the Australian Alps of the southeast, and as observed by Fitton,* the west coast of the Gulf of Carpentaria and the islands off its north cape; besides, also, the northwest coast: the inlets of the coast correspond almost uniformly to one of the two courses pointed out. The Galapagos illustrate distinctly both trends, and they are so mentioned without alluding to any general law, by Darwin.† Beyond the American continent, in the Atlantic, we find the Azores closely parallel with the Hawaiian line; and the same is illustrated in the Canaries, according to the position of the islands given by von Buch,‡ and also in the Cape Verds. These lines are also parallel with northeast South America, and the Pyrenees. Thus, not only over one ocean, but over both, the same system prevails, and alike also over the intermediate continents, the one corroborating the other. The system in truth belongs to the world. To this conclusion Humboldt, Necker, Boué, and other geologists appear to have arrived.

But if we survey the facts more minutely, may we not find that an element in this branch of physical geography has not been properly apprehended? Do not the exceptions throw in a vexatious doubt, if they cannot be blended with the theory? We propose, then, to pursue the subject still farther; and we believe that instead of proving that there are as many distinct systems in orography as there are mountain courses,§ it will

* Sketch of the Geology of Australia, Phil. Mag., 1826, lxviii, 18, 132. The regular lines of islands were observed by Flinders, as remarked by Fitton, (ibid., p. 132.) See Flinders's Voyage, ii, 246.

† Volcanic Islands, p. 115. "Three great craters on Albemarle island, form a well marked line, extending N. W. by N. and S. E. by S.; Narborough island and the great crater on the rectangular projection of Albemarle island, form a second parallel line. To the east, Hood's island and the islands and rocks between it and James' island, form another nearly parallel line; which, when prolonged, includes Culpepper and Wenman islands, lying seventy miles to the north. The other islands, lying further eastward, form a less regular fourth line. Several of these islands and the vents on Albemarle island, are so placed that they likewise fall on a set of rudely parallel lines, intersecting the former lines at right angles; so that the principal craters appear to lie on the points where two sets of fissures cross each other."

‡ Les Iles Canaries, 369. The craters of Gran Canary, Teneriffe and Palma, are in a northwest line, while a transverse trend is distinct in the several islands.

§ Essentially the theory of Elie de Beaumont, in which view he is supported by many distinguished names in geology.

appear more in accordance with facts, to refer even wide deviations of directions to one and the same system.

General character of the lines of Mountains, Coasts, and Islands.—A careful study of the courses of island groups, coasts and mountain chains, leads us to the following important results:—

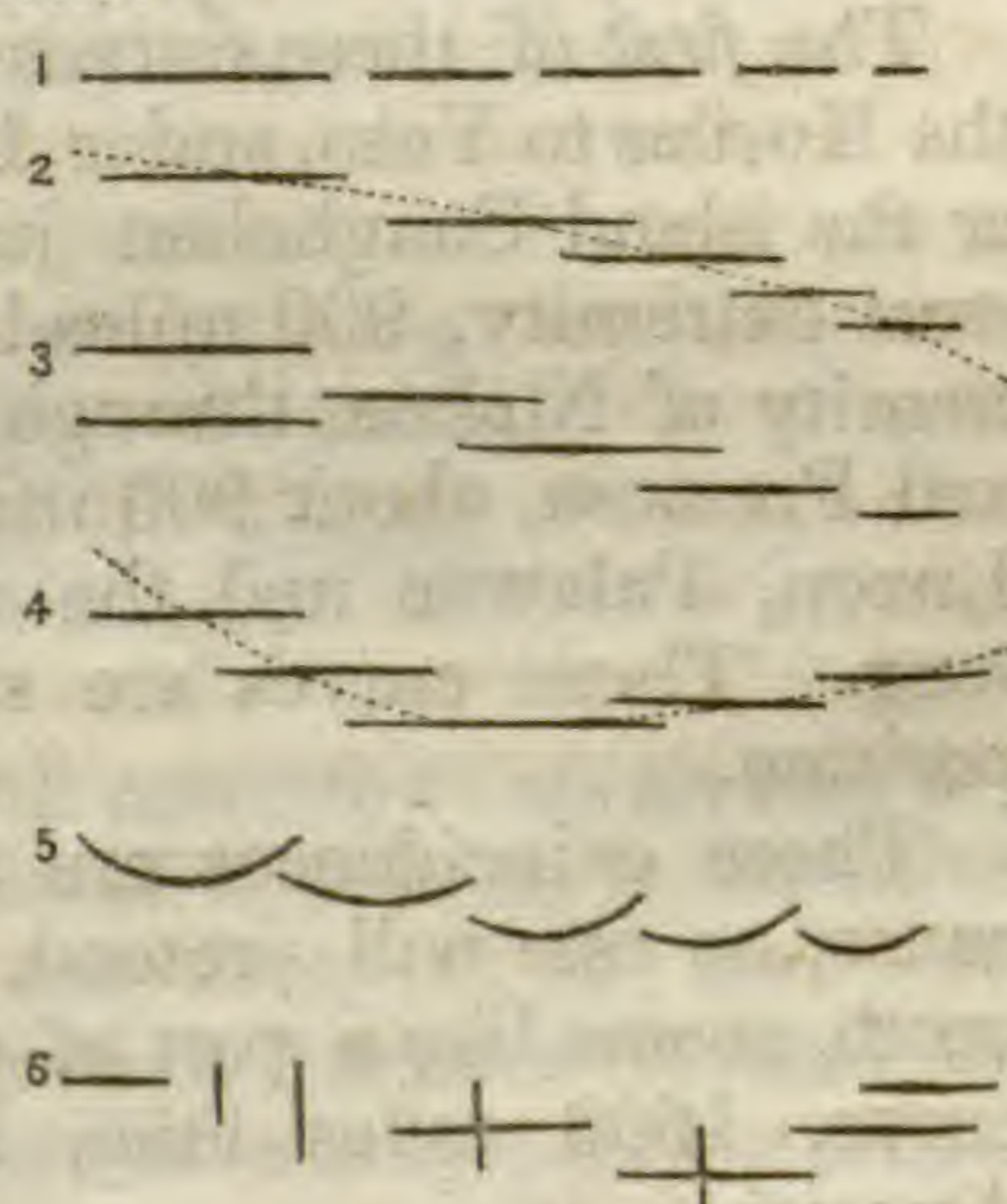
I. *The ranges are made up of shorter consecutive and sometimes parallel lines, instead of being uninterrupted for long distances.*

II. *The ranges are more commonly curved, than straight or coincident with the course of a great circle.*

III. *The straight ranges are generally straight in the constituent lines, but may consist of a series of curves.*

IV. *Curved ranges may arise from a general curvature in the whole; but often proceed from the positions of the several consecutive parts.*

V. *The same range, owing to the mode of curving, may vary greatly in its course, in different portions.*



In these points we are stating merely the facts or results of observation, free from speculation. The following figures may serve to illustrate the propositions stated.

In figure 1, the entire range is straight, as well as the parts.

In figures 2, 3, and 4, the parts are straight and overlap, and thus form a range which is sometimes straight as a whole, but is more frequently curved. The direction of the whole range, as shown by the dotted line, differs from the direction of the subordinate lines.

Figures 3 and 7 represent a common condition in which there are parallel lines in some parts of a range.

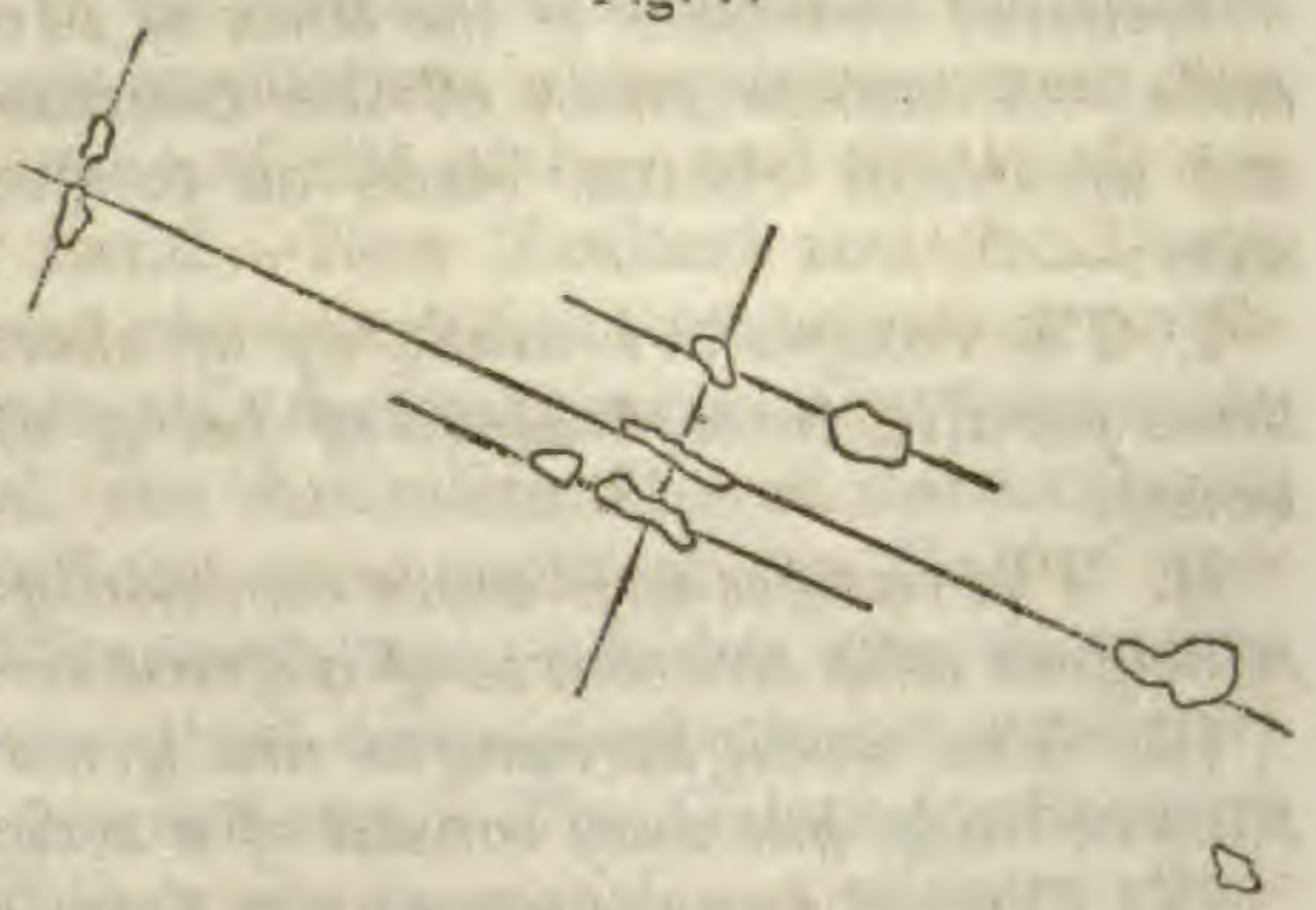
In figure 5, the parts are curved; and here, too, the resulting range may be straight or curved.

Fig. 6 represents a range made up of longitudinal parts along with some transverse; this is of common occurrence (figure 7.)

The more thorough the examination of the trends of groups of islands and of mountain chains, the more distinctly will this system of things be apparent; and instead of straight lines, or parts of great circles, it will be found that the predominant courses in the earth's features are curves. All these points might be abundantly illustrated by the groups of the Pacific islands; but we omit the details, as the subject will be fully presented in the Report, by the writer, on the Geology of the Ocean. Suffice it to say, that in the Hawaiian range these principles are distinctly represented; so also in the Samoan group, the Kingsmills, the Ladrones, and others.

The citation from Mr. Darwin, in the note to p. 384, exhibits both parallel and transverse lines in the Galapagos; and in the Canaries there are similar facts. The position of the Azores here given, well illustrates the subject. The main parallel lines are too obvious to require particular remark, and the transverse are also apparent.

Fig. 7.



Azores or Western Islands.

A system of curves, on a grand scale, is seen along the east of Asia, resembling figure 5. The reader, to appreciate the facts, should refer to his map, and the best and largest within reach.

The *first* of these curves extends from Kamschatka south by the Kuriles to Yeso, and is 1500 miles long; a *second*, from Yeso, or the island Sanghalian just north, along Niphon to its southwest extremity, 900 miles long; a *third*, from the southwest extremity of Niphon, through Kiusiu and other islands, to Loochoo and Formosa, about 900 miles long; a *fourth*, from Formosa, by Luzon, Palawan and the western coast of Borneo, 2000 miles long. These curves are singularly alike in form and relative position.

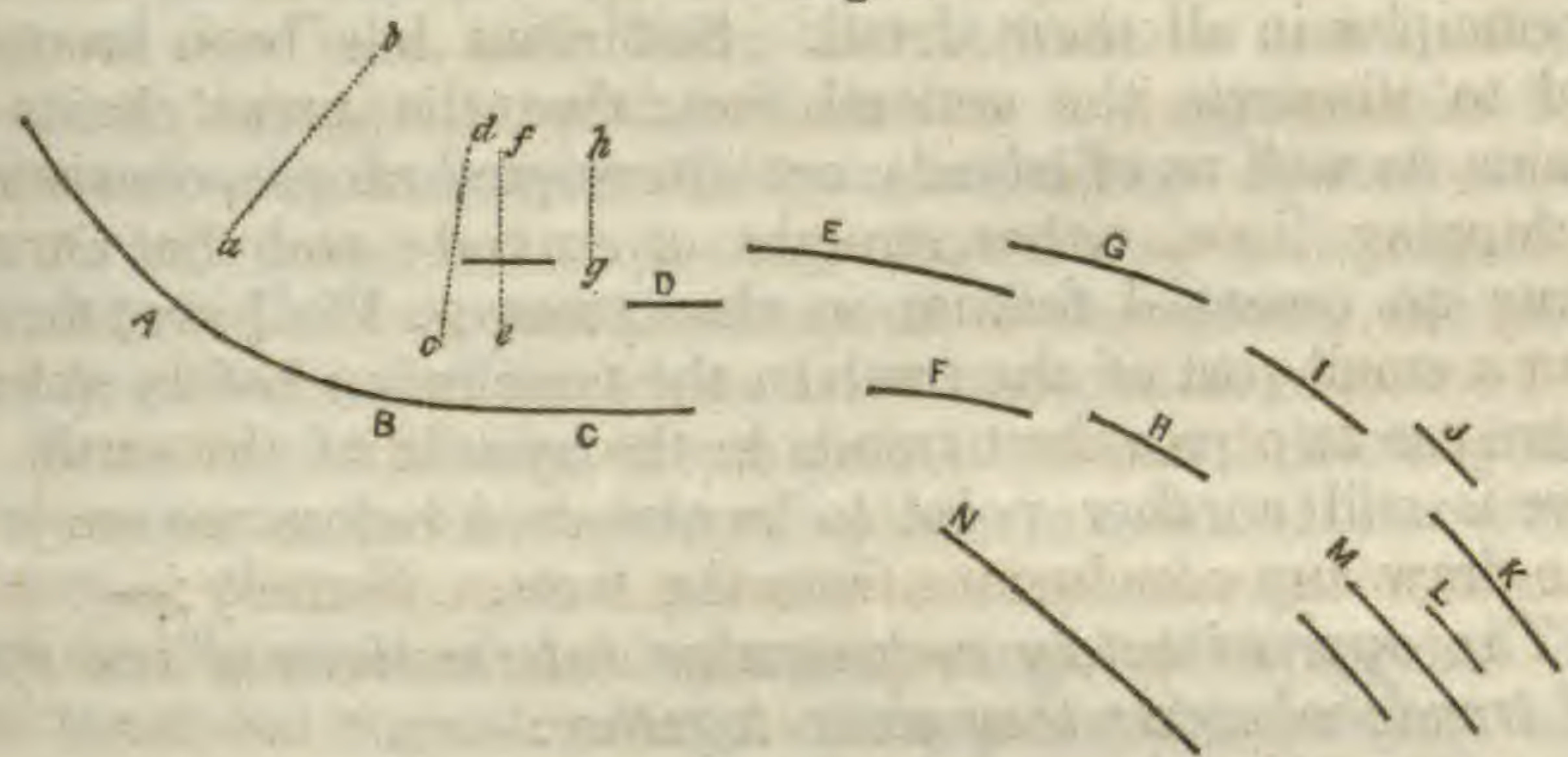
These coincidences are facts: accidental, that is, without a cause, no one will pretend. The Alaschka Archipelago, at the north, seems like a part of the same system; it forms a regular curve, 1600 miles long, between Kamschatka and Russian America.

Another corresponding system is apparent in the west coast of Asia, though less regular, as its outline is varied by differences in the extent of the plains and slopes of the land. But we cannot fail to observe the curving lines from Okhotsk south to Pekin; from Pekin to Tongquin; and perhaps also from Tongquin to Malacca. The mountain ranges of the eastern side of the continent also correspond, as laid down on the best charts. The Stanovoi and the Khingan mountains form three great curves of similar character, convex in the same direction; and the Altai range, farther in the interior, is parallel with the last.

When the particular islands in the curved lines south of Kamschatka, are laid down with minute accuracy, there is reason to believe that each of the curves pointed out, will be found to be not a simple curve line throughout, but a compound one, having some degree of resemblance either to figure 2, 3, 4, 5 or 6.

On a large recent map of the Pacific and East Indies, the range of the New Hebrides (K, fig. 8) and the nearly parallel New Caledonia, (M,) is observed to be continued in the Salomon islands, New Ireland and Louisiade group, (I, G, H,) as before stated; but the range, we remark farther, is becoming to the westward, gradually more east and west in direction, changing from N. 40° W. to N. 65° W. The range does not stop here: it is continued

Fig. 8.



A. Sumatra; B. Java; C. Sumbawa; D. Ceram; E. North New Guinea; F. South New Guinea; G. Admiralty and New Ireland; H. Louisiade; I. Salomon Group; J. Santa Cruz Group; K. New Hebrides; L. Brittania Group; M. New Caledonia; N. Northeast Australia; O. North New Zealand.

in New Guinea, (E, F,) falling off still more towards an east and west course; and the southern division of it, at least, is continued farther through Flores, Sumbawa, and Java, (C, B,) and from the last island trends northward through Sumatra (A) and the Andaman Islands. This is an example of a long curving range; and we may properly connect with it, northern New Zealand, northeastern New Holland, and the islands between this coast and New Caledonia. Viewing the broad band, we observe the whole conforming to one system; and the separate parts, if analyzed on a good map, confirm each the same principles.

Malte Brun mentions the great range of the central Pacific from the Marshal Islands by the Samoan to the Austral Islands south of Tahiti, which is full 5000 miles long. Leaving the particulars for another place, we observe only that this great range curves north as it goes westward, varying from N. 66° W. to N. 35° W.

It is also true of mountain ranges that they have this compound character, though they have seldom been surveyed with sufficient care to allow of deriving much accurate knowledge of them from maps or descriptions.

In the valuable work on New South Wales, by Strzelecki, this intelligent and laborious traveller mentions and figures the successive curves, convex westward, which characterize the mountains of Eastern Australia, and without reference to any hypothesis, or to such a system of things elsewhere. Profs. Rogers in their elaborate papers on the Appalachians, mention that these mountains, in their course from Maine to Georgia, are made up of a series of great curves, which they describe separately and with detail. We shall allude, on a following page, to Dr. Percival's interesting observations on the trap ridges of New England, which sustain the same principles in all their detail. Sufficient has been brought forward to illustrate the general fact, that the great chains of mountains, as well as of islands, are interrupted ranges, consisting of overlapping lines, either straight or curved; and that curves constitute an essential feature in the system. We have, therefore, but a small part of the truth in the conclusion before stated, that there are two prevalent trends in the system of the earth.

There is still another point to be observed before we are prepared to draw any conclusions from the facts. Namely:—

VI. *The approximately rectangular intersections of two systems of trends wherever they occur together.*

The curving direction of the Java range has been pointed out in its course from Sumatra east. Looking again at the map, the reader will observe that the coast lines of the large islands north, are approximately north and south in direction; but vary exactly with the Java curve. Celebes and Gilolo are north and south (*ef*, *gh*, fig. 8) like western Mindanao; and correspondingly, the Java line in the meridian of Celebes, is east and west. The east coast of Borneo varies a little to the east of north, and a line drawn along it (*cd*, fig. 8) would meet the Java range at right angles, or where this range inclines about as many degrees to the north of west. The west side of Borneo varies forty degrees to the east of north, (*ab*, fig. 8,) and at the same time the Java range, where the line of this side continued would meet it, has a like variation to the north of west, not differing even a degree, thus making the intersection rectangular. Hence it would seem that the shape of Borneo was connected in origin with the trend of the Java range; and not only this, the whole surface covered by the islands from Luzon to the Java range, has nearly the same shape as Borneo.

The successive curves on the east coast of Asia, are nearly at right angles with one another at their extremities. Thus Niphon stands nearly at right angles with the south extremity of the Kurile range; so Kiusiu, with the same extremity of the Japan range: and also Formosa with that of the Loochoo range.

In New Zealand, the two systems, as shown by the outline of the group, are nearly at right angles. The Tonga range is nearly at right angles with the Samoa or Navigators. Passing by other facts in the central Pacific, the Galapagos present the same rectangularity of the two systems. The line of active vents in Mexico and that of the great chain are at right angles, as stated by Humboldt, and the former is parallel with Cuba. The Canaries present the same facts as the Galapagos.

We often find parts of a chain at right angles with the rest, as illustrated in figure 6. In the chain of lakes from Lake Erie to Bear, which has the *northeast* course, several of the lakes themselves are oblong *across* this course. This is the case with the parts of Bear lake, with Slave lake, Athabasca, and the northwest shore of Superior; and the whole line is at right angles with the line of the St. Lawrence, Ontario, and Erie. Indeed such facts are closely connected with those first stated with regard to the relation of the two prevalent trends of the globe, the northeast and northwest, and have long been recognised.

We have not alluded to a highly important branch of the subject:—the direction of cleavage joints in rocks. It has often been observed that there is a general correspondence between them and the direction of the mountain ranges of a region. Necker has presented a great variety of facts on this subject, showing the prevalence of northeast and northwest lines in Europe and elsewhere.* Professor Sedgwick, in 1831, stated the law of parallelism.† De la Beche mentions the same in Devon and some other parts of England, where north-northwest and a transverse direction are the common courses.‡ Phillips observes that in Yorkshire, fifty-five out of eighty-nine of the cleavage joints observed by him, were between northwest and north, and twenty-eight were at right angles with these; only six were anomalous. The same facts have been remarked by other English geologists. Fitton has presented similar facts from Australia.§ Mr. Darwin in his work on South America, gives various facts showing that the principle holds west of the Andes, that the cleavage joints are in general parallel to the mountain range. It is also true of the United States, east of the Appalachians. We observe therefore that the question with regard to the cause of this structure is intimately connected with that of the origin of mountains.

This survey of the geological features of our globe leads to several important conclusions.

A. *That the earth has a strongly marked physiognomy, or a system in its grand outlines.*

B. *That throughout this system, northwest and northeast lines are every where prevalent.*

C. *That these strongly drawn lines are usually curved instead of conforming to the direction of a great circle; and*

---

* Bibliothèque Univ., de Genève, xliii, 166. 1830.

† Trans. Geol. Soc., London, ii ser., iii, 68.

‡ Geol. Rep. on Cornwall, Devon, and W. Somerset, 8vo, London, 1839.

§ Sketch of the Geology of Australia, Phil. Mag., lxviii, 135.

whether curved or straight, consist of a series of subordinate parts ; these parts having often a different direction from the line of the range.

D. *That the lines, even when curving, cross or meet any transverse lines very nearly or quite at a right angle, the one dependent on the other or varying with it.* Consequently—

E. *That the same grand chain may vary even sixty degrees or more in its course, and hence the trend of a ridge is no independent evidence of its age.* Thus a northwest course may gradually change to an east and west, as in the great Java range from New Hebrides to Java, and thence become northwest again, as in Sumatra:—a west-northwest range may change to north-northwest, as in the great Pacific chain from the Society Islands to the northernmost of the Marshall group. A north-northeast range may change through northeast, to east and west; and also a north and south range may go through the same changes, as shown along the east coast of Asia and elsewhere.* Just west of New Guinea the east and west line is a little north of east in Timor. Consequently, while northeast and northwest lines are on the whole most common, there are other courses to be considered, and all are so dependent that they evidently must have a common explanation.

Causes of the Earth's Features.

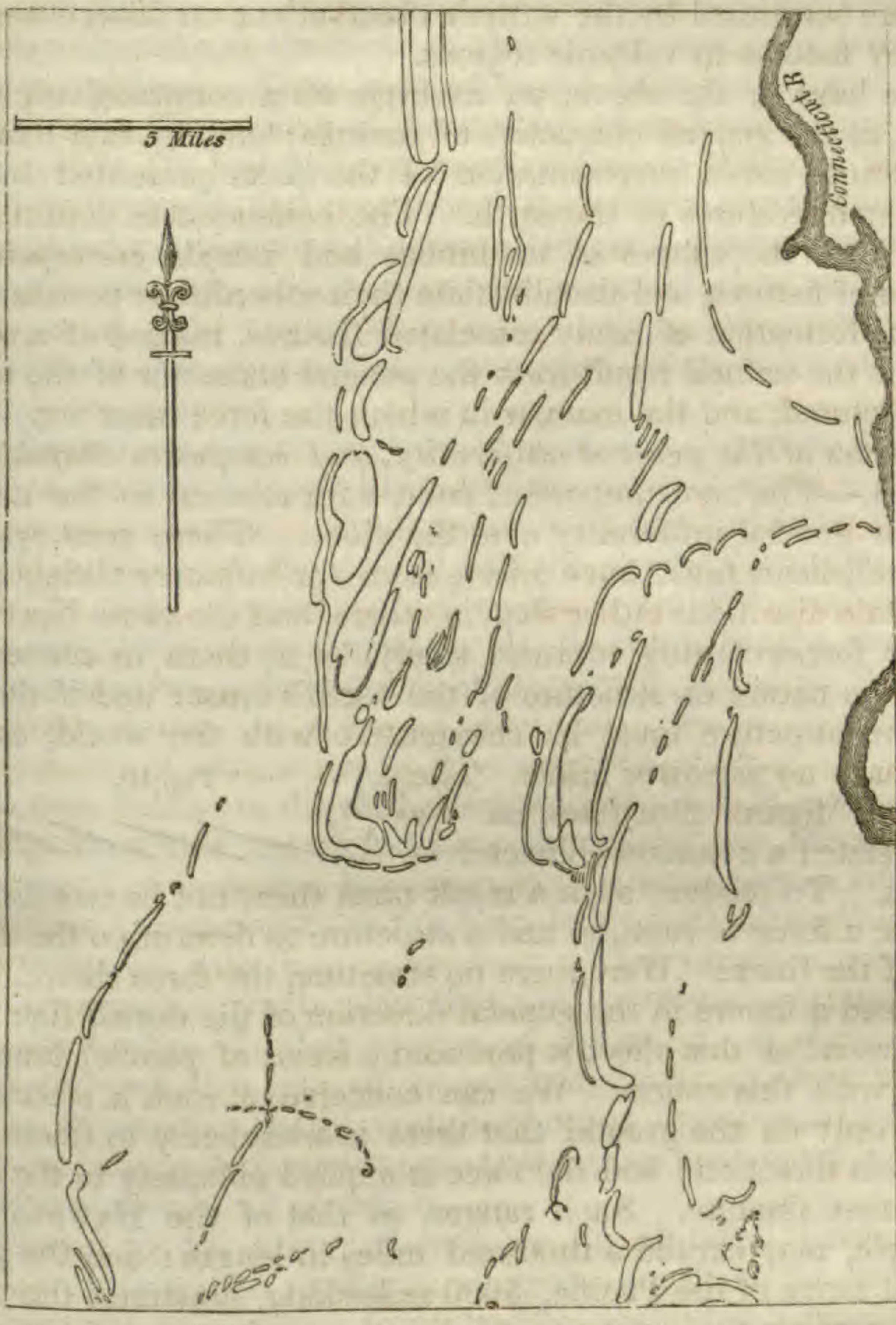
The direction of mountain chains is universally attributed to the courses of former fissures in the earth's surface; and as islands come under the same head, and coast lines are mostly dependent on the ranges of heights adjoining, the question before us is reduced to this:—What can have occasioned such *ranges of fissures*, with their several peculiarities; their composite character, general uniformity of direction, curves, irregularities, and usual rectangular intersections?

Peculiarities of Fissures.—Before proceeding farther, it is important to understand the general character of fissures; and we present a case to the point from the map accompanying the elaborate Report of Dr. J. G. Percival on the Geology of Connecticut;†—a work of vast labor, and of minute and cautious research, by one of the ablest men of America. Dr. Percival has afforded us a key to this subject, of the highest value, by the results of his investigations among the trap dikes of New England. The chart annexed is a small section of the map near its centre, showing the positions of the dikes or trap ridges. They commence twelve miles south of the portion here given, in the vicinity of New Haven bay, and extend northward into Massachusetts, and beyond into New Hampshire.

* The same principle is recognized by the Professors Rogers, in view of the facts observed by them in the Appalachians. Trans. Assoc. Amer. Geol., 1840–42, p. 540.

† Report, &c., by James G. Percival, 495 pp. 8vo., New Haven, 1842.

Fig. 9.



The dikes (courses of fissures) have the following characteristics:—

1. A general uniformity of direction.
2. A situation in several parallel ranges.
3. An interrupted character, and a frequent advancing or receding in the successive parts of a line, or an overlapping of the extremities, as in figures 1, 2, 4, 5, constituting what Dr. Percival has well designated "advancing," "receding" or "continued" series.
4. Curved lines; some simple, others composed of several straight lines, and others of subordinate curves.
5. Various irregularities in the lines, and deviations from parallelisms, although belonging to the same general system.

These peculiarities, as laid down and described by Dr. Percival, are confirmed by the writer's observations on dikes elsewhere and by fissures in volcanic regions.

We have in the above, an example on a comparatively small scale, of the general characters of fissures; and we find that it is an almost exact representation of the facts presented by the prominent features of the earth. The coincidences confirm the view that the ranges of mountains and islands correspond to ranges of fissures, and also illustrate their subordinate peculiarities.

The formation of many associated fissures, instead of a single rent, is the natural result from the general character of the material ruptured, and the manner in which the force must act.

Causes of the general uniformity, and composite character of ranges.—The most important point with relation to the ranges, is their general uniformity over the globe. These great systems of parallelisms must have arisen from the ruptures taking place in certain directions rather than in others, and the cause lies either in the forces causing ruptures solely, or in them in connection with the nature or structure of the earth's crust: and if the latter, the structure must be coextensive with the world, as the facts have no narrower limits. The annexed figure illustrates as we have stated a common character of ranges. To produce such a result must there not be two distinct causes, a force to rupture, and a structure to determine the direction of the lines? Were there no structure, the force should have produced a fissure in the general direction of the dotted line A B. But instead of this effect it produced a series of parallel lines oblique with this course. We can conceive of such a systematic result only on the ground that there is a tendency to fracture in a certain direction; and the force is applied obliquely to the lines of easiest fracture. Such ranges, as that of the Hawaiian for example, may exceed a thousand miles in length: and the great central range of the Pacific, 5000 miles long, illustrates the same point, proving the existence of directions of easiest fracture in the very nature of the earth's crust. The fact of such a structure has been suggested by Necker,* De la Beche,† Boué‡ and other geologists.

Fig. 10.

The nature of this structure, or the cause of this tendency to break in two directions, is a difficult subject of inquiry. The material of the crust, to which we naturally look for an explanation, is crystallized rock, for all igneous rocks are crystalline in their nature on cooling; and we observe that such rocks often break most easily, in certain directions dependent on the crystallization of some one of the included minerals or the position

* Bib. Univ. de Genève, xliii, 1833, 180.
† Geol. Report on Cornwall, Devon and W. Somerset. p. 281.
‡ Bull. Soc. Geol. de France, xiv, p. 439, 1843, and ii Ser., i, pp. 353, 355. 1844.

of crystalline grains; though there may be also other independent lines of fracture. There is abundant evidence of a uniformity of cleavage direction in the rocks of the surface over large areas, as already explained. Such a cause would have acted more uniformly at the first cooling of the surface, when from the previous free liquidity, the material was more uniform in character than at any time afterward: and even though the material were different in different parts, it matters little, since feldspar is common in almost every igneous rock, and is a frequent source of cleavage in two directions at right angles with one another, independently of the foliation due to mica and hornblend when either of these minerals are present.

M. Necker, in the article already alluded to, suggests that the trends of mountains, coast lines, and the strike of strata, coincide with *magnetic curves.* The same cause is appealed to by Boase* and De la Beche, on the ground that the electrical currents traversing the globe may influence the polar forces of crystallization. It has since been demonstrated by Mr. R. Hunt that the direction of crystallization is influenced by magnetism,† and R. W. Fox had before shown the action of electrical forces in determining the direction of lamination.‡ The magnetic chart of the world, by Captain Sabine in the sixth Report of the British Association, exhibits some striking coincidences throughout the Pacific; the exact trend of both the Hawaiian and Samoan groups and also the east and west courses in the East Indies and in the West Indies, correspond with lines on his chart. The exceptions are many and look insurmountable; but they are to some extent removed by a knowledge of other sources of influence. It should also be remembered that lines of magnetic intensity, as Brewster has shown, correspond nearly with isothermal lines; and the two agencies, heat and magnetism, must therefore have acted in some degree together, at all periods.§

Hopkins in his able "Researches on Physical Geology,"‖ (1835,) attributes the regularity of joints in rocks to the mechanical action of an elevating force, and he establishes a perfect uni-

---

* Treatise on Primary Geology, by H. S. Boase, M. D.; 8vo, London, 1834, and L. and E. Phil. Mag., and Jour. of Sci., ix, 4; x, 14.

† Phil. Mag., Jan., 1846, p. 1; Amer. Jour. Sci., ii Ser., ii, 116.

‡ Report of the Polytechnic Society of Cornwall, for 1837, pp. 20. 21 and 68, 69.

§ M. Boué observes:—Sans avoir besoin de supposer que la terre ait été primitivement un cristal, it suffit de lui *accorder un certain ordre dans ses irrégularités de surface en harmonie avec son mode de refroidissement, ses forces intérieures et les forces centrifuge et centripète.* Ceci admis, on en doit déduire nécessairement que les premières mers ont occupé les parties du sphéroide les plus accidentées, certaines grandes chaines offrant encore les indices de ces formes régulières, ou pseudo-régulières; et puisque ces séries de montagnes constituent l'ossature des continents, et déterminent leur figure, on voit de nouveau combien la similitude des continents éclaire *l'etude pour ainsi dire cristallographique du noyau terrestre.* Bull. de la Soc. Geol. de France, i, ii Ser., 355.

‖ Trans. Camb. Phil. Soc., vii, I.

formity between the facts and the necessary effects of this cause. Mr. Darwin adopting essentially the same view in his remarks on the parallel relation of the planes of cleavage in western South America to the axis of the Andes range, explains the uniformity by supposing the mass to have been subjected to tension unequal in different planes, arising from the elevation of the mountains.* Mr. Sedgwick in his valuable memoir "On the Structure of Large Mineral Masses," (1835,) also appeals to tension as the cause, and supposes that this tension may arise from the contraction attending solidification.† If tension be the proximate cause, the various facts require that both sources of it, the mechanical and that of refrigeration, be equally appealed to.‡ With reference to this subject, it should be considered that if curves of magnetic intensity are approximately isothermal lines, they must have been lines of equal cooling, and consequently *lines of equal tension.* This cause would then coöperate with the electrical, and might aid in producing the general uniformity of trend, which could not proceed from contraction alone. Acting during the period of early cooling, its effects should therefore have been universal: and through subsequent ages, the cooling or crystallization, *beneath* the crust, making still slower progress, (inconceivably slow,) would have continued to be governed by the same cause, liable to those modifications that isodynamic lines have undergone. But a perfect correspondence in the *surface* plutonic rocks, with the structure of the crust, should not be expected, since the lines of tension, determining the structure of the former, must have depended somewhat on the direction of the force producing fissures and mountain elevations.

The bare possibility that the earth's axis of rotation has been at any time changed, suggests that a cause may have coöperated in these results, whose influence cannot be fully estimated. Yet if magnetism has been a cause of structure, the coincidence of trend with existing curves of magnetic intensity tends to prove that such a change of axis has not taken place. It would be a grand result for geology if the science should settle this debated point. The coincidence of the magnetic curves with the trends in the central Pacific and north of New Holland, and also in the West Indies, is so close, that we have reason to suspect that the two facts are some way mutually dependent and have always been so. Still if the earth's axis may have changed, it is possible that the trends may once have had a direction that could have been

---

* Darwin on South America. 8vo, London, 1846. p. 163.

† Trans. Geol. Soc., London, ii Ser., iii, 480, March, 1835.

‡ Tidal movements in the fluids during incipient cooling might be a source of tension, transverse to the line of motion. And a gradual change in the oblateness of the globe would be another source of tension. But it does not appear that the existing system would correspond with the possible effects of either of these causes.

mainly caused by tension consequent on a diminution of the earth's oblateness.

Whatever the origin, there can be no doubt of the *fact*, that a kind of cleavage structure, or, at least, a capability of fracturing most easily in two directions, was given the crust during its formation, and that such a structure has influenced the direction of the lines of fissures that have since taken place. And while there is evidence of this structure, there is proof that the rupturing force often acted obliquely to the planes of easiest fracture, causing deviations from straight lines in the long ranges. The next question is with reference to this *rupturing force.*

Contraction is a known dynamical cause that must have begun with the beginning of refrigeration; and it is hence essential to consider how far it meets the various facts in view. In the theory of mountain ranges, by Elie de Beaumont, this agency is appealed to; we believe as confidently in its efficiency, though led by the facts to somewhat different results.

The effects of contraction have been illustrated elsewhere in this volume. A prime feature in the operation of cooling, influencing all the results proceeding from it, depends on the tendency of heat to spread itself circularly, or to diminish circularly, around a centre. This cause gives a circular form to pools of lava, and they retain this form as they cool. The great crater areas of the moon, several hundred miles in diameter, illustrate it; and this size is no necessary limit to their extent. In a cooling globe there would therefore be necessarily such vast circular or elliptical areas. Here then we perceive a cause modifying all the results of cooling; and we observe that throughout all ages there must therefore have been some reference to such circular or elliptical areas in contraction; and especially, to aggregations of such areas, which also would be more or less curvilinear in outline, and would act as a whole in the progressive subsidence.

The force of tension in the crust from contraction beneath, is exerted to a great extent horizontally; and in a subsiding area, the direction would be nearly radial, or from the centre outward. This cause then should generally *act obliquely to the lines of structure*, though sometimes coincident with them. If the tension cause ruptures, the rents should follow the lines of cleavage structure in the earth, in case the direction of the force corresponded; otherwise a series of rents should result having a direction of range different from the direction of the line of structure. The peculiarities of fissures, which have been explained, the "receding," or "advancing," or "continued" series of parallel courses, and the curved directions, are therefore necessary effects of the cause appealed to. Curved as well as straight ranges, ought therefore to characterize the grand features of the globe.

The important generalizations of Mr. Hopkins with regard to the *direction of fractures* and the necessary *dependence of two* *transverse lines* in an elliptical area under a state of tension, not only remove any difficulty arising from the existence of two transverse systems and their rectangular intersections, but actually require this result.*

Areas of non-contraction or of comparative slow contraction, should modify the direction of the ranges of fissures formed in a surrounding region where more rapid contraction is going on. Also, the interference of two contracting areas would produce irregularities; still wider effects would proceed from more extended combinations, such as have produced the oceanic depressions and the continental areas. Thus the continents which were early free from fires† have generally experienced the tension along their borders; and fissures and mountain ranges, frequently several in parallel series, have been formed, whose main courses are a resultant between the direction of the planes of cleavage structure in the earth and the action of the force of tension arising from the contraction going on over the oceanic areas.‡ Causes of certain irregularities in mountain ranges were mentioned on page 185 of the last number of this Journal, and these discussions afford a more extended view of the action of these causes. The principles explained in the paper just referred to, have here their full application.

Any other cause besides contraction, occasioning elevations or subsidences would produce the same general result as regards direction of lines of fissures; but we know no other cause of probable operation that would be so related to elliptical or circular areas; and thus none but this cause appears to satisfy the conditions presented in the frequent curvilinear forms of ranges.

The positions of some great contracting areas may be distinguished over the oceans, from the curving lines which enclose them. The great Pacific range of lands, from the Marshall Islands to the Society group, 5000 miles in length, has been described as convex to the southwest, while the line of the Hawaiian range, 2000 miles long, is nearly straight. May not this part of the ocean have been one of the large *compound* contracting areas, and a line from Pitcairn's, in lat. 25° S., long. 130° W., to northern Japan the course of its axis? Using the registers of

---

* The mathematical deductions of Mr. Hopkins were made with special reference to the elevation of the Wealden, though brought out so as to be of general application. He lays down the facts, that in "districts where faults abound, two distinct systems are usually found, in each of which the faults approximate to parallelism with each other;" and that "the common direction of one of these systems is approximately perpendicular to that of the other;" and he establishes the necessary dependence of these transverse systems by calculation.

The mode of producing the tension required by fracture is different in the foregoing explanations, from what is assumed by Mr. Hopkins; but it does not appear to alter the general results; and it is believed to set aside some objections urged by Dr. Boase to the conclusions of Mr. Hopkins. See *L. and E. Phil. Mag., and J. of Sc.*, ix, 4, 171, 368, and x, 14. 1836.

† See this Journal, ii, 132, and iii, 181. ‡ Ibid, iii, 98, 181.

subsidence, so happily distinguished and brought forward by Mr. Darwin, the Coral Islands, we have evidence that an elliptical area with the same line for its axis was subsiding even as late as since the tertiary epoch. The very region therefore which bears evidence of having been the original great elliptical area of contraction for the Pacific, on which the courses of the islands were in part dependent for their direction, was also undergoing contraction till within a late period; and we know not that some parts about the Northern Carolines—the nearest to the centre of the area—may not still be contracting as there is some evidence of it, which the writer will elsewhere present. The *transverse* line including New Zealand, the Kermadec and Tonga Islands, crossing the other systems nearly at right angles, would pass in its course northward the Samoan and Hawaiian Islands, and also some smaller groups intermediate.

The position of a large area undergoing *little contraction compared with the region around,* is before us in New Holland, as is evident from the absence from this semi-continent of volcanoes or their remains. Such an area would occasion a tension acting to some extent circularly around it; and which might determine the courses of ranges in its vicinity. The ranges of islands from New Zealand by the New Hebrides to New Guinea and Java, is just such a concentric range, as the view would seem to require. Borneo is another vast region without volcanic traces over its interior, and may have influenced the upward trend exemplified in Sumatra. However this may be, the cause brought forward—large isolated areas of comparatively slight contraction,—must have had their influence in determining the direction of lines of tension or of forces causing rupture.

M. Boué remarks that the trends in the tropics in general approach a parallelism with the equator, and he attributes the supposed fact to the centrifugal force of rotation. It holds true to a considerable extent. There are however so many exceptions that we may perhaps doubt whether the fact is sufficiently general for so general a cause.

The conclusions which appear to flow from the facts that have been presented, are as follows:—

That the general direction and uniformity of the grand outline features of the globe may be in a great degree the simple effects of the earth's cooling: this operation resulting in (1) solidification, and under the circumstances, whatever they were, an attendant jointed structure or courses of easiest fracture, in two directions at right angles nearly with one another, both varying together according to the rates of cooling in different parts;—and (2) occasioning tension in the crust through the contraction going on beneath, with some relation to circular areas but especially to large compound areas, which tension caused ruptures conforming or not to the lines of jointed structure according as the force of tension acted in accordance with this structure or obliquely to it. (3) The age of mountains cannot therefore be determined necessarily by their courses; a different direction in a particular region in different ages is not improbable, since the same contracting area might exert its horizontal force in somewhat different directions at different epochs, or other such areas might coöperate, and exert a modifying influence; and at the same time, an identity of direction for different ages was to have been expected.

From the facts before us it may be inferred that the great volcanic band which is drawn by von Buch in the East Indies, in the shape of the letter U, from Sumatra and Java around by the Philippines, gives an incorrect view of the volcanic system in that part of the world. Much the larger part of the Philippines consists of primary and secondary rocks instead of volcanic, and in Luzon, the southern volcanic portion corresponds nearly to the west-northwest trends of the Pacific. The volcanic line of Sumatra and Java, including also the islands farther east, belongs, as we have shown, to the system of the Pacific, to the northwestward courses which characterize nearly all the groups of that ocean; and it is continued east by a volcanic line along North New Guinea to the New Hebrides. Although an erroneous impression may therefore be conveyed by the chart of von Buch, it presents properly the fact intended to be illustrated by its distinguished author, that volcanoes prevail along the track laid down. The band seems like a grand volcanic border to the Asiatic continent, stretching from the vicinity of northern New Holland, (and we may say from New Zealand,) to Kamschatka; and it curves around into the great American range through the Alaschka Archipelago.

It is a fact of no little interest that the Pacific Ocean should thus be nearly encircled with volcanoes, active or extinct, as well as by high mountains, while the sides of the narrow Atlantic and Indian Oceans have comparatively few traces of such fires; and it tends to confirm the opinion thrown out as to the agency by which the deep ruptures and elevated ranges of the globe have been produced.*

This subject properly forms an introduction to the preceding papers on the earth's contraction, in this volume;† and the whole is offered as a simple view of the earth's dynamics, the sufficiency of which is to be tested by future discoveries.

Note.—On page 188, it is implied that Lyell and Poisson admitted the former fluidity of our globe; whereas the writer simply intended to acknowledge that these authors first brought forward the argument that a crust could not form upon a globe while it was in a state of free liquidity. See Lyell's Principles, ii, 439, where Cordier is mentioned as having presented the argument subsequently to himself.

* See this volume, pp. 96, 98, 181, 185, 186. † Ibid, pp. 94, 176.

ART. XL.—*Notes on the Algæ of the United States;* by J. W. BAILEY, Professor of Chemistry, &c., at the U. S. Military Academy.

(Continued from Vol. iii, Second Series, p. 80.)

IN the continuation of the list of Algæ hitherto found in the United States, I have thought it best to adopt for the Conferveæ, the names employed by Harvey, in his Manual of British Algæ; for although the recent subdivisions of the old and heterogeneous genus *Conferva*, are doubtless necessary and proper, yet Algologists do not seem agreed as to what names shall be generally adopted. The old and well known names will answer all my present purposes.

LIST OF NORTH AMERICAN ALGÆ, (CONTINUED.)

Conferva alpina? Bory. Murdiner's Creek, near Newburgh, N. Y.; v. sp., in herb. Tor.

Conferva ericetorum, Roth. Salem, N. Ca., Schweinitz!

Conferva floccosa, Ag. Salem, N. Ca., Schweinitz! Rhode Island, S. T. Olney. West Point, N. Y. Common.

Conferva bombycina, Ag. Salem, N. Ca., Schweinitz! Rhode Island, S. T. Olney. Ponds near West Point.

Conferva rivularis, Linn. Common from Maine to Ouisconsin, and south to Virginia.

Conferva aerea, Dillw. Narragansett Pier, S. T. Olney! Newport and Seaconnet.

Conferva (Elachista) fucicola, Velley. Very common on *Fucus vesiculosus* at Stonington, Newport, &c.

Conferva fracta, Fl. Dan. West Point, N. Y. Providence, R. I.

Conferva glomerata, Linn. Lake Ontario, Pickering! Falls of Niagara, and in Lakes Erie, Huron and Michigan. Also in Fourth Lake, near Madison, Ouisconsin.

Conferva refracta, Ag. Eastport, Maine, Rev. J. L. Russell! Very common on shores of Rhode Island. I have not now at hand Schweinitz's specimens of Conferva from North Carolina, and therefore can only present the following memoranda, which I made while examining them, some time since, in Dr. Torrey's herbarium. I give in one column the names attached by Schweinitz, and in the other the more modern names, where I have been able to determine them from the often unsatisfactory examination of the dried specimens.

Schweinitz's labels.		True name.
Conferva serpentinum, Salem, N. Ca.	=	*Conferva serpentinum*, Ag.?
" *fugacissima*, " "	=	" *floccosa*, Ag.
" *bipunctata*, " "	=	*Tyndaridea cruciata*, Harv.

Schweinitz's labels.				True name.
Conferva mutabilis, Salem, N. Ca.			=	*Draparnaldia glomerata*, Ag.
" *pectinalis*,	"	"	=	*Fragillaria pectinalis*, Lyngb.
" *lubrica*,	"	"	=	*Oscillatoria, sp.*
" *vaginata*,	"	"	=	*Microcoleus repens*, Harv.
" *genuflexa*,	"	"	=	*Mougeotia genuflexa*, Ag.
" *jugalis*,	"	"	=	*Zygnema quininum*, Ag.
" *fluitans*,	Schweinitz, Salem, N. Ca.			Not recognized.
" *amphibea*,	" " "			
" *setiformis*,	" " "			
" *varia*,	" " "			
" *semistrangulata*,	" " "			

It appears from the above, that to Schweinitz is due the credit of being the first to collect and study any of our fluviatile Algæ.

Hydrodictyon utriculatum, Roth. This most interesting plant was found by Dr. Paul B. Goddard and myself, growing abundantly in a small pond at the foot of Broad street, in Philadelphia, near the turn of the railroad. I kept living specimens for many months, and watched the singular method of reproduction. I also succeeded in sending living specimens to correspondents in London.

Mougeotia genuflexa, Ag. Providence, R. I. West Point, N. Y. Detroit, Michigan. Fort Winnebago, Ouisconsin.

Tyndaridea cruciata, Harv. Common in the Northern States. Also in Virginia.

Tyndaridea pectinata, Harv. Common with the above.

Zygnema nitidum, Ag. Waterville, Maine, to Culpepper Co., Virginia, and west to Ouisconsin.

Zygnema deciminum, Ag. Alabama, Dr. Gates! Very common with the above.

Zygnema quininum, Ag. Salem, N. Ca., Schweinitz! Common with the above.

If the numerous forms described and figured by Hassall, are really distinct species, the list of our species of Zygnema and Tyndaridea might be greatly extended, as I recognize among his figures many forms which are common in the United States, and which appear to me to be merely varieties of the above mentioned very polymorphous species.

Sphæroplea crispa, Berk. West Point, N. Y.

Vaucheria velutina. Shores of Hudson River, at West Point; in fruit in September. Shores of Seakonk River, near Providence, R. I.

Vaucheria cæspitosa, Salem, N. Ca., Schweinitz. Common at West Point, N. Y.; Waterville, Maine; Culpepper Co., Va.

Botridium granulatum, Grev. North Providence, R. I. West Point, N. Y. Very abundant on shores of small ponds, near the Ocean House, Newport, R. I.

Rivularia calcarea, Sm. Niagara Falls, on rocks wet with spray.

Rivularia atra, Roth. Rocky sea shores, Rhode Island. Rocks near low water, in the Hudson River, at West Point.

Rivularia angulosa, Roth. Common on leaves of Vallisneria in the Hudson River. Occurs also in Rhode Island, and in the Fourth Lake, Ouisconsin.

Stigonema atrovirens, Ag. Moist rocks at Indian Falls, Putnam Co., N. Y.

Stigonema mammilosum, Ag. Abundant in Round Pond, near West Point, covering submerged rocks, &c.

Scytonema ocellatum, Harv. Warden's Pond, R. I. Abundant at Niagara Falls, on rocks wet with spray.

Scytonema contextum, Carm. Foot of Crow's Nest, West Point.

Tolypothrix distorta, Kütz. Warden's Pond, R. I. Reservoir Pond, West Point. Fourth Lake, near Madison, Ouisconsin.

Calothrix confervicola, Ag. Very abundant on marine Algæ every where in Narragansett Bay, R. I.

Calothrix scopulorum, Ag. Rocks at Newport and Seaconnet, R. I.

Oscillatoria. The species of this genus are very difficult to identify by the descriptions, and it is even stated by Mayen, that many species undergo manifold changes during their growth. It is therefore with much hesitation that I present the following names.

Oscillatoria tenuissima, Ag. Warm Springs of Washita, Dr. James! v. sp. in herb. Tor.

Oscillatoria tenuis, Ag. Providence, R. I. West Point, N. Y. Culpepper Co., Va.

Oscillatoria decorticans, Grev. On pumps, &c. Common every where.

Oscillatoria muscorum, Ag. On mosses in the ravine on the Crow's Nest, West Point.

Oscillatoria nigra, Vauch. Common at West Point, N. Y.

Oscillatoria Corium, Ag. Mill dams near West Point.

All our species of Oscillatoria have a strong and peculiar swamp-like odor, which I have not seen alluded to by writers. Their extraordinary oscillations and radiations, so well described by Carmichael, (See Hooker's Brit. Flor., Vol. v, p. 372,) I have often witnessed, and I feel satisfied that it is impossible to account for these motions by evolutions of gases, currents in the liquid, elasticity of filaments, and other mechanical causes, which have been suggested by some writers in explanation of the phenomena.

Microcoleus repens, Harv. Common in damp earth. West Point, N. Y. Providence, R. I. Hingham, Mass., Rev. J. L. Russell!

Porphyra vulgaris, Ag. Narragansett Pier, S. T. Olney. Seaconnet, R. I. Massachusetts, G. B. Emerson and Rev. J. L. Russell!

Ulva latissima, Linn. Rhode Island. Common, Old Point Comfort, Va. Sullivan's Island, S. Ca.

Ulva lactuca, Linn. Rhode Island.

Ulva bullosa, Roth. Salem, N. Ca., Schweinitz. Newburgh, N. Y.

Merismopedia punctata, Meyen. Round Pond, near West Point. A larger variety occurs in freshwater pools, near the Pavilion, at Rockaway, Long Island, N. Y.

Bangia fusco-purpurea, Lyngb. Narragansett Pier, George Thurber! Newport and Seaconnet, R. I.

Enteromorpha intestinalis, Link. Hudson River, from Newburgh to New York city. Narragansett Bay, R. I. Common.

Enteromorpha compressa, Link. Common with the above.

Enteromorpha erecta, Hook. Newport and Seaconnet, R. I.

Tetraspora gelatinosa, Desv. Maine to Ouisconsin. Very common.

Tetraspora gelatinosa, var? *perforata*, Bailey. Perhaps a variety of the above, but remarkable for the numerous perforations in its pond. West Point, N. Y. Chautauque Co., N. Y., M. S. Petit!

Palmella hyalina, Lyngb. Rhode Island to Ouisconsin. Common.

Anabaina flos-aquæ, Bory. Round Pond, West Point. Hassall thinks that Bory's account of the ambulatory faculty, and vermiform motions of this curious organism, is "fanciful and overstrained." I have, however, frequently watched its active and extraordinary vermiform motions.

Protococcus nivalis, Ag. Red snow plant, forming red stains on gneiss rocks. Kosciusko's garden, in early spring.

Hæmmatococcus Grevillei ? Ag. Common on summit of Crow's Nest, West Point, N. Y.

Nostoc foliaceum ? Ag. Wet grounds near mill dams, &c. West Point, N. Y., and Providence, R. I.

Nostoc sphæricum, Vauch. Streams near West Point.

Nostoc cristatum, Bailey. A species apparently new, with flattened fronds resembling a cock's comb; occurs on stones in rivulets, near West Point. I have found it only late in autumn.

Since the publication of the first part of this list, I have referred some of our plants about whose true names I was in doubt, to the practised eye of the eminent British Algologist, W. H. Harvey, and I have to thank him for much useful information with regard to them, which although not sent with a view to publication, may I think be presented now without impropriety.

Laminaria? trilaminata, Harvey, MS. A curious three winged species, of which a fragment was found by Mr. Olney at Narragansett Pier, and of which I also found imperfect specimens at Stonington. Harvey remarks "it is new to me, and must be either a Laminaria or an Alaria, probably the former, but until perfect specimens are obtained we cannot decide."

Dictyosiphon fœniculaceus, Grev. Common at Newport and Seaconnet, R. I.

Gracilaria, n. sp. This species of Gracilaria grows in vast quantities in Narragansett Bay, near Providence, R. I. Harvey remarks concerning it, "it is new to me, and as far as I can make out undescribed. Agardh's Sphærococcus subulatus from Canada, seems to come nearest to it. It may be the same."

Chrysimenia, n. sp. Abundant near Providence, R. I. Harvey states, that "it is allied to C. clavellosa, but still more nearly to C. secunda, *Hook.* and *Harv.*, (a native of New Zealand,) and it may be identical with it."

Spyridia filamentosa, Harv. A slender variety of this, is the plant which I mistook for an undescribed species of Griffithsia. It occurs both at Providence and Newport.

Callithamnion corymbosum, Ag. Harvey thinks that the small Callithamnion common near Providence, is of this species, but he has not seen the fruit, which however I have studied myself on the recent plant, and I find it to agree with the description of C. corymbosum.

Polysiphonia Olneyi, Harv. MS. This beautiful plant grows in great abundance near Providence, R. I., where it was first found by S. T. Olney, Esq. of that city. I had confounded it with P. violacea, to which Harvey remarks it is very near but not exactly the same.

Polysiphonia variegata, Ag. fide Harv. Common near Providence, R. I.

Rhodomela subfusca, Ag. Common at Newport and Seaconnet Point, R. I.

Tetraspora perforata, Bailey. Harvey says, "this is certainly a new species. I have never seen any thing like it." It is common throughout the state of New York, and characterized by perforations of various sizes in all parts of the frond, so that when dried on paper it has a reticulated appearance.

(*To be continued.*)

ART. XLI.—*A few Remarks on the Silurian Classification;* by SIR RODERICK IMPEY MURCHISON, G. C. St. S., F. R. S., Memb. Imp. Acad. Soc. of St. Petersburg, Cor. of the Roy. Inst. France.

Belgrave Square, March 3, 1847.

TO THE EDITORS.

Gentlemen—I have sent to you, through your booksellers, a copy of my last memoir on the Silurian Rocks of Sweden, which may prove interesting to some of the American geologists on account of the distinctness which it establishes between the lower Silurian strata of the continent of Scandinavia and the isle of Oland, and the upper Silurian of the large island of Gothland, which I have placed in detailed parallel with our Wenlock and Ludlow rocks of England. In calling your attention, and that of your readers, to the concluding observations in that memoir, I must remind you, that when I wrote, I was arguing against a former proposition of my friend, Professor Sedgwick, viz: to subtract the Wenlock shale from the "upper," and add it to the "Lower Silurian;" and I then showed, that as my original division was founded on clear and typical districts of England, so it was equally applicable to Scandinavia, Russia and North America, where the beds with small Pentameri beneath the Wenlock shale, seemed to form the upper horizon of the lower Silurian division. Since that period, my able coadjutor, M. de Verneuil, has been among you, and after traversing large districts of your country, and inspecting many of your museums, has satisfied me that the broad divisions of lower and upper Silurian are clearly recognizable in North America, as so well developed, indeed, by your own authors. Again, in Europe, Bohemia has been described by M. B*———, to contain (particularly around Prague) a very symmetrical Silurian basin, composed of upper and Silurian rocks, loaded with characteristic fossils, among which are species of trilobites, the lowest fossiliferous beds resting on slaty grauwacke, without fossils, to which the author applies the term Cambrian.

I call your notice to this last mentioned fact, (intending to visit Bohemia in company with M. de Verneuil, in the ensuing summer,) because I have, in the course of this winter, been compelled for the first time to defend my "Lower Silurian" against a new proposal of Professor Sedgwick, which almost amounts to the suppression of the term, and the substitution, in its place, of the word "Cambrian." To this proposition I am entirely opposed. The latter term was suggested a year after I gave my first general view of the upper and lower Silurian rocks (in 1835) as forming one natural system, and the word Cambrian was afterwards

* The MS. did not enable us to ascertain this name.

applied to the masses lying beneath the "Lower Silurian," which might be found to be characterized by a distinct group of organic remains. Subsequent researches, however, in various parts of Europe and America, have shown that no typical fossils can be detected in any of the lower strata differing from those by which I characterized the lower Silurian, and hence, on the principle of "strata identified by fossils," I have for some years past maintained, in all my publications, that the base line of the Silurian rocks so descended as to embrace the earliest clear traces of organic life. The government geologists of Britain, under Sir Henry De la Beche, have pointed out, that throughout South Wales, the very strata which I had described as "Lower Silurian," fold over and over, and occupy large tracts, to which I had, in my first work, erroneously applied the word "Cambrian;" and now these same surveyors, particularly Mr. Ramsay and that able palæontologist, Professor Edward Forbes, assure me, that throughout all North Wales, from Bala to Snowden, the rocks which I had hoped might be typified by other or "Cambrian" fossils, are charged with the same lower Silurian forms, and often with the very same species which are described by me as occurring in my Carodoc sandstone or Llandeilo Flags. They further confirm my original views of classification, in stating that these North Welsh strata, whether lower or upper Silurian, are so linked together, that they form one natural system; there being found many more species common to the upper and lower division than I had been able to detect, when I completed the Silurian system, in 1839.

Now, whilst my memoir on Gothland demonstrates the identity of its upper Silurian functions with those of Britain, the labors of our government geologists are daily opening out new features of comparison between the "Lower Silurian" of Russia and Scandinavia, as described by de Verneuil, Keyserling and myself, and the North and South Welsh strata. Thus the *Cystidea*, those earliest forms of Crinoids, with which I was unacquainted when the Silurian system was published, and which occur in myriads in the lower Silurian limestone around the Baltic, have been found pretty abundantly near Bala, Harefordwest, &c.; and among them is the very species, *Echino-sphærites (Sphæronites) aurantium*, which abounds in Russia and Sweden. It follows, therefore, that the terms which I was the first to propose must be adhered to, particularly as I have myself applied them to very large regions of Europe, on fair inductive evidence, and that North American geologists have honored me by doing the same in their country.

Again, whilst no zoologist has attempted to define any distinct types of life of earlier date than the lower Silurian, so is it impossible (at least in any region which I have seen) to separate that group physically from the upper Silurian, by any line of general dislocation. If the lower Silurian rocks in America were unconformable to the upper, then it might be contended by those geologists who look rather to great physical phenomena than to organic life, that the Cambrian was one epoch and the Silurian another. But such is not the fact. In North Wales, as in other parts of Europe, the upper and lower Silurian fold over in conformable masses, and the lines of dislocation in that broken and porphyritic region run at one place through parts of the upper, and in others in the inferior fossil beds. There are, it is true, certain tracts, particularly that of the Longmynd in Shropshire, described by me in the year 1835,* where certain lower Silurian strata abut against and repose unconformably on very ancient grauwacke, without fossils, and the same may be said of a limited tract of inferior grauwacke, near St. Davids. To such rocks, lying *unconformably* beneath strata charged with lower Silurian fossils, the term Cambrian may be applied, and in the process of research some few and, perchance, peculiar organisms may be found in them. But I distinctly maintain that the so called Cambrian never having been characterized by any published fossils, cannot now be created into a system at the expense of the larger part of my well recognized and long established Silurian system, the more so as I am supported by every naturalist who has studied the subject, in the opinion that the upper and lower Silurian constitute one natural series only. This view is every day strengthened by new discoveries. Only a few months ago, I firmly believed, that as no remains of vertebrata had been detected in the lower Silurian rocks of any part of the world, there was a period when other classes of marine animals abounded in the seas, without being accompanied by fishes. But I now learn from Prof. E. Forbes, that the defence of an Onchus has been found in the lower Silurian rocks, near Bala; whilst it appears that Professor Sedgwick and his companions detected last summer a similar fragment in true Llandeilo flags. It is therefore proved that the same genus Onchus, which Agassiz first described for me from the fish bed of the Ludlow rocks,† is now found to range down into the lower Silurian; and as rare portions of ichthyolites have also been found in the intermediate strata of Wenlock shale, &c., I willingly correct a generalization which I attempted, in declaring my belief that the lower Silurian was an invertebrate period. My eminent friend Agassiz, who is now making himself as beloved and admired in the United States, as in England and other countries he has visited, has thus in the end been borne out by the new discoveries. For, whilst I reasoned

* Phil. Mag., June, 1835.

† See Silurian System, page 256, *et seq.*

mainly on the fact that no remains of fishes had ever been found in lower Silurian rocks, among the countless myriads of other marine animals, and that I was also influenced in my views by the proofs afforded by geological enquiry of a progression in creation, Agassiz has proved right in his conjecture that with such associates, fishes would sooner or later be detected. In one respect, indeed, I rejoice in the discovery, as the occurrence of an Onchus in upper Ludlow rocks and in Llandeilo flags, unites with other palæontological evidences to bind all the Silurian rocks together in one natural system.

In conclusion, I would observe that whilst it is impossible, for the reasons above cited, to admit that the Silurian system can be broken into two systems, I might convince you, by another method of reasoning, that the adoption of such a proposition would entirely destroy the very term Silurian, in reference to regions of the continent of Europe, to which it has been applied, such as large parts of Russia, Scandinavia, &c., where the lower Silurian alone is developed. But I have already said more than enough, and will only add, that notwithstanding our recent animated discussions, Professor Sedgwick and myself have still as warm a friendship for each other as ever, and however he may ultimately persist in calling certain rocks of North Wales "Cambrian," (although they are loaded with true lower Silurian fossils,) I must seize this opportunity of declaring that I consider this to be little more than a geographical distinction; and further, I must express my belief that if he should produce a work upon the geological structure of the old and slaty tracts of Britain, upon which he has been long occupied, it will be found to be in every way worthy of his deservedly high reputation, and will throw important new lights on those parts of geological science which his eloquence and memoirs have already adorned.

Art. XLII.—*Hydrate of Nickel, a New Mineral;* by Prof. B. Silliman, Jr.

This mineral occurs incrusting the surface of chromic iron from Texas, Lancaster County, Pennsylvania, and has been circulated among American mineralogists during the past year, under the name of green oxyd of chrome. I found it, however, on analysis, to be a hydrous green oxyd of nickel nearly pure. It is found in lustrous emerald green crusts, on the surface of some specimens of the chrome iron from these mines; rarely in stalactites and columnar masses. It is often covered with a thin coating of carbonate of lime or magnesia which obscures its color. Alone it is quite transparent and of the most brilliant emerald green color. Hardness 3 or 3·25, being a little above calc spar. Gravity 3·0523, as taken in small fragments with the specific gravity bottle. Its lustre is highly vitreous and its fracture uneven and scaly. It is extremely brittle and is readily pulverized, giving a light yellowish green powder; it is very easily detached from the gangue on which it rests. Its pyrognostic character is perfectly decisive. Alone in a close tube it affords a copious yield of water, which is neutral to test paper; and it loses its fine color at a temperature but little above 212°; with a higher heat it becomes blackish gray and is then quite unchanged by long continued heat. An empyreumatic odor is also found in the tube when it is heated. It forms no bead with carbonate of soda in either flame of the blowpipe; with borax, it readily fuses into a transparent bead, of a dark yellow or reddish color when hot, and nearly colorless when cold. In the reducing flame, with a larger quantity of the mineral, the bead becomes gray and opake from the presence of numerous particles of finely divided metallic nickel which cannot, by long blowing be fused into a bead. On crushing this borax glass in an agate mortar under water, a gray powder appears, which is strongly attached by the magnet, and which burnishes under the pestle, showing the reddish white color of metallic nickel. With salt of phosphorus its behavior is precisely like the artificially prepared oxyd of nickel. An examination in the wet way detected only trifling traces of oxyd of iron and perhaps alumina. It dissolves completely and with very slight heat in dilute chlorohydric acid, and the few black particles which collect on the bottom of the flask are minute flakes of chrome iron mechanically entangled in the mineral. The solution has the fine grass green tint which belongs to the salts of nickel. Sulphuretted hydrogen produces no turbidness in the solution, and no traces of oxyd of chrome could be detected. Indeed the blowpipe decisively indicates the absence of this oxyd, since an exceedingly small trace would give the borax glass its characteristic green tint when cold. The beautiful green color of this mineral, as found, led no doubt to the supposition that it was the native green oxyd of chrome, which seemed a plausible conjecture. Its water was determined by ignition of a weighed quantity of the mineral in a carefully counterpoised platinum crucible, cooling after ignition in a desiccator over sulphuric acid. It lost as the mean of four trials 38·50 pr. ct. of water, which is rather more than two atoms. Its constitution will probably be correctly expressed by $\dot{N}i\,2\dot{\mathbf{H}}$. It will be remembered that the artificial hydrate of nickel prepared by precipitation with potash from the nitrate is $\dot{N}i\,\dot{\mathbf{H}}$ or only one atom of water.

The discovery of the composition of this mineral led me to examine the composition of several specimens of carbonate of magnesia from the same mines, which have a green tint more or less deep. I found in all of them the oxyd of nickel, in quantity proportioned to the depth of color of the specimen. In some of them, the green color seems to be an exterior coating and in others to penetrate the mass uniformly. These specimens of carbonate of magnesia are not crystallized although they appear to be so, but are only a congeries of little spherical grains about $\frac{1}{100}$ of an inch in diameter, which are cracked in radii from the centre. The same appearance, resembling aggregations of crystals, I have observed in one specimen of the hydrate of nickel which led me at first to suppose that I had found it crystallized. The constitution of the chrome iron on which this new mineral is found, now becomes an interesting inquiry. I owe these and many other interesting minerals from the same region, to Mr. L. W. Williams, of Westchester, Pa.

Note.—Since these observations were made, I have seen a mention in the Proceedings of the Boston Nat. Hist. Soc., Nov. 18, 1846, from Dr. Jackson, of "a green crust, which he supposed to be a new mineral, adhering to a mass of chrome ore." This mineral, as I learn from Dr. Jackson, is from the same mines as the one described in the foregoing article, and is undoubtedly the same species.

New Haven, March 30th, 1847.

Art. XLIII.—*On Cupellation with the Blowpipe*; by William W. Mather.

A notice of a new mode of cupellation on mica with the blowpipe, was published by me in this Journal, vol. xxxv, p. 321. A writer has subsequently in vol. xlii, p. 394, mentioned another equally simple, which was taught him by Prof. H. Rose of Berlin. That method consists in pressing moistened pulverized bone ash into cavities in charcoal, and cupelling on that. If the surface of the cupel be not very smooth, almost polished, the grain of silver, if very small, will disappear in the pores of the cupel, or be buried in the excrescences of its surface. This method of cupellation, and that on small cupels, have been long in use and are well known. The bone ash cupels have the advantage of absorbing the oxyd of lead as fast as formed; but they have the disadvantage of absorbing some silver with the litharge. This is a serious inconvenience where a strict quantitative determination of the silver is desired. This may be obviated to a great extent on mica, by keeping the oxydizing metal more or less immersed in the fluid oxyd. When bone earth cupels are used, the globule of lead when reduced to a very small size, should be put upon a fresh cupel, or on a clean place on the one in use, where the surface is very smooth, else if the globule of silver or gold be very small, it will not appear.

When the cupellation is performed on mica, the oxydation is nearly as rapid as on the bone ash cupel, and the globule is kept partially immersed in the melted oxyd of lead, and thus the silver that would otherwise be lost in the litharge, is mostly taken up by the lead.* A little skill in the operator will enable him when the oxyd has accumulated to some extent around the globule of lead, to slide the melted globule by a slight inclination to another place, without losing it off from the mica. This obviates in a great degree the loss of time, that would otherwise arise from the necessity of cooling to detach the globule, put it in a new place and heat it again to the proper temperature. When the cupellation globule is reduced to the size of a mustard seed, whether bone ash or mica be used for cupelling, it is well to remove it to a new very smooth cupel, or to a fresh piece of good mica, and then, when melted, make the globule slide by inclining the cupel, and by means of the blast, to fresh surfaces, until, finally, the globule of silver or gold remains pure, or as nearly so as cupellation will make it. No silver is lost in this way, except the extremely minute quantity carried off in the litharge, and that which is vaporized if the heat be too high.

The method of cupellation on mica I consider more accurate than that on bone earth, and if the mica be of good quality, so as not to exfoliate at all by heat, or permit the litharge at the proper temperature to pierce it, globules of $\frac{1}{1,000,000}$ grain in weight may be seen on its surface by the naked eye. When good mica cannot be obtained, I use bone earth cupels made compact, smooth, almost polished, flat and discoidal in form, about the size of a wafer and $\frac{1}{20}$ to $\frac{1}{40}$ inch thick. These answer for the last part of the operation of cupelling nearly as well as the mica. Mica is more portable than cupels, or the materials of which cupels are made, and when the surface becomes loaded with oxyd, a thin scale can be split off and leave the surface fresh and ready for new cupellations. The difficulties of this mode of cupellation are, lack of skill in manipulation, and the difficulty of getting the right quality of mica. The advantages are, 1st. avoiding nearly all the loss of silver that is usually carried off by the litharge, and 2d. greater accuracy in the results of quantitative cupellation. It is generally supposed that the detection and quantitative estimation of silver in solution by means of chlorohydric acid in a dilute solution, was more certain than cupellation. I do not find it to be so, but cupellation properly conducted, will not only detect silver, but afford quantitative results, where the most refined methods of analytical research fail to give any indication of its presence. I have found it impracticable, thus far, to obtain

* This is the explanation of the well known fact that the cupellation of lead in the large way, always gives a larger yield of silver, than is indicated by cupellation in the small way on bone ash cupels.

lead entirely free from silver. The German granulated lead prepared expressly for this purpose, contains a notable quantity of silver. Nitrate of lead and acetate of lead when reduced and cupelled yield silver; and I have precipitated lead with zinc, rejecting the half of the lead first precipitated, as being that likely to contain all the silver, and saving only that part precipitated last, and still found it to contain silver. As lead absolutely pure seems to be unattainable, I estimate the difference between the weights of cupellation globules, obtained from the metal or ore, and from an equal quantity of lead cupelled alone of the same kind as that used in the cupellation.

The buttons or cupellation globules of silver or gold, vary in magnitude in lead, lead ores, &c., as usually cupelled with the blowpipe, from $\frac{1}{10}$ grain to $\frac{0}{m}$. It is comparatively rare that their weights can be correctly appreciated, even by our best balances. I use two methods of appreciating their weights.

(1.) By having a series of cupellation globules of known weights from $\frac{1}{10}$ grain down to $\frac{1}{10000}$ grain,* and by means of a microscope, comparing the diameter of the cupellation globule with those of known weight. This method by means of a good micrometer microscope affords approximations to truth, more to be relied on than the balance, when the globules are small.

---

* These weights are easily made by a little skill in manipulation. To make moderately small weights I have used silver lace, which when unravelled, is a silk thread wound with flattened wire of silver of great tenuity. I found how many inches of this gave 1 grain of silver, and then by means of dividers and a sector scale, cut off such lengths as would make $\frac{1}{10}$, $\frac{1}{100}$, $\frac{1}{1000}$, &c. grains. With the sector scale, $\frac{1}{100}$ and even $\frac{1}{200}$ of an inch can be measured. One hundred and twenty inches in length of the lace, gave 2·2 grains of silver. Twelve inches = ·22 grain, 1·2 in. = 0·022 grain, 0·12 in. = 0·0022 grain, &c., and generally, 120 in. : 2·2 grs. :: x length required : y the weight required. If $y = \frac{1}{1000}$ grain, then 120 in. : 2·2 :: x : $\frac{1}{1000}$ $\therefore x = \frac{12}{220}$ inch, which is easily laid off on the sector scale. Having the length cut off, moisten it with borax water and melt on charcoal. The borax water enables the silver to coalesce without separating into several globules, as it would do, if it was not thus moistened and rolled up into a little pellet. The borax is so small in quantity, where the thread is moistened with borax water, that it does not dissolve any sensible quantity of silver. By rolling the moistened thread into a little pellet, I can easily make all the silver coalesce into a single globule when the thread is ten to twenty inches in length.

For still smaller weights I use fine plated copper wire, and cupel it. That used is from an epaulette, of which by careful analysis, I found 1800 feet in length gave 16 grains of silver, = 1350 inches in length for 1 grain of silver. 13·5 inches then would give $\frac{1}{100}$ grain of silver; 1·35 inches = $\frac{1}{1000}$ grain of silver, and 0·135 inch = $\frac{1}{10000}$ gr. of silver. This is not strictly accurate, for a little of the silver is lost by the litharge and by vaporization, and a little gained from the lead used in cupellation of the wire. Still, it is sufficiently accurate for use.

For gold weights of comparison, I have used Wollaston's method; enclosing a very delicate wire of gold in a very coarse silver wire, with a hole drilled to let the gold wire in, and then drawing down the silver to its limit, and dissolving the silver by nitric acid, leaving the gold almost as fine as spider's web thread. Then ascertain how many yards weigh a grain, lay off and cut off the lengths for the required weights, and melt into a globule.

(2.) I use also the principle of Harkort's scale,* in measuring the diameters of minute cupellation globules, but applied somewhat differently. In most of the boxes of French mathematical drawing instruments, a brass sector scale is found, which when closed, shuts so as to leave, if well made, a junction that is a mere line to the eye. From the centre of motion, a line is drawn on each arm of the scale six inches in length, divided into two hundred equal parts, and when the scale is completely closed, the two hundreth equal part at the end of one of these lines, is exactly one inch from the two hundreth equal part at the end of the other line.†

If we wish to measure the diameter of cupellation globules, less than $\frac{1}{40}$ inch in diameter, (and most blowpipe globules are smaller,) measure one inch between the points of the dividers, and set their points in the equal parts marked 195; (for $\frac{1}{40}$ inch $= \frac{5}{200}$ and $200 - 5 = 195$.) The arms of the sector scale between the points marked 200 are then $\frac{1}{40}$ inch apart, and approach each other to the centre of motion, where their distance $= 0$. In this way the scale may be set to any fraction less or greater than an inch that may be desired. The cupellation globule is laid between the diverging arms of the scale, and slidden along by a pin or other convenient instrument, until the globule *falls in* between the arms of the scale. The width of the opening between the arms at this point, gives the diameter of the globule. Suppose the scale set to measure globules between $\frac{1}{40}$ inch and 0, and the globule falls in opposite the equal parts marked 45. The diameter of the globule is then $\frac{45}{200}$ of $\frac{1}{40} = \frac{45}{8000} = \frac{1}{177}$ inch.

A globule of silver of $\frac{1}{177}$ inch in diameter weighs about 0·00006 grain. This weight is about $\frac{1}{9}$ more than the actual weight of a cupellation globule of that diameter, because the above is calculated for a *sphere* of silver, and the cupellation globules are always more or less *flattened* on the lower side, unless they are extremely minute. A globule of silver $\frac{6}{100}$ inch diameter, if a sphere, would weigh 0·298665 grains; but owing to the flattening of the cupellation globule, the actual weight of one of that diameter is only 0·18 grains, or about $\frac{3}{8}$ less. I do not generally permit myself to estimate the weights of cupellation globules by their diameters when greater than $\frac{1}{40}$ inch diameter, in consequence of the rapid variation in the law of the relative weights to the diameters, and globules above that size can be as correctly appreciated by a good balance. The eye can generally unaided by a magnifier see a globule of silver of $\frac{1}{1000}$ inch diameter, which weighs about $\frac{1}{1,000,000}$ grain, and this can be

* Vide Whitney's edition of Berzelius on the Blowpipe, p. 104.

† A similar method of mensuration will be found in the Appendix to Muspratt's translation of Plattner's work on the blowpipe, by Prof. O. Byrne.—*Eds.*

measured with considerable accuracy by means of a micrometer microscope. This degree of accuracy is sufficient for all practical purposes, for if ten grains of lead only gave $\frac{1}{1,000,000}$ grain of silver, $312\frac{1}{2}$ tons would be required to produce one oz. of silver. If ten grains of lead or rather alloy cupelled yield $\frac{1}{1000}$ grain of silver or $\frac{1}{10,000}$ of its weight, it would contain only $3\frac{1}{5}$ oz. per ton, or if it yielded $\frac{1}{100}$ grain, it would be 32 ounces of silver per ton of lead or alloy.

Means of estimation like those mentioned are sufficiently accurate for practical purposes, by using one grain weight of the alloy or one mixed with a suitable quantity of lead.

Quantities of silver far more minute can be detected by suitable care in blowpipe cupellation. With a good microscope a globule of silver $\frac{1}{25,000}$ inch diameter ought to be visible, which would weigh about $\frac{1}{10,000,000,000}$ of a grain.* A metal that would yield this minute quantity of silver or gold from the weight of one grain would require 5,000,000 tons to produce one pound of silver or gold.

The above theoretical limit of mensuration is perhaps also about the practical limit of detection of silver and gold in bodies suspected to contain them, in consequence of the volatility of these metals at a high temperature in a current of air, and the litharge taking away some. In cupellation the heat should never be raised above a high red heat, until just before the *lightening* of the metal, and then only for an instant, else there will be a loss of silver or gold.

To save trouble in estimating the weights of cupellation globules, a table is subjoined, and the weights of globules of several diameters are indicated, supposing them to be spheres. A deduction of about one-fourth should be made in globules from $\frac{1}{20}$ to $\frac{1}{40}$ of an inch in diameter, about one-fifth in those from $\frac{1}{40}$ to $\frac{1}{60}$, about one-sixth in those from $\frac{1}{60}$ to $\frac{1}{100}$, about one-seventh in those from $\frac{1}{100}$ to $\frac{1}{150}$, about one-eighth in those from $\frac{1}{150}$ to $\frac{1}{200}$. Those smaller than $\frac{1}{200}$ inch scarcely differ from a sphere.

The weights of spheres of gold or silver of any other diameters than those in the table, are easily calculated by the formula $W = CD^3$. C is a constant for the same metal, and represents the weight of a sphere of the metal one inch in diameter. This weight

* For 1 cubic inch of distilled water weighs 252·46 grains. If the specific gravity of silver be called 10·5, then 1 cubic inch of silver would weigh 252·46 grains $\times$ 10·5 the sp. gr. of silver = 2640·8 grains. Solids are proportional to the cubes of their like linear dimensions. An angle of $1''$, the limit of the visual angle, at a distance of 8 inches subtends $\frac{8}{200,000}$ of an inch, $= \frac{1}{25000}$ inch. $\therefore (1 \text{ inch})^3 : (\frac{1}{25000})^3 :: 2640{\cdot}8$ grains $: x = \frac{2640{\cdot}8}{15625{\cdot}000{\cdot}000{\cdot}000} = \frac{1}{5916767676} =$, about one six thousandth million of a grain, or in a spheroid form, a globule of about one ten thousand millionth of a grain. Small globules may be rendered more distinct by pressure in an agate mortar, which not only gives them a greater area, but a much greater reflecting surface.

for gold is 2577·667 grains, and for silver 1382·72248 grains.* D represents any diameter whether a whole number or fraction, and W the weight required. Logarithms are easily applied, and save much labor. Log. W = log. C + 3 log. D.

Table exhibiting the Weights of Spheres of Gold and Silver of varied diameters, of fractions of an inch.

Diameters of spheres in inches.		Parts on sector scale set to $\frac{1}{20}$ inch.	Weights of spheres expressed in grains.		Diameters of spheres in inches.		No. of equal parts on sector scale open $\frac{1}{20}$ inch.	Weights of spheres expressed in grains.	
Decimals.	Vulgar fr.		For gold.	For silver.	Decimal fractions	Vulgar fractions		For gold.	For silver.
1·000	1	. .	2577·667	1382·7224	·0072	$\frac{1}{138}$	29	0·0009868	0·0005261
0·100	$\frac{1}{10}$	. .	2·57766	1·382722	·0069	$\frac{1}{143}$	28	0·0008814	0·0004728
0·080	$\frac{1}{12\frac{1}{2}}$	. .	1·31975	0·70656	·0067	$\frac{1}{148}$	27	0·0007951	0·0004265
0·0625	$\frac{1}{16}$	. .	0·62931	0·33757	·0065	$\frac{1}{153}$	26	0·0007197	0·0003860
0·0600	$\frac{1}{16\frac{2}{3}}$	. .	0·55677	0·29866	·0062	$\frac{1}{160}$	25	0·0006293	0·0003375
0·0500	$\frac{1}{20}$	200	0·32221	0·17284	·0060	$\frac{1}{166}$	24	0·0005635	0·0003022
0·0400	$\frac{1}{25}$	170	0·16497	0·088494	·0057	$\frac{1}{173}$	23	0·0004978	0·0002670
0·0300	$\frac{1}{33}$	121	0·069618	0·037333	·0055	$\frac{1}{181}$	22	0·0004347	0·0002331
0·0250	$\frac{1}{40}$	100	0·040276	0·021605	·0052	$\frac{1}{190}$	21	0·0003758	0·0002015
0·0200	$\frac{1}{50}$	80	0·020611	0·011061	·0050	$\frac{1}{200}$	20	0·0003222	0·0001728
0·0166	$\frac{1}{60}$	66·6	0·011934	0·0064015	·0047	$\frac{1}{210}$	19	0·0002783	0·0001493
0·0160	$\frac{1}{62\frac{1}{2}}$	64	0·010557	0·0059305	·0045	$\frac{1}{222}$	18	0·0002355	0·0001263
0·0142	$\frac{1}{70}$	57	0·007515	0·0040312	·0042	$\frac{1}{235}$	17	0·0001986	0·0001065
0·0133	$\frac{1}{75}$	53	0·006110	0·0032775	·0040	$\frac{1}{250}$	16	0·0001649	0·0000884
0·0125	$\frac{1}{80}$	50	0·005034	0·0027006	·0037	$\frac{1}{266}$	15	0·0001368	0·0000734
0·0119	$\frac{1}{83\frac{1}{3}}$	48	0·004474	0·002400	·0035	$\frac{1}{285}$	14	0·0001113	0·0000597
0·0117	$\frac{1}{85}$	47	0·004295	0·002251	·0032	$\frac{1}{307}$	13	0·0000890	0·0000477
0·0111	$\frac{1}{90}$	44	0·003535	0·001896	·0030	$\frac{1}{333}$	12	0·0000682	0·0000374
0·0105	$\frac{1}{95}$	42	0·003006	0·001612	·0027	$\frac{1}{363}$	11	0·0000533	0·0000289
0·0100	$\frac{1}{100}$	40	0·002577	0·001382	·0025	$\frac{1}{400}$	10	0·0000402	0·0000215
0·0097	$\frac{1}{102\frac{1}{2}}$	39	0·002393	0·001283	·0020	$\frac{1}{500}$	8	0·0000206	0·0000110
0·0095	$\frac{1}{105}$	38	0·002226	0·001194	·0016	$\frac{1}{600}$	6·6	0·0000119	0·0000064
0·0093	$\frac{1}{107\frac{1}{2}}$	37	0·002075	0·001113	·0014	$\frac{1}{700}$	5·7	0·0000075	0·0000040
0·0091	$\frac{1}{110}$	36	0·001936	0·001038	·0012	$\frac{1}{800}$	. .	0·00000503	0·00000269
0·0088	$\frac{1}{112\frac{1}{2}}$	35·7	0·001810	0·000971	·0011	$\frac{1}{900}$	. .	0·00000353	0·00000189
0·0087	$\frac{1}{115}$	35	0·001694	0·000909	·0010	$\frac{1}{1000}$	. .	0·00000257	0·00000138
0·0083	$\frac{1}{120}$	33·3	0·001491	0·000800	·0008	$\frac{1}{1200}$	. .	0·00000149	0·00000079
0·0080	$\frac{1}{125}$	32	0·001319	0·000707	·0006	$\frac{1}{1600}$	. .	0 00000062	0·00000033
0·0077	$\frac{1}{129}$	31	0·001200	0·000644	·0005	$\frac{1}{2000}$	. .	0·00000032	0·00000017
0·0075	$\frac{1}{133}$	30	0·001095	0·000587	0·002	$\frac{1}{2500}$	. .	0·00000016	0·00000008

Jackson C. H., Ohio, March 3d, 1847.

* It has been shown in a preceding note, that a cube of silver of 1 inch, would weigh 2640·8 grains. The sphere of the same diameter would weigh 2640·8 × 0·5236 = 1382·72248 grains. The cube of gold of one inch, weighs 4922·97 grains, and a sphere of the same weighs 2577·667. The contents of a cube : that of an inscribed sphere, : : 1 : 0·5236, for the contents of a sphere = $\frac{4}{3}\pi R^3$ = when the diameter is unity, $\frac{4}{3}\pi(\frac{1}{2})^3 = 0{\cdot}5236$.

ART. XLIV.—*On the Variation of a Differential Coefficient of a Function of any number of Variables;* by A. D. STANLEY, Professor of Mathematics in Yale College.

WHEN a quantity is a function of a *single* variable, the *variations* of its differential coefficients are, as is well known, easily determined. But the variations of differential coefficients of a function of *two* variables have not been ascertained without difficulty. Lagrange, the inventor of the Calculus of Variations, never obtained them by a method duly general. Poisson was the first to do this; which however has since been done in a somewhat simpler manner by Mr. Ostrogradsky. But for the *general* case in which we have any number of independent variables, or even for the third case in point of complexity, viz. that in which *three* variables are concerned, the variations in the differential coefficients of a function have not been determined by either of these analysts. To obtain them by the complex methods which they used in dealing with two variables, would be extremely difficult, if not quite impracticable. Indeed Poisson never undertook to extend his investigations beyond the case in which two variables are concerned. Mr. Ostrogradsky, however, abandoning the method which he had pursued successfully in the case of two variables, attempted by a simpler process to determine the variations in question for the general case in which the variables are of any number whatever. But the attempt was unsuccessful, as must we think be evident on carefully examining the principle that is made the basis of his investigations; which is, that the variation of the differential of a function is equal to the differential of the variation of the function; or to state the principle in algebraic language, $\delta d\mathrm{V} = d\delta\mathrm{V}$. (That this statement is inadmissible, we shall, at another time, attempt to show.) There is however an article on the Method of Variations by Mr. Pagani, published in the fifteenth volume of Crelle's Mathematical Journal, that contains a correct solution, and, as is believed, the only one yet given, of the general problem we speak of. Before meeting with the investigations of Mr. Pagani and Mr. Ostrogradsky, the writer of this article had fallen upon two different methods of procedure, each of which leads directly to a solution of the problem under view, in its most general form. The principles employed in one of them are the same substantially as appear in that of Pagani; though this may not be readily perceived, as we use them in a manner considerably different from his. But the other method is essentially different, and is much more simple and concise. Still as the problem concerned is of fundamental importance in the Calculus of Variations, it may not be useless to state the former as well as the latter method of solution.

Let then $u=f(x, y, z, \&c.)$, and by *variation* let this equation become $\mathrm{u}=\mathrm{f}(\mathrm{x}, \mathrm{y}, \mathrm{z}, \&c.)$: also let $\delta u=\mathrm{u}-u$, $\delta x=\mathrm{x}-x$, $\delta y=\mathrm{y}-y$, $\delta z=\mathrm{z}-z$, &c. δu, δx, δy, δz, &c. being functions of all the independent variables, x, y, z, &c. These variations being *assumed*, our object is to determine the *resulting* variations in the differential coefficients of u; as for instance, the variation of $\frac{du}{dx}$.

Now by reason of the variations assumed, $\frac{du}{dx}$ becomes $\frac{d\mathrm{u}}{d\mathrm{x}}$: the variation of $\frac{du}{dx}$ therefore, is $\frac{d\mathrm{u}}{d\mathrm{x}}-\frac{du}{dx}$; and if this be denoted by $\delta\frac{du}{dx}$, we have the equation $\delta\frac{du}{dx}=\frac{d\mathrm{u}}{d\mathrm{x}}-\frac{du}{dx}$: but $u=\mathrm{u}-\delta u$;

hence,
$$\delta\frac{du}{dx}=\frac{d\mathrm{u}}{d\mathrm{x}}-\frac{d\mathrm{u}}{dx}+\frac{d\delta u}{dx}.$$

Now
$$\frac{d\mathrm{u}}{dx}=\frac{d\mathrm{u}}{d\mathrm{x}}\,\frac{d\mathrm{x}}{dx}+\frac{d\mathrm{u}}{d\mathrm{y}}\,\frac{dy}{dx}+\frac{d\mathrm{u}}{d\mathrm{z}}\,\frac{dz}{dx}+\&c.$$

and $\frac{d\mathrm{x}}{dx}=\frac{d(x+\delta x)}{dx}=1+\frac{d\delta x}{dx}$, $\frac{d\mathrm{y}}{dx}=\frac{d(y+\delta y)}{dx}=\frac{d\delta y}{dx}$, $\frac{d\mathrm{z}}{dx}=\frac{d\delta z}{dx}=\&c.$

Hence, $\delta\frac{du}{dx}=\frac{d\delta u}{dx}-\frac{d\mathrm{u}}{d\mathrm{x}}\,\frac{d\delta x}{dx}-\frac{d\mathrm{u}}{d\mathrm{y}}\,\frac{d\delta y}{dx}-\frac{d\mathrm{u}}{d\mathrm{z}}\,\frac{d\delta z}{dx}-\&c.$ and if we consider that $\frac{d\mathrm{u}}{d\mathrm{x}}=\frac{du}{dx}+\delta\frac{du}{dx}$, and* neglecting the infinitesimal $\delta\frac{du}{dx}$, substitute $\frac{du}{dx}$ for $\frac{d\mathrm{u}}{d\mathrm{x}}$, and substitute also $\frac{du}{dy}$, $\frac{du}{dz}$, &c. for $\frac{d\mathrm{u}}{d\mathrm{y}}$, $\frac{d\mathrm{u}}{d\mathrm{z}}$, &c. we obtain the equation

$$(1.)\qquad \delta\frac{du}{dx}=\frac{d\delta u}{dx}-\frac{du}{dx}\,\frac{d\delta x}{dx}-\frac{du}{dy}\,\frac{d\delta y}{dx}-\frac{du}{dz}\,\frac{d\delta z}{dx}-\&c.$$

This is easily reducible to the following form, which will be found convenient for purposes of generalization;

$$\delta\frac{du}{dx}=\frac{d}{dx}\left(\delta u-\frac{du}{dx}\,\delta x-\frac{du}{dy}\,\delta y-\frac{du}{dz}\,\delta z-\&c.\right)$$
$$+\frac{d^2u}{dxdx}\,\delta x+\frac{d^2u}{dxdy}\,\delta y+\frac{d^2u}{dxdz}\,\delta z+\&c. \text{ or}$$

---

* The objections to which this mode of reasoning, so common in the Calculus, is liable, may be obviated by regarding the sign = as indicating, not that the two quantities on opposite sides of it are equal, but that the limit of their ratio is unity; and we doubt whether it is possible to present the Method of Variations in a satisfactory light, without employing instead of equations, the other kind of comparisons here alluded to.

$$\delta u' - \frac{du'}{dx}\delta x - \frac{du'}{dy}\delta y - \frac{du'}{dz}\delta z - \&c.$$
$$= \frac{d}{dx}\left(\delta u - \frac{du}{dx}\delta x - \frac{du}{dy}\delta y - \frac{du}{dz}\delta z - \&c.\right);$$

where u' is put for $\frac{du}{dx}$.

Now $\frac{du}{dx}\delta x + \frac{du}{dy}\delta y + \frac{du}{dz}\delta z + \&c.$ is the variation in the function u, that is due to the variations δx, δy, δz, &c. independently of any change in the *form* of that function. And the excess of the whole variation δu above this partial variation, may be regarded as the variation occasioned in the function by its change of form. Let this excess be denoted by $\varDelta u$, and let a similar notation be used in other like cases. Then $\varDelta u' = \frac{d\varDelta u}{dx}$; that is, $\varDelta\frac{du}{dx} = \frac{d\varDelta u}{dx}$. Hence we readily derive the general equation

$$(2.) \qquad \varDelta\frac{d^{l+m+n\&c.}u}{dx^l dy^m dz^n\&c.} = \frac{d^{l+m+n\&c.}\varDelta u}{dx^l dy^m dz^n\&c.}.$$

Now for brevity, let D be put for the complex characteristic $\frac{d^{l+m+n\&c.}}{dx^l dy^m dz^n\&c.}$; then since $\varDelta Du$ is only a substitute for the expression $\delta Du - \frac{dDu}{dx}\delta x - \frac{dDu}{dy}\delta y - \frac{dDu}{dz}\delta z - \&c.$ and, as has just been proved, is equal to $D\varDelta u$ or $D\left(\delta u - \frac{du}{dx}\delta x - \frac{du}{dy}\delta y - \frac{du}{dz}\delta z + \&c.\right)$ it follows that

$$(3.) \qquad \delta Du = D\left(\delta u - \frac{du}{dx}\delta x - \frac{du}{dy}\delta y - \frac{du}{dz}\delta z - \&c.\right)$$
$$+ \frac{dDu}{dx}\delta x + \frac{dDu}{dy}\delta y + \frac{dDu}{dz}\delta z + \&c.$$

which is the general formula required: for it exhibits the value of the variation of any differential coefficient of u, due to the assumed variations δu, δx, δy, δz, &c. in terms of those variations; in other words, it assigns for the dependent variation δDu, in which δ is separated from u by the characteristic D, an expression in which none but the assumed variations occur, in which the characteristic δ is found, only as *immediately* preceding one or another of the variables u, x, y, z, *&c.*

We have now to state a second method of obtaining the same result; the method to be preferred as the most simple and direct. We will begin by showing that when a function varies in consequence of changes in the values of its variables and in its form, the whole variation is equal to the variation due to the change in the form of the function, independently of any change in the variables, added to the variation which is due to the changes in the values of the variables independently of any change in the form of the function: a theorem which though seemingly obvious, is not however to be assumed without proof.

Let $u = F(x, y, z, \&c.)$, and by variation let x, y, z, &c. become $\mathrm{x}, \mathrm{y}, \mathrm{z}$, &c. while u becomes $\mathrm{u}+\mathrm{v}$, where $\mathrm{u} = F(\mathrm{x}, \mathrm{y}, \mathrm{z}, \&c.)$ and $\mathrm{v} = f(\mathrm{x}, \mathrm{y}, \mathrm{z}, \&c.)$. Then the whole variation of u which we will denote by δu, is $\mathrm{u}+\mathrm{v}-u$. But if there were the same change as we have supposed in the form of the function, without any variation in x, y, z, &c. the variation of u would be $f(x, y, z, \&c.)$, which we may denote by v or Δu. And if there were no variation in the form of the function u, but the same variation as has been supposed in the values of x, y, z, &c. the variation of u would be $\mathrm{u} - u$, which we will denote by Γu. Then $\delta u = \Delta u + \Gamma u + (\mathrm{v} - v)$. But as v is the same function of $\mathrm{x}, \mathrm{y}, \mathrm{z}$, &c. that v is of x, y, z, &c. $(\mathrm{v} - v)$ is an infinitesimal of the second order and may be neglected. We have then finally the equation

$$(4.) \qquad \delta u = \Delta u + \Gamma u;$$

a result which verifies the theorem stated above. We now proceed to determine the variation of a differential coefficient of a function. Let u be the function, and Du the differential coefficient; where D is put for $\frac{d^{l+m+n\,\&c.}}{dx^l dy^m dz^n\,\&c.}$. Then when u varies to $\mathrm{u}+\mathrm{v}$, Du varies to $\mathrm{D}(\mathrm{u}+\mathrm{v})$, where D is put for $\frac{d^{l+m+n\,\&c.}}{d\mathrm{x}^l d\mathrm{y}^m d\mathrm{z}^n\,\&c.}$. And if δDu be put for the variation of Du,

$$\delta Du = \mathrm{D}(\mathrm{u}+\mathrm{v}) - Du = \mathrm{Du} + \mathrm{Dv} - Du.$$

But Du is the same function of $\mathrm{x}, \mathrm{y}, \mathrm{z}$, &c. that Du is of x, y, z, &c.: then agreeably to the notation already used, ΓDu may be put for $\mathrm{Du} - Du$. And as Dv is the same function of $\mathrm{x}, \mathrm{y}, \mathrm{z}$, &c. that Dv is of x, y, z, &c., $\mathrm{Dv} = Dv + \Gamma Dv$. Hence if the infinitesimal ΓDv, which is of the second order, be neglected, and if for v, its equivalent Δu be substituted,

$$(5.) \qquad \delta Du = D\Delta u + \Gamma Du:$$

and if for Δu we substitute its equal $\delta u - \Gamma u$, then

$$(6.) \qquad \delta Du = D(\delta u - \Gamma u) + \Gamma Du.$$

Now the meaning of Γ is such that if infinitesimals of the second order be neglected,

$$(7.) \qquad \Gamma u = \frac{du}{dx}\,\delta x + \frac{du}{dy}\,\delta y + \frac{du}{dz}\,\delta z + \&c.$$

Therefore,

$$(8.)\qquad \delta Du = D\left(\delta u - \frac{du}{dx}\,\delta x - \frac{du}{dy}\,\delta y - \frac{du}{dz}\,\delta z - \&c.\right) + \frac{dDu}{dx}\,\delta x + \frac{dDu}{dy}\,\delta y + \frac{dDu}{dz}\,\delta z + \&c.$$

which is the same as the equation (3) before obtained.

If Du be put for u in the equation (4), then

$$(9.)\qquad \delta Du = \varDelta Du + \Gamma Du;$$

and if this be compared with the equation (5), it follows that

$$(10.)\qquad \varDelta Du = D\varDelta u;$$

which is of the same import with the above equation (2). The equation (8) may be presented in another simple form, that is worthy of notice, when $l+n+m+\&c. = 1$; as for example, when $l=1$, and $0=m=n=\&c.$ for then

$$\delta\frac{du}{dx} = \frac{d}{dx}\left(\delta u - \frac{du}{dx}\,\delta x - \frac{du}{dy}\,\delta y - \frac{du}{dz}\,\delta z - \&c.\right) + \frac{d^2u}{dxdx}\,\delta x + \frac{d^2u}{dxdy}\,\delta y + \frac{d^2u}{dxdz}\,\delta z + \&c.$$

or

$$(11.)\qquad \delta\frac{du}{dx} = \frac{d\delta u}{dx} - \frac{du}{dx}\,\frac{d\delta x}{dx} - \frac{du}{dy}\,\frac{d\delta y}{dx} - \frac{du}{dz}\,\frac{d\delta z}{dx} - \&c.$$

which is the same as the former equation (1).

Mr. Delaunay, in a paper on the calculus of variations lately published, and which has particular reference to the variations of Multiple Integrals, has thought it sufficient to vary the limits of integration, and the *form* of the function which the dependent variable is of the independent variables, without assigning to the latter any variations; in which case no investigation is needed to determine the variation of a differential coefficient of the dependent variable; for it is obvious at once, that

$$\delta\frac{d^{l+m+n\,\&c.}u}{dx^l dy^m dz^n\,\&c.} = \frac{d^{l+m+n\,\&c.}}{dx^l dy^m dz^n\,\&c.}\delta u.$$

Now with reference to the variation of a double *definite integral*, it is plain that if the integral be presented in the following form, $\int_a^A dx \int_{f(x)}^{F(x)} dy\,\mathrm{V}$, and be considered a substitute for such an expression as this, viz., $\mathrm{W}_{\substack{y=F(A)\\x=A}} - \mathrm{W}_{\substack{y=F(a)\\x=a}} - \mathrm{W}_{\substack{y=f(A)\\x=A}} + \mathrm{W}_{\substack{y=f(a)\\x=a}}$;

where W is such a function of x and y, that $\frac{d\mathrm{W}}{dx} + \frac{d\mathrm{W}}{dy}\,\frac{dy}{dx} = \mathrm{U}$,

and U such that $\frac{d\mathrm{U}}{dy} = \mathrm{V}$, then the method of Delaunay will suffice, and the variation of the integral may be exhibited with entire generality in the following manner,

$$\delta\int_a^A dx\int_{f(x)}^{F(x)} dy\, \mathrm{V} = \int_a^A dx\int_{f(x)}^{F(x)} dy\, \delta\mathrm{V} + \int_a^A dx\left(\mathrm{V}_{y=F(x)}\delta F(x) - \mathrm{V}_{y=f(x)}\delta f(x)\right)$$

$$(12.)\qquad +\delta A\int_{f(A)}^{F(A)} dy\, \mathrm{V}_{x=A} - \delta a\int_{f(a)}^{F(a)} dy\, \mathrm{V}_{x=a};$$

where $\delta\mathrm{V}$ denotes the variation in the form of V considered as a function of x and y. But it may at times be necessary or convenient to regard a double or other multiple *definite integral* as the sum of an infinite number of infinitesimal elements, or more correctly perhaps as the limit of this sum, and variations may need to be attributed to these infinitesimal elements *severally* rather than *in the aggregate*, in which cases, (as has been remarked by Ampère in a paper on the Calculus of Variations applied to mechanics,) it is not sufficient to regard the variations of the independent variables as nothing, but general values must be assumed for them as well as for the variations of the dependent variables. The method of Delaunay is therefore essentially deficient in generality.

By means of the formulæ already stated, it is easy to obtain the proper expression for the variation of any function of both dependent and independent variables. Let V be such a function, whose variation is to be determined; let the independent variables be x, y, z, &c., and let P be one of the dependent variables. Then as V is a function of x, y, z, &c., and of quantities which are functions of x, y, z, &c., it is virtually a function of these independent variables only; and though regarded as a *uniform* function in respect to *all* the variables, dependent and independent, that are contained in it, it may however be considered variable in its form, when viewed as a function of the independent variables, on account of the variations in the forms of the dependent variables.

Then in the general equation $\delta\mathrm{V} = \varDelta\mathrm{V} + \mathit{\Gamma}\mathrm{V}$, $\varDelta\mathrm{V}$ must be the sum of all the partial variations of V, that are analogous to the following, $\frac{d\mathrm{V}}{d\mathrm{P}}\varDelta\mathrm{P}$; which sum may be denoted thus $\Sigma\frac{d\mathrm{V}}{d\mathrm{P}}\varDelta\mathrm{P}$. But P may be a differential coefficient of a function: we will suppose it such, and put instead of it, Du, that is, $\frac{d^{l+m+n\ \&c.}u}{dx^l dy^m dz^n\ \&c.}$. Then,

$$\varDelta\mathrm{V} = \Sigma\frac{d\mathrm{V}}{d\mathrm{P}}\varDelta Du = \Sigma\frac{d\mathrm{V}}{d\mathrm{P}}D\varDelta u = \Sigma\frac{d\mathrm{V}}{d\mathrm{P}}D(\delta u - \mathit{\Gamma}u).$$

Therefore,

$$(13.)\quad \begin{aligned}\delta V = \Sigma \frac{dV}{dP}\, D\left(\delta u - \frac{du}{dx}\,\delta x - \frac{du}{dy}\,\delta y - \frac{du}{dz}\,\delta z - \&c.\right)\\ + \frac{dV}{dx}\,\delta x + \frac{dV}{dy}\,\delta y + \frac{dV}{dz}\,\delta z + \&c.,\end{aligned}$$

where $P = Du$, and $\frac{dV}{dx}, \frac{dV}{dy}, \frac{dV}{dz}$, &c., are *complete* or *total* differential coefficients with respect to x, y, z, &c.

One other theorem, which has not, we believe, been elsewhere stated, seems worthy of notice here.

Let V be a function of several variables, x, y, z, &c., either variable or constant in its form with respect to them; then by virtue of the equation (1), we readily obtain the following,

$$dx\,\delta\frac{dV}{dx} + dy\,\delta\frac{dV}{dy} + dz\,\delta\frac{dV}{dz} + \&c.$$

$$(14.)\quad = d\delta V - \frac{dV}{dx}\,d\delta x - \frac{dV}{dy}\,d\delta y - \frac{dV}{dz}\,d\delta z - \&c.$$

Now regarding dV as a *uniform* function of $\frac{dV}{dx}, \frac{dV}{dy}, \frac{dV}{dz}$, &c. dx, dy, dz, &c., viz., the function $\frac{dV}{dx}dx + \frac{dV}{dy}\,dy + \frac{dV}{dz}\,dz + \&c.$, we have the equation,

$$(15.)\quad \begin{aligned}\delta dV = dx\,\delta\frac{dV}{dx} + dy\,\delta\frac{dV}{dy} + dz\,\delta\frac{dV}{dz} + \&c.\\ + \frac{dV}{dx}\delta dx + \frac{dV}{dy}\delta dy + \frac{dV}{dz}\delta dz + \&c.,\end{aligned}$$

which combined with the last gives the following,

$$\delta dV = d\delta V + \frac{dV}{dx}(\delta dx - d\delta x) + \frac{dV}{dy}(\delta dy - d\delta y) + \frac{dV}{dz}(\delta dz - d\delta z) + \&c.$$

and if we put the characteristic θ for $(\delta d - d\delta)$,

$$(16.)\quad \theta V = \frac{dV}{dx}\,\theta x + \frac{dV}{dy}\,\theta y + \frac{dV}{dz}\,\theta z + \&c.$$

which is the theorem that was to be stated.

If either of the variables x, y, z, &c., as for example x, is a function of the rest, whether variable in its form or not, then

$$\theta x = \frac{dx}{dy}\,\theta y + \frac{dx}{dz}\,\theta z + \&c.,$$

and

$$\theta V = \left(\frac{dV}{dx}\,\frac{dx}{dy} + \frac{dV}{dy}\right)\theta y + \left(\frac{dV}{dx}\,\frac{dx}{dz} + \frac{dV}{dz}\right)\theta z + \&c.\text{; or if } \frac{dV}{dy}, \frac{dV}{dz}, \&c.$$

be put for *total* differential coefficients of V, with respect to y, z, &c., $\theta V = \frac{dV}{dy}\theta y + \frac{dV}{dz}\theta z$, &c.; the same result that would be obtained by regarding V at first as a function of only y, z, &c., subject to all the variation of form with respect to these variables, which is due to any variation of form that may have been attributed to it, with respect to x, y, z, &c., and which is due to any variation of form that may be assumed for x, considered as a function of y, z, &c.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the presence of Fluorine in Anthracite;* by George C. Schaeffer, (communicated for this Journal.)—But little attention has hitherto been paid to the curious pseudo-sublimate formed in the flues of stoves in which anthracite coal is burned. Several years ago a committee of the Franklin Institute made a report on the corrosion of iron pipe, &c. by the burning of anthracite. This is the only notice of this substance known to us. The committee attributed the corrosion to the action of ammoniacal salts containing sulphuric acid and chlorine.

The substance in question is not wholly a sublimate, being formed partly by the condensation of ammoniacal salts and partly by the direct action of the gaseous products of combustion on the iron; when the fire has been frequently rekindled, there is more or less mixture of carbonaceous matter.

The action of damp air on this substance when cold, increases the corrosion of the pipe, as demonstrated in the report above mentioned. This however is not the *sole* cause, for large flakes may easily be separated from pipes which have not been exposed to damp air, and these will always be found to contain much iron.

There is another substance found in the pipes; this is formed of the ashes carried up by the draught, and is more or less incrusted and mixed with the condensed products of combustion.

Soon after the report of the committee of the Franklin Institute was published, my attention was drawn to the same subject. I found on subliming even the smallest portion of these flakes in an open glass tube, that the glass was corroded. As I was engaged in determining the presence of another substance, I did not pay much attention to this indication of the presence of fluorine.

I have more recently tried the usual test for fluorine, and find that with a small quantity of the sublimate, the glass is always engraved; even a few grains will suffice to give marks which are visible when the glass is dimmed by breathing on it.* This reaction uniformly takes

* If the leaden vessel in which this experiment has been tried, is allowed to stand for some time, a large quantity of transparent and perfect octahedrons of iron and ammonia alum will be found. These may be readily freed from the black residue by agitation with a small quantity of water. The crystals however soon become opake and brown when exposed.

place, and we may therefore add fluorine to the number of elements already found in anthracite.

Since making these experiments, my attention has been directed to a note by the Messrs. Rogers, on the occurrence of fluor spar in anthracite; these gentlemen correctly attribute the fluorine to the vegetation of the coal plants, although no attempt seems to have been made to determine its constant presence in the coal.

A single trial has shown that phosphoric acid is likewise present. I have not repeated the experiment, but there can be no doubt that this constituent of plants of our era, was equally abundant in the coal plants.

It may be remarked, that the sulphur is not altogether found as sulphuric acid in the sublimate, for hydrochloric acid disengages a large quantity of sulphurous acid. The investigation of this curious substance is not yet completed. The results, if worth recording, will be communicated to this Journal.

2. *Arseniate of Magnesia and Ammonia, and its applications;* by M. Levol, (Com. Rend., July, 1846; Ann. de Chim. et de Phys., Aug., 1846.)—This salt is said to correspond in all respects with the phosphate of magnesia and ammonia; it is formed in the same way and possesses the same sparing solubility in water containing ammonia. The presence of one part of arsenic acid in 56818 of ammoniacal water was rendered evident on the addition of a strong solution of ammoniacal sulphate of magnesia. M. Levol proposes this salt as a means of estimating arsenic acid when arsenious acid is present. The dried precipitate must be heated to a red heat, care being taken to avoid reduction of the acid, there remains $2MgO,AsO_5$. The insolubility of this salt renders it probable that the ammoniaco-magnesian salts will prove antidotes in cases of poisoning with arsenic acid. G. C. S.

3. *On the Acids of Tobacco;* by M. E. Goupil, (Com. Rend., July, 1846; Ann. de Chim. et de Phys., Aug., 1846.)—The chief organic acid of the tobacco is the malic. Bimalate of ammonia may be obtained readily from the plant, which in its dry state affords 3 to 4 per cent. M. Goupil has discovered that the conversion of the precipitated malate of lead into a crystalline mass does not take place unless there is free acid present. This is an important fact, as the conversion into crystals is commonly assigned as a distinguishing character.

Citric acid is found in the tobacco plant but in a very small quantity. No other organic acids could be found. G. C. S.

4. *On the Fusion of Phosphorus;* by M. Ed. Desains, (Comptes Rendus, July, 1846.)—The melting point of phosphorus, determined very carefully, was found to be $111\frac{1}{2}°$. The phosphorus should be covered with water and constantly agitated while cooling; without this precaution it may remain liquid even at 72°; on solidifying, its temperature rises to about 104°. The rate of cooling of the solid and liquid phosphorus between these two points would indicate the same specific heat for the two different states of the substance.

5. *On Coffee,* (third part;) by M. Payen.—In order to isolate the aromatic substance of the coffee, the usual hot infusion was distilled in a vessel connected with several successive receivers kept at different temperatures. The aromatic principle was found almost entirely condensed in that which had preserved a temperature of about 80°. Sev-

eral purifications are required to separate a solid fat which is entirely inodorous; the true aromatic substance is a mixture of two oils, one probably an alteration of the other. This oil, upon which the flavor of the coffee depends, is but the ·0002 of the berry; it is not surprising, therefore, that a single drop diffuses the odor of coffee throughout a room.

M. Payen gives a curious calculation of the value of this aroma, by which it appears that about one thousand dollars per pound is paid for this oil. G. C. S.

6. *Determination of Nitrogen in Organic Bodies;* by GEORGE KEMP, M. D., (Chem. Gaz., Nov., 1846.)—Dr. Kemp cautions us against the following source of error in the manipulation of Varrentrap and Will's process for estimating nitrogen. When the substance to be analyzed contains a small proportion of nitrogen and much hydrogen, a larger quantity of the substance must be taken to obtain a sufficient amount of ammonia. Much water is of course formed, and this condensing in the cooler parts of the tube, forms a pasty mass with the soda-lime, which forms a plug in the front end of the tube, and spoils the analysis, or at the drawn-out end prevents the removal of all the ammonia, so that as much as one-third may be lost. To avoid this difficulty, four parts of lime to one of hydrate of soda are to be used, instead of the usual proportion of two to one. The end, instead of being drawn up abruptly, is to be drawn out for about a quarter of an inch, and then upwards, so as to form a segment of a circle. In loading the tube, about an inch of coarsely powdered lime is to be introduced before the mixture.

Dr. Kemp also points out the ammonia floating in the air, as a source of error, particularly in large laboratories, where several different operations are carried on at the same time, and by different persons; in private laboratories, there is less risk of introducing ammonia in this way. G. C. S.

7. *On the Preparation of Caustic Baryta;* by Dr. E. RIEGEL, (Chem. Gaz., Nov., 1846.)—The author gives the preference to the process with sulphuret of barium and peroxyd of manganese, as described in the books; with oxyd of copper, he states that the product is less pure, as the ley generally contains a slight trace of copper. This is directly contrary to what is commonly asserted of these two methods. G. C. S.

8. *Nitrogen not a Constituent of Picrotoxine;* ERDMANN and MARCHAND, (quoted in Jour. de Pharm. et de Chim., ix, p. 470.)—Liebig has asserted, when speaking of the vegetable alkalies, that "no remedy, devoid of nitrogen, possesses a poisonous action in a similar dose;" and adds that this consideration led to the re-examination of picrotoxine, by Mr. Francis, who ascertained that nitrogen did exist in it.

This being contrary to the analysis of several distinguished chemists, Messrs. Erdmann and Marchand have examined the subject with the greatest care. The test of M. Lassaigne, which, as is well known, is exceedingly delicate, failed to give any indication of the presence of nitrogen. The ordinary mode of combustion was then tried, one gramme of the substance being burned each time. Had the picrotoxine contained half of one per cent. of nitrogen, there would have been collected 4 cub. cent. of that gas. In two experiments, they obtained

·5 and ·7 of a cub. cent., in two others, 4 and 5 cub. cent.; this gas, however, was not nitrogen, *for it was inflammable.* This result shows that caution should be exercised in the determination of nitrogen, and that both carbon and hydrogen may escape combustion and create a loss, falling of course mainly upon the carbon. G. C. S.

9. *On the Influence of Protoxyd of Nitrogen upon Vegetation;* by M. Vogel, Jr., (Jour. de Pharm. et de Chim., x, p. 101.)—Seeds of the cress were exposed on a moistened sponge to an atmosphere of pure protoxyd of nitrogen. For the sake of comparison, seeds were placed in the same manner in a jar of common air. At the end of a few days, the latter vegetated and began to form leaves. The seeds in the protoxyd swelled, and were covered with a mucous coat, but remained for two weeks without any other signs of vegetation. On being taken out and exposed to the air, they immediately germinated. The gas was found unaltered.

Plants of the cress were then introduced into the gas; on the third day they became yellow, and at the end of a week they drooped. Brought into the air, they resumed in a few days their green color and erect position.

From these experiments, the author concludes that the protoxyd of nitrogen favors neither the germination of seeds, nor the vegetation of plants already forward, that the gas is not decomposed by the leaves, even under the direct rays of the sun, and that seeds do not lose their vitality by a short exposure to its influence.

These conclusions are true for the pure gas, but it by no means is to be inferred that the gas is altogether unfavorable to vegetation; we are persuaded that the contrary will be found true. In a similar manner, Braconnot, not long since, demonstrated that salt was injurious to vegetation: plants coated with a tolerably strong solution of salt, withered and died; *ergo*, salt was injurious! G. C. S.

10. *On the Volatile Oils of the Cruciferæ;* by F. Pless, (Liebig's Annalen, lviii, p. 36.)—The leaves and seeds of the *Thlaspi arvense* yield, by distillation with water, a volatile oil, which, on examination, proves to be a mixture of oil of mustard and oil of garlic. This oil does not preëxist in the plant.

The leaves and seeds of *Alliaria officinalis* give a similar mixture of these two oils, although the oil of garlic is sometimes absent.

The oil of mustard alone is formed from the leaves of *Iberis amara*, and in very small quantity from the seeds of *Capsella bursa-pastoris*, (shepherd's purse,) *Raphanus raphanistrum*, (charlock,) and *Sisymbrium officinale*, (hedge mustard.)

An essential oil, containing sulphur, is also obtained by macerating in water the seeds of *Lepidium ruderale*, *L. sativum*, (pepper-grass,) and *L. campestre*.

The same reaction is observed with the roots and seeds of the radish, and the seeds of the *Brassica napus*, *Cochlearia draba* and *Cheiranthus annuus*, (stock jilly.) G. C. S.

11. *On the Oil of Monarda;* by A. E. Arppe, (Liebig's Annalen, lviii, p. 41.)—This oil, the product of the *Monarda punctata*, (horsemint,) was brought from the United States. It consists of a fluid oil and a stearoptene. The former is a yellowish-red fluid, with the odor of

thyme; it boils at 435° F. It is apparently a mixture, as the stearoptene boils nearly at the same point. It is easily converted into a resin by contact with the air or any drying substances.

The stearoptene forms fine crystals; its boiling point is 428°. The formula is C_{10} H_7 O. (Gerhardt remarks that this is the formula for stearoptene of carraway oil.) This substance combines with hydrochloric acid gas, but does not form a crystalline compound. G. C. S.

12. *On the Substances contained in Achillea millefolium*, (*Yarrow*;) by B. ZANON, (Liebig's Annalen, lviii, p. 21.)—This plant possesses much reputation as a febrifuge, both in this country and in Europe. M. Zanon obtained from it a bitter extract, which he calls *Achilleine*, and a crystallized non-volatile acid, which formed salts with potash, soda, ammonia, lime and quinine. No analysis is given, so that we are unable to say whether the *achilleic* acid and the extract are new substances, or are already known. G. C. S.

13. *On the Formation of Caoutchouc from Drying Oils;* by L. E. JONAS, (Archiv. de Pharm., xlvi, p. 159.)—Linseed oil, boiled for a long time, yields a brownish varnish; this is to be boiled for a long time in water containing nitric acid, the loss by evaporation must be supplied and the acid not allowed to act too violently. At last a substance is obtained, which gradually solidifies; this is to be washed to free it from acid. This substance does not adhere to the fingers, is plastic, does not melt by itself, and when heated, strikingly resembles caoutchouc.

It dissolves partially in ether and sulphuret of carbon; entirely in oil of turpentine. Walnut and poppy oils furnish the same body, to which the name of oil-caoutchouc is given.

When linseed oil is boiled with half a part of sulphur, as soon as the temperature reaches a certain point, the whole is converted into a gelatinous mass, resembling oil-caoutchouc; dilute nitric acid converts all the sulphur into sulphuric acid; the residue has a brick-red color, which however is not elastic. G. C. S.

14. *Purification of Mercury;* by M. MILLON, (Ann. de Chim. et de Phys., Nov. 1846.)—Mercury may be perfectly purified by agitating it for a considerable time with weak nitric acid. With two pounds of the metal, about an ounce and a half of the acid diluted with twice its volume of water may be employed. The mercury freed from the nitrate thus formed is to be boiled with pure nitric acid sufficient to dissolve about nine-tenths of the metal; the resulting nitrate of mercury is to be reduced to red oxyd by heat, and this is to be calcined in a porcelain retort to reduce it.

By the action of the first portion of nitric acid the more oxydable metals are acted upon; the second portion of acid leaves the metals less oxydable than mercury in the undissolved portion.

As the mercury reduced by this process dissolves a notable quantity of oxyd, this last is to be separated by agitation with sulphuric acid; it is afterwards to be washed with a very large quantity of water, and dried in the receiver of the air-pump over sulphuric acid. Mercury thus purified was employed by M. Regnault in his third determination of its density.

M. Millon states that when a saline solution, such as chlorid of calcium, hydrochlorate of ammonia, nitrate of potash, &c., is added to mercury in a bottle, the mercury is always divided into rounded globules, which remain separated from each other for a long time; but what is very striking is, that the size of the globules, which varies enormously, is always connected with the nature of the aqueous solution. Some solutions immediately cause extreme division in the mercury; others, on the contrary, produce only very large globules, to whatever extent the agitation may have been carried; and the same effect is always produced with the same solution. It is to this influence of saline solutions that is due the difficulty often witnessed in collecting mercury when it has been reduced in the moist way.

15. *Grove's Galvanic Battery, improved for the use of the Telegraph.*—To increase the power of this battery, it is common to amalgamate the zinc cylinders with mercury. In the use of the battery at the stations of the telegraph, the mercury is soon attacked by the nitric acid which passes through the porous cup or by impurities in the sulphuric acid, and perhaps by both. It thus became necessary to repeat the amalgamation daily or every day or two, at no inconsiderable expense from the oxydation of the mercury. In trying some experiments, Mr. Swan of this city, was led to put crystals of sulphate of soda into the diluted sulphuric acid, when he found the action to be more uniform, and the mercury to be unattacked. On making the trial of the sulphate of soda in the telegraph battery, the experiment was entirely successful and the amalgamation was not repeated for weeks. In the new line on the Canada shore, it is stated by the superintendent, that they began with the use of the sulphate of soda, and that the quicksilver appeared uninjured after weeks of use. Should this fact be established, the saving on the telegraph lines will be some thousands of dollars annually. Indeed the experiments are already conclusive. The result is probably due to the decomposition of the sulphate of soda, by which nitrate of soda is formed and sulphuric acid liberated, while the nitric acid is thus prevented from acting on the quicksilver. There may be other effects; but the advantage gained from the sulphate of soda is very great. The crystals of sulphate of soda must be renewed so often that the dilute sulphuric acid may be a saturated solution. C. D.

Rochester, Feb. 15, 1847.

16. *Maximum Density of Pure Water*, (Phil. Mag., Jan., 1847, xxx, 41.)—Messrs. Joule and Playfair, after detailing several series of experiments, give as their final conclusion, which they remark cannot be more than a hundredth of a degree from the truth, that the maximum density of pure water is 39°·1 F. They object to the use of 60° F. as a standard in researches on specific gravity, on account of the high rate of expansion of water at that temperature, and suggest, that there would be greater accuracy if water at its maximum density were taken as the unit. This standard has already been adopted in France under the authority of Arago.*

The result arrived at by Despretz, from a very extensive series of experiments with an apparatus similar to that employed by Hope, was

* This standard was used by Mr. Hassler, in his elaborate investigations during the years 1830–1832, with regard to the weights and measures of the United States, after previously determining, by a long series of experiment, 39°·83 to be the temperature of maximum density.

39°·176, which agrees nearly with the above result. But other results show considerable discrepancy; e. g., Hallström, 39°·38, Blagden and Gilpin, 39°, Hope, 39°·5, Deluc, 41°, Lefebvre Gineau, 40°, Dalton, 38°, Rumford, 38°·8, Muncke, 38°·804, Stampfer, 38°·75 F. The mean of all these observations, is 39°·24.

17. *On a new and practical form of Voltaic Battery of the highest powers, in which Potassium forms the positive element*; by John Goodman, Esq. Communicated by S. Hunter Christie, Esq.. A.M., Sec. R.S., (Royal Soc., Jan. 11; Phil. Mag., Feb., 1847, xxx, 127.)—The author succeeded in constructing a voltaic arrangement of some power by fixing a piece of potassium to the end of a copper wire, placed in a tube containing naphtha, and bringing it into contact with a small quantity of mercury, held by a layer of bladder closing the lower end of the tube, which was itself immersed in acidulated water immediately over a piece of platinum, and then completing the circuit by establishing a metallic contact between the copper wire and the platinum. This battery acted with energy on the galvanometer, and effected the decomposition of water. A series of twelve pairs of similar plates exhibited a sensible attraction of a slip of gold leaf. Thus it appears that the substance which possesses the highest chemical affinity manifests also the greatest power of electrical tension.

18. *On Photographic Self-Registering Meteorological and Magnetical Instruments*; by Francis Ronalds, Esq., F.R.S., &c., (Royal Soc., Jan. 21; Phil. Mag., Feb., 1847, xxx, 127.)—The apparatus employed by the author at the Kew Observatory, and which he terms the Photo-Electrograph, is described by him in the following words:—"A rectangular box, about sixteen inches long and three square, constitutes the part usually called the *body* of a kind of lucernal microscope. A voltaic electrometer (properly insulated, and in communication with an atmospheric conductor) is suspended within the microscope, through an aperture in the upper side, and near to the *object end*. That end itself is closed by a plane of glass, when daylight is used, and by condensing lenses, when a common Argand lamp is employed. In either case an abundance of light is thrown into the microscope. Between the electrometer and the ether, or eye-end of the microscope, fine achromatic lenses are placed, which have the double effect of condensing the light upon a little screen, situated at that eye-end, and of projecting a strong image of the electrometer, in deep *oscuro*, upon it. Through the screen a very narrow slit, of proper curvature, is cut, (the chord of the arc being in a horizontal position,) and it is fitted into the back of a case, about two-and-a-half feet long, which case is fixed to the eye-end of the microscope, at right angles with its axis, and vertically. Within the case is suspended a frame, provided with a rabbet, into which two plates of pure thin glass can be dropped, and brought into close contact by means of six little bolts and nuts. This frame can be removed at pleasure from a line, by which it is suspended, and the line, after passing through a small aperture (stopped with grease) cut through the upper end of the long case, is attached to a pulley (about four inches in diameter) fixed, with capacity of adjustment, on the hour arbor of a good clock. Lastly, counterpoises, rollers, springs, and a straight ruler are employed for ensuring accurate rectilineal sliding of the frame, when the clock is set in motion.

"A piece of properly prepared photographic paper is now placed between the two plates of glass in the movable frame; the frame is removed (in a box made purposely for excluding light) and is suspended in the long case; this is closed, so as to prevent the possibility of extraneous light entering with it; the clock is started, and the time of starting is noted.

"All that part of the paper which is made to pass over the slit in the screen, by the motion of the clock, becomes now therefore successively exposed to a strong light, and is consequently brought into a state which fits it to receive a dark color on being again washed with the usual solution, excepting those small portions upon which dark images of the lower parts of the pendulums of the electrometer are projected through the slit. These small portions of course retain the light color of the paper; and form the long curved lines or bands, whose distances from each other, at any given part of the photograph, i. e. at any given time, indicate the electric tension of the atmosphere at that time.

"By certain additions to the instrument above described, the kind as well as the tension of electrical charge is capable of being registered; and by the employment also of a horizontal thermometer, &c., it is adapted to the purposes of a *Thermograph*, as well as *Photo-barometrograph* and *Magnetograph*."

II. Mineralogy and Geology.

1. *Buratite, a new Mineral;* by M. Delesse, (Comptes Rendus, Oct. 26.)—This mineral is a hydrous carbonate of zinc, copper and lime, in definite proportions; it crystallizes in bluish radiating needles; and has the specific gravity 3·20. According to the analysis of M. Delesse, it consists of carbonic acid 21·45, oxyd of zinc 32·02, lime 8·62, oxyd of copper 29·46, water 8·45. This leads to the formula $2(Zn, Cu, Ca,)\ C+aq$, or admitting the ideas of M. Scheerer on polymerous isomorphism, $CO^2\ (RO)^2$.

Buratite has been found in the copper mines of Lotefskoi in the Altai mountains, at Chessy near Lyons, at Temperino in Tuscany, and at several other localities.

2. *Groppite, a new Mineral;* by L. Svanberg, (Arsb. Berz., 1846, p. 240.)—This mineral, from Gropptorps, constitutes a rose red to brownish red crystalline mass having much resemblance to rosite. The structure is somewhat foliated. Hardness between that of gypsum and calc spar; specific gravity 2·73. It affords water before the blowpipe, and on analysis gave, silica 45·008, alumina 22·548, oxyd of iron 3·063, lime 4·548, magnesia 12·283, potash 5·227, soda 0·215, water 7·110, undecomposed 0·131=100·213, leading to the formula $rS^2+2AS+Aq$. It is near gigantolite in composition.

3. *Herschelite*, (Ann. de Ch. et de Phys., xiv, 97.)—According to Damour, Herschelite is a zeolite with essentially the same composition as chabazite, or $\dot{R}^3\dddot{Si}^2+3\dddot{Al}\,\dddot{Si}^2+15\dot{H}$. The analysis agrees very closely with Thomson's analysis of the variety Levyne.

4. *Aspasiolite, a new Mineral;* by M. Scheerer, (Arsb. Berz., 1846, p. 241.)—Aspasiolite occurs with iolite, quartz, feldspar and mica at Kragerö, in Norway. It resembles iolite in crystalline form, has a greenish color, the hardness of calc spar, and the specific gravity

2·764. In composition it differs little from iolite, affording silica 50·90, alumina 32·38, magnesia 8·01, lime *a trace*, protoxyd of iron 2·34, water 6·73, manganese *a trace*.

5. *Castor and Pollux, two new minerals;* by BREITHAUPT and PLATTNER, (Pogg. Annal., lxix.)—These minerals occur in granite on the Island of Elba. *Castor* has a vitreous lustre and rough surface, and is transparent and colorless, with two axes of double refraction and two cleavages inclined at an angle of 128½ or 129 degrees. Hardness, a little above adularia; specific gravity 2·3801—2·401. Fuses with difficulty before the blowpipe to a limpid colorless glass, coloring the exterior flame red. Composition according to Plattner, silica 78·012, alumina 18·856, peroxyd of iron with traces of manganese 1·613, lithia with traces of potash and soda 2·760=100·241.

Pollux resembles castor in crystallographic and physical characters, except that there are only traces of cleavage, and it has the specific gravity 2·868 to 2·892. Heated in a tube, water is disengaged. Before the blowpipe the edges are rounded to a blebby enamel, and it colors the exterior flame reddish yellow. It contains 46·2 per cent. of silica, with 16·5 of potash, 10·47 of soda and 2·321 of water. There was a loss in the analysis unaccounted for of 7·25 per cent.

6. *Pleochroism.*—Haidinger has applied the term pleochroism to the property pertaining to many crystals, of presenting different colors in different directions. The terms dichroism and trichroism heretofore used are too limited in signification, as different colors are presented in some species in more directions than three.

7. *Russian Geology*, (Proceedings of the Acad. Sci. of St. Petersburg; L'Institut, No. 681, Jan. 20, 1847.)—M. HELMERSEN has ready for publication an extended account of the geological observations which he has made in his different journeys through the departments of Livonia, Estonia, Pskov, St. Petersburg, Novgorod, Tver, Moscow, Toula, Kalouga and Orel; and in the summer of 1845, he made a tour into Sweden and Norway in order to compare his results with the facts there presented and give greater completeness to his description of the palæozoic and other deposits of Northern Europe.

8. *On Slaty Cleavage in North Wales;* by DANIEL SHARPE, (Geol. Soc., March, 1844; Quart. Journal Geol. Soc., No. 7, p. 309.)—In the course of a valuable article on the geology of North Wales, Mr. Sharpe makes the following statements with regard to slaty cleavages.

In North Wales, not only in the Cambrian but also in the Lower Silurian rocks, slaty cleavage is universal: it is very common in the Wenlock series; and in many localities it runs, in a marked degree, through the whole thickness of the Ludlow shales; but in other localities these shales are wholly exempt from it. The principal epoch of slaty cleavage, however, preceded the formation of the Ludlow beds; for these beds are in many instances undisturbed by the faults which have broken up the planes of cleavage in the older rocks. The author was assiduous in measuring the position of the planes of bedding and cleavage in various parts of North Wales, in the hope of making out some general laws respecting cleavage. In measuring the angles, however, he does not pretend to have approximated nearer than within 5° of the truth, as the surface of the beds is rarely flat enough to allow of greater accuracy.

One law respecting slaty cleavage was announced in 1831 by Professor Sedgwick,* and is now well known: that law is, that the cleavage planes maintain their parallelism over extensive areas, irrespective of the varying position of the beds which they cut through, or of the mineral character of the beds. Another law respecting slaty cleavage was detected by the author† in the progress of his tour, and is the following: viz. that the strike of the cleavage coincides with the strike of the bedding, whenever the latter continues uninterruptedly the same for a considerable distance; but when the strike of the beds is inconstant, and shifts at short intervals, then the cleavage planes hold their course right on, irrespective of the varying position of the planes of bedding; in other words, that the strike of the cleavage coincides with the prevailing strike of the beds in each district, and does not vary with the subordinate and local irregularities in the strike of the beds. Whence it follows, that the strike of the cleavage in a district is far more constant and regular than the strike of the beds.

In order to present, in a succinct form, the evidence from which the author has deduced this second law respecting slaty cleavage, the observations he made, in various parts of North Wales, of the positions of the planes of bedding and cleavage, are arranged in a table. [See Quart. Jour. Geol., p. 315.]

From the author's observations it appears that the district of North Wales in which the parallelism between the strike of the bedding and cleavage appears in the most marked degree, is all that part of Carnarvonshire which lies north of Tremadoc. Throughout this area, on the south of the Holyhead road, the beds as well as the cleavage plains strike northeast. On the west side of the Snowdon anticlinal, the beds are much tossed about and dip at various angles either northwest or southeast, and the cleavage planes are nearly vertical. On the east side of the anticlinal, the beds dip southeast, and the cleavage dips northwest from 60° to 65°. On the eastern side of the Carnarvonshire synclinal, the beds dip northwest, as does also the cleavage, but at an angle which gradually diminishes as you recede from the Snowdon chain. Thus at the Rhiw Brefder quarries the angle is 55°; at the Diffwys quarries it is 45°, and at Manodmawr 35°. Towards the northern extremity of the county of Carnarvon the strike of the beds changes from northeast to N.N.E., as does also the strike of the cleavage. To the south of Tremadoc the beds change in strike from northeast to east, and the cleavage changes in strike from northeast to E.S.E.

The parallelism in the strike of the planes of bedding and cleavage prevails also, in a marked degree, in the slaty district north of the Dee, and also in the North Berwyns. The common strike of the two planes approaches to east; but it is subject to many local variations; and in

---

* Geol. Trans., ii Ser., vol. iii., p. 68.

† While the author was drawing this conclusion from his observations in Wales, a nearly similar law was announced to the British Association at Cork by Professor Phillips, in the following terms:—"The cleavage planes of the slate rocks of North Wales are always parallel to the main direction of the great anticlinal axis, but are not affected by the small undulations or contortions of these lines. In North Wales they maintain the same direction for fifty miles, not varying more than two or three degrees." [See also, pages 389, 393, 394, of this number.—J. D. D.]

such cases the two planes vary in strike together. The cleavage has a northerly dip at angles varying from 25° to 65°.

In the Barmouth chain the strike of the cleavage is somewhat irregular; but its mean direction is north and south, and its dip is from east 60° to west 60°.

In the district intersected by the great porphyritic eruption of Arenig, Arran Mowddy, &c., the planes of cleavage have lost their original bearings, and are subject to the greatest irregularity both in respect to direction and dip; and the same observation applies to the district of Lower Silurian rocks extending along the Holyhead road between Bryn-y-ddinas and Corwen.

From the circumstance that the position of the planes of cleavage depends, not on the varying position of the beds at each particular spot, but on their main position, the author infers that slaty cleavage cannot have arisen from any power analogous to that of crystallization; and from the almost mathematical regularity with which those planes are arranged, he concludes that they are not the effect of mechanical force or pressure exerted at the moving or upheaving of the rocks.

The author further concludes from his observations, that in those parts of North Wales where the strata are least disturbed, the planes of bedding and cleavage meet at an angle of from 15° to 30°; and hence he infers, that in those cases where, at the time of cleavage, the beds were horizontal, such was also the angle at which the cleavage intersected the bedding (15° to 30°). The author further observed, that in the quarries of North Wales which afford the slate of the best quality, the bedding and cleavage rarely meet at an angle less than 25°, and never less than 20°; and that whenever the angle is less than 20°, the slate is of inferior quality. An increase in the angle at which the planes meet has no injurious effect; for in many instances when the slate is of the best quality, the angle of intersection is 45° and upwards.

9. *On the Salt and Salt Lakes of Algeria;* by H. Fournel, (Ann. des Mines, 1846, ix, 541.)—The extended memoir of M. Fournel gives many interesting details and important deductions with regard to the salt deposits of Algeria. Salt lakes or marshes and streams appear to be innumerable; and besides these, banks and even mountains of salt are met with. The salt is associated with gypsum. The most important deposit is that of the salt mountain near Biskra, where the salt is imbedded in the cretaceous formation. The mines five leagues west of Milah are represented as inexhaustible. The lake Zagrez, which is at least twelve leagues long and two broad, was covered throughout, in April, 1844, with a crust of salt having a glistening surface and looking like ice. The crust which is quite thin in some seasons increases to a foot and finally to more than two feet, towards the middle of the lake. The salt is perfectly white and pure, and of good quality, and the quantity not less than 127 millions of cubic meters. There is a mountain of salt near this lake. Lake *el Mèlah*, in the province of Oran, is another of the same kind, but less extensive.

10. *Volcanic Peak of the Island of Fogo, Cape Verds;* by C. Deville, (Bull. Soc. Geol. de France, 1846, 2d ser., iii, 656.)—The

peak of Fogo is 2790 meters in height. It stands in the centre of a basaltic crater, rising 1000 meters above its base. The enclosing walls extend entire half way around so as to form a semi-circular crest. On the broken side there are numerous scoria cones thrown up at the eruptions of 1785 to 1799, when all that flank of the island was covered with lavas.

Mr. Deville gives many particulars with reference to the island, and presented to the Geological Society of France a topographical chart of it.

11. *Notice of an Example of apparent Drift Furrows dependent on Structure;* by C. B. Adams, State Geologist of Vermont, &c. &c., (communicated for this Journal.)—The attention of geologists having been lately called to the question, whether the grooves and striæ commonly attributed to drift agency may not be due to *structure*,* it may not be improper, in anticipation of the results of the survey of Vermont, to mention an example in which this is undoubtedly the case. Mr. Macintosh, the author of the article which is alluded to, and which was read before the Geological Society of London, particularly suggests that such may be the origin of the examples in the United States described by President Hitchcock, a suggestion, we will venture to add, which must have occasioned much surprise in those who are familiar with these effects of drift agency in the New England States, unless they also may have met with facts of the same nature with those which are the subject of this brief notice.

Not far from the geographical centre of Vermont, in the town of Randolph, on ascending a hill a mile east of the centre village, may be seen a ledge of argillo-mica slate, in which the planes of lamination do not coincide with those of deposit. The former have a direction of north 35° east (true meridian) and a dip of 30° to the north 55° west. The true strata have a direction of north and south with a dip of 65° west, and although much less conspicuous than the cleavage planes, are distinguished without much difficulty by a slight difference of materials, in consequence of which they weather unequally, so as to form shallow grooves with a well rounded excavation of three to six inches wide and an inch deep. The coincidence of the direction of these grooves with the ordinary cases of drift furrows, and their obliquity to the planes of lamination which are obvious to the passing traveller, who may not without special examination recognize the true stratification of the rock, as well as the well rounded excavation of the grooves, due no doubt to the gradual transition in the characters of the strata, combine to present a case of extraordinary resemblance to genuine drift furrows.

It is proper to add that the examination of several hundred examples of rounded, smoothed, striated and furrowed rocks has brought to light only this case, in which *structural grooves* bear any resemblance to those which have resulted solely from an external mechanical force. The suggestion of Mr. Macintosh is therefore plainly incapable of general or even common application, although cases may occur in

* See this Journal, ii Ser., Vol. i, p. 277; and Sir R. I. Murchison's Geology of Russia and the Ural Mountains, Vol. i, p. 566.

which it is worthy of careful attention. Indeed, President Hitchcock has himself* most scrupulously distinguished the drift furrows from those which are due to structure. Sir R. I. Murchison also remarks that "the greater number of the deviously parallel scratches on the worn surface of the hard crystalline rocks of the north, are, in our opinion, clearly *mechanical*, and cannot be connected with structural condition."

III. Zoology.

1. *On the Range of the Beaver in the United States;* by S. B. Buckley, (communicated for this Journal.)—In DeKay's Zoology of the State of New York, it is erroneously stated that the most southern limit of the beaver within the United States is the northern part of the State of New York. There were beaver living among the mountains of North Carolina in the year 1842, where I saw trees newly cut down by them, and I was informed by my guide that he had seen the beaver. This was in Haywood County, a few miles from Waynesville, on the Big Pigeon River,—a wild, rough region, abounding in grand scenery and rarely visited by man, being little known even to the hunters.

2. *On the situation of the Olfactory Sense in the terrestrial tribe of the Gasteropodous Mollusca;* by Joseph Leidy, M.D., (Proceed. Acad. Nat. Sci. of Philadelphia, Dec., 1846, iii, 136.)—While no observer of the habits of the terrestrial Gasteropoda doubts the existence of the sense of smell in them, but on the contrary, asserts positively that it does exist, the anatomist has not hitherto been able to point out its precise seat.

Swammerdam, in his Biblia Naturæ, speaks decidedly of the existence of this sense in Helix pomatia, but offers no conjecture as to its situation. Blumenbach remarks, under the head of Vermes, "Several animals of this class appear to have the sense of smelling: as many land-snails (Helix pomatia, &c.") and afterwards adds, "But the organ of this sense is hitherto unknown; perhaps it may be the stigma thoracicum." Cuvier, in his Mémoire sur la Limace et le Colimaçon, after remarking on the delicacy of this sense, thinks it probable it may reside "dans la peau toute entière, qui a beaucoup de texture d'une membrane pituitaire."

In investigating the anatomy of this tribe of Gasteropodous Mollusca, I detected an organ which appeared to have been entirely neglected, or has escaped the notice of those who have dissected these animals. It is a depression or cul-de-sac, having its orifice beneath the mouth, between the inferior lip and the anterior extremity of the podal disk, and which in many species of different genera is elongated backwards into a blind duct, more or less deep, occupying a situation just above the podal disk within the visceral cavity. In Bulimus fasciatus it extends backwards as far as the tail, and is several times folded upon itself; in Glandina truncata it extends the length of the podal disk; in the various species of Helix it is found from a superficial depression to a sac the length of the podal disk; in Succinea obliqua it is of considerable length; in Limax and Arion it is a superficial depression; in an unde-

* Final Report on the Geology of Massachusetts, p. 385.

termined species of Vaginula, hereafter to be described, I found it half an inch in length, &c.

It is composed of two laminæ; a delicate lining mucous membrane and an external layer, having a whitish or reddish glandular appearance. A large nerve, on each side, from the subœsophageal ganglia, is distributed to its commencement, besides which it receives numerous smaller branches along its course from the same ganglia. Its arterial supply is derived from the cephalic branch of the aorta.

This organ, from its situation, relative size to the degree of perfection of the olfactory sense, as in the carnivorous Glandina truncata, &c., its structure, and nervous supply, I think, is the olfactory organ.*

3. *Description of a new species of Anser;* by GEORGE N. LAWRENCE, (Annals Lyc. Nat. Hist. N. York, iv, 171; read March 16th, 1846.)—*Anser nigricans*, Black-bellied Goose. *Specific character:*—

A large white patch on the middle of the neck in front, and extending on the sides; belly brownish black; bill higher than broad at the base.

Bill black, legs and toes black tinged with flesh color, iris dark hazel; head black, tinged with brownish rufous adjoining the bill, with a dirty white line under the eye; neck and fore part of the breast black; a large white patch on the centre of the neck intermixed with black, except at the lower part, where it forms a distinct band of pure white, it is nearly two inches in width, rounding on each side of the neck and almost meeting behind; belly brownish black, sides brownish ash margined with white; back dark brown, each feather margined with a lighter shade; rump-feathers black; axillars and lower wing-coverts greyish black; tail black, consisting of sixteen feathers; upper and lower tail-coverts white; wings black, extending half an inch beyond the tail; second primary one line longer than the first; third half an inch shorter; vent white.

Length $22\frac{1}{2}$ inches; alar extent 44; bill a little higher than broad, measures along the ridge $1\frac{3}{16}$ inches; from gape $1\frac{3}{8}$; lower mandible $1\frac{1}{4}$; tarsus $2\frac{1}{4}$; middle toe 2; outer $1\frac{7}{8}$; inner $1\frac{1}{2}$; weight 3 pounds.

I have taken the above description and figure from an adult female procured at Egg Harbor, N. J., in January. Since then two others have been obtained at the same place, one of which I have in my possession. On dissection it proves to be a male. It agrees in markings with the female, but is evidently a younger bird, being somewhat lighter in the color of its plumage. From this I infer they become darker by age. It is a little larger than the female, the bill being also stouter, measuring $\frac{7}{8}$ in. high at the base. When on a shooting excursion some years since, at Egg Harbor, I noticed a bird flying at some distance from us, which our gunner said was a Black Brant. This was the first intimation I had of such a bird. Upon further inquiry of him, he informed me he had seen them occasionally, but they were not common.

* Since writing the above, I have had an opportunity, through the kindness of Mr. Cassin, of examining a specimen of Helix pomatia, from Europe, in which I find the organ in question existing as a funnel-shape depression beneath the mouth, and extending backwards along the podal disk for the distance of three-fourths of an inch. This I consider particularly interesting, as the same species has been minutely dissected and described by Swammerdam, Cuvier, and others, without any reference whatever to this cul-de-sac.

I have learned from Mr. Phillip Brasher, who has passed much time at that place, that speaking to the gunners about them, they said they were well known there by the name of Black Brant, and one of them mentioned that he once saw a flock of five or six together.

From these facts it appears to be known to gunners, but has heretofore escaped the notice of ornithologists. With all my inquiries I have not been able to procure a specimen before this winter. I think it a good and well-marked species.

4. *A new species of Procellaria from Florida;* by G. N. Lawrence, (Lyc. Nat. Hist., N. Y., Feb. 8, 1847.)—*Procellaria brevirostris.* Above brownish black; beneath white. Bill short; upper tail coverts white; lower, white tipt with ash, and very long: tarsi pale yellow, marked with black at their ends for two-thirds their length. Length 16 inches; extent 39 inches.

5. *Food of the Mastodon;* by Prof. A. Gray, (Proc. Bost. Soc. Nat. Hist., Nov. 1846, p. 92.)—Prof. Gray stated that there had been recently placed in his hands specimens of earthy matter, filled with finely broken fragments of branches of trees, which were said to have been found occupying the place of the stomach in the skeleton of the Mastodon exhumed on Schooley's Mountain, N. J., and lately exhibited in Boston. As similar observations are said to have been made in several instances, Prof. Gray was induced to examine the substance brought to him. The wood evidently consisted of branchlets of one, two and three years old, broken, quite uniformly, into bits of half an inch or so in length, with only, now and then, traces of the bark remaining on the wood. The wood was not at all fossilized, and was but slightly decayed. From the appearance of the branchlets examined, Prof. Gray inferred that they belonged to some coniferous tree or shrub, and, probably, to a kind of spruce or fir, rather than to a true pine. This inference was borne out by the examination of thin slices of the wood by the microscope. The woody fibre was very beautifully and distinctly marked with the circular discs that are characteristic of all coniferous wood. The structure agreed quite perfectly with that in similar branchlets of the common hemlock spruce.

6. *On the Moose and Carabou, and on the American Raven;* by L. Agassiz, (Proc. Bost. Soc. Nat. Hist, Nov. 1846, p. 187.)—These species differ from the European species, according to Prof. Agassiz, who consequently has named them anew, designating the Moose (Cervus alces) the *C. lobatus;* the Carabou, (C. tarandus,) the *C. hastalis;* the American Raven, *C. lugubris.*

7. *Pyranga roseo-gularis, a new species from Yucatan;* by Dr. Cabot, (Proc. Bost. Soc. Nat. Hist., Dec. 2, 1846, p. 187.)—Male, top of head, outer edge of primaries and secondaries, and surface of greater and lesser wing coverts, the tail and its upper coverts, bright brownish-red. Under side of tail and its under coverts, throat and flexures of wings, bright rose-color. Back and posterior part of cheeks dark brownish ash-color; anterior part of cheeks, breast, and belly, bright ash-colored. Twelve tail feathers. Bill strongly toothed, horn-color at top, lighter beneath. Legs and feet horn-colored. Total length $6\frac{1}{4}$ inches; of bill $\frac{5}{8}$ inch; along the ridge $\frac{6}{8}$; along the gape $\frac{5}{16}$ of an inch; across at base $\frac{3}{8}$ through from above down. Tooth situated at $\frac{1}{4}$ inch

from point of bill. Tarsus rather more than $\frac{3}{4}$ inch in length. Tail $2\frac{6}{8}$ inches long. Wings from flexure $3\frac{1}{8}$ inches.

8. *Pygorynchus Gouldii, a new Echinus from the Millstone Grit of Georgia;* by M. Bouvé, (Proc. Bost. Soc. Nat. Hist., Dec. 1846, p. 192.)—Above, conico-convex, a little more sloping posteriorly than anteriorly. Margin somewhat rounded, except near and under the anus, where by an excavation or depression it becomes acute. Inferior surface sub-circular. Mouth situated about one-third of longitudinal diameter from the anterior margin. Apex sub-central, a little anterior, but not so much so as the mouth. Ambulacra radiating at unequal angles, the interambulacral spaces dividing the three anterior from the two posterior, being wider than the rest. The pores of each diverge considerably from the apex, becoming quite dilated a short distance from it, then converge as they descend, until about two-thirds the distance from the summit to the margin, where they are very limited in width, and where the double rows become single. On the margin they again slightly dilate, and are readily traceable to their termination about the mouth, where they are prominent. The anterior ambulacrum is much narrower than the rest. Anus transverse, and situated at about one-fifth the distance from the posterior margin to the apex. Whole length, as shown by three individuals examined, $1\frac{7}{8}$ inches, greatest width $1\frac{3}{4}$ inches, height 1 inch. Locality, Baker County, Georgia. Description of characters from specimens in Cabinet of the Society.

I have named this beautiful species after my respected friend, Dr. Augustus A. Gould.

IV. Meteorology.

1. *Meteorological Observations at Waioli,* on Kauai, one of the Hawaian Islands: from April 1st, 1845, to March 31st, 1846;* by Edward Johnson, Missionary of the A.B.C.F.M.—(Communicated.)

	FAH. THER.						WINDS.				WEATHER.									
Months and date.	Average at $5\frac{1}{2}$ A. M.	Average at 1 P. M.	Average at $6\frac{1}{2}$ P. M.	Maximum.	Minimum.	Mean.	N. E. Trades, A. M.	N. E. Trades, P. M.	Variable, A. M.	Variable, P. M.	Fair, morning.	Fair, P. M.	Cloudy, A. M.	Cloudy, P. M.	Showers, A. M.	Showers, P. M.	Rain, A. M.	Rain, P. M.	Rain at night.	Rain in inches and tenths.
April, 1845,	66·0	75·0	70·0	82·0	62·0	70·2	21	20	10	11	9	4	4	11	10	9	7	6	17	14·0
May, "	69·6	80·3	74·0	85·0	66·0	74·6	27	27	4	4	11	10	5	4	14	15	1	2	10	6·0
June, "	71·6	82·6	75·0	90·0	66·0	76·4	25	27	5	3	16	17	2	1	10	10	3	3	12	4·6
July, "	72·0	82·0	75·8	86·0	69·0	76·3	30	30	1	1	9	7	7	6	9	16	6	2	21	8·0
August, "	71·6	83·2	76·9	89·0	67·0	77·2	29	29	2	2	19	15	2	5	7	8	3	3	12	5·5
Sept. "	71·4	82·6	76·6	87·0	68·0	76·8	28	27	2	3	16	12	3	4	11	13	0	1	14	5·4
Oct. "	69·6	78·5	73·8	84·0	64·0	74·0	18	16	13	15	11	10	5	3	9	10	6	8	22	18·4
Nov. "	66·7	78·3	72·0	82·0	57·0	72·3	4	4	26	26	22	19	2	4	4	4	2	3	10	5·2
Dec. "	65·2	75·0	69·0	82·0	57·0	69·7	7	7	24	24	18	19	6	5	6	6	1	1	11	5·0
Jan. 1846,	62·0	71·8	67·9	79·0	54·0	67·2	3	3	28	28	18	17	8	8	1	4	4	3	10	4·6
Feb. "	63·3	73·5	68·4	78·0	57·0	68·4	10	10	18	18	16	14	10	10	0	1	2	3	10	3·0
March, "	63·4	75·8	69·5	80·0	56·0	69·5	18	18	13	13	15	14	6	8	4	4	6	5	16	6·6

Remarks.—By an inspection of the above table, it will be seen that the thermometer was noticed three times each day, viz. at 5 o'clock

* Waioli is in about 22° 15′ N. Lat., and about 160° W. Long., from Greenwich.

30m. A. M., and 1 and 6½ o'clock, P. M. It was suspended in an open lanai, in the shade.

The highest point of the thermometer was 90° in the month of June, and the lowest 54° on the mornings of the 10th and 11th of January. On the 11th of August it rose to 113°, placed upon a tin water-gauge in the sun.

It will be seen that the greatest fall of rain in any one month, was in October; which was 18·4 inches. The greatest amount noticed in any one day, was on the 17th of the same month; which was 2·39 inches.

There was a squall with thunder on the 19th of April, in which a native schooner with six foreigners and one islander were lost, and another considerable blow from the N.W. on the 26th of the same month. There was also a light squall on the 1st day of May.

On the 10th of October, there was a gale from the N.W. at night, and on the next evening there was vivid lightning skirting the horizon from north to west.

Nov. 27th, wind strong from westward. Also, strong from N.W. on Feb. 18th and 19th, and on the three last days of March; on which latter days the surf rolled heavily into our bay.

By the "Friend," printed at Honolulu, I learn, that the American whale-ship Luminary was struck by a severe gale from W.N.W., in N. lat. 33°, long. 177° 20′ W., on the afternoon of March 27th, in which a heavy sea was shipped that took off six men from the deck, and mortally wounded another. The ship was so materially injured as to render it necessary to put back to Honolulu for repairs. This disaster occurred between 1 and 2 P. M., and on the morning of the next day the gale reached this place.

The northeast trades have prevailed 219 days out of the 365. These winds purify the air, and render a summer residence, especially in the more sultry parts of the islands, much more agreeable and healthy than it would otherwise be.

Fair days 170. The weather has been more pleasant, for this place, take the year together, and less rain has fallen, than is usual.

In the columns marked fair, cloudy, showers and rain, there is necessarily some error from imperfect estimates. Yet the aim has been to give the prevailing state of the weather each day.

I may here remark that the Sandwich Islands afford every variety of weather according to the position of the place, and its proximity to mountains; the northern and eastern sides being usually rainy and comparatively cool, while the southern and western sides are warm and dry.

All degrees of temperature may here be found, from the ice-clad tops of Mauna Loa and Mauna Kea, to the scorching sun of Honolulu.

The islands are usually considered healthy, yet almost the whole population of the group were visited by a kind of influenza in April, 1845, that continued through the month. Considerable numbers of the natives died from this attack, and in many other cases other diseases appeared to be aggravated, and death was the result.

Waioli, Sandwich Islands, April 20th, 1846.

2. *On the Amount of Rain and Snow at St. Louis for the years* 1837 *to* 1846 *inclusive;* by Dr. G. ENGELMANN, (communicated.)—Mr. Lyell in his interesting essay on the delta of the Mississippi, in the

January number of the American Journal of Science, has requested observers along the Mississippi to furnish data as to the quantity of rain falling during the year in their respective localities. In accordance with this desire, I here give the result of ten years observation at this place.

Quantity of atmospherical water (rain and snow water) which fell at St Louis, from 1837 *to* 1846.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	May, June, July.
1837,	0·97	1·62	2·84	3·27	3·01	4·15	0·89	2·36	2·83	0·42	2·33	2·31	27·00	8·05
1838,	3·72	1·11	1·51	3·36	1·68	3·73	3·13	4·47	0·06	3·06	2·09	0·44	28·36	8·54
1839,	2·21	2·50	2·60	5·46	7·93	7·26	5·71	2·89	2·45	3·96	2·48	2·00	47·45	20·90
1840,	1·80	1·22	2·10	3·31	4·58	6.27	2·36	7·15	3·96	6·30	1·73	0·71	41·49	13·21
1841,	0·84	0·88	4·99	3·85	2·38	1·67	3·09	5·63	3·22	6·81	5·44	3·92	42·72	7·14
1842,	0·45	3·90	2·21	3·58	3·22	5·12	1·76	2·64	2·17	2·57	2·38	1·69	31·69	10·10
1843,	2·34	1·90	3·49	4·87	4·15	3·95	2·49	1·32	2·19	1·55	4·82	1·72	34·79	10·59
1844,	3·36	1·73	4·84	3·86	11·26	6·85	8·13	0·45	0·30	2·25	1·09	1·61	45·73	26·24
1845,	1·83	1·07	3·48	2·26	4·44	9·93	4·75	6·21	1·03	1·16	1·10	0·93	38·19	19·12
1846,	1·98	1·27	1·27	4·84	3·53	5·21	0·84	4·73	4·84	2·72	2·11	10·89	45·23	9·58
Mean of 10 years	2·050	1·720	2·933	3·866	4·618	5·414	3·315	3·785	2·305	3·080	2·557	2·622	38·265	13·347

Number of days on which it rained or snowed in every month, from 1837 *to* 1846.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	May, June, July.
1837,	6	11	6	5	10	10	8	7	8	5	8	6	90	28
1838,	8	11	5	7	6	8	4	7	1	7	9	5	78	18
1839,	9	5	5	9	10	12	9	5	6	7	8	10	95	31
1840,	9	5	8	11	8	9	10	12	5	7	7	3	94	27
1841,	10	6	12	10	4	9	8	4	4	9	9	7	92	21
1842,	3	8	7	10	8	11	10	7	6	5	7	5	87	29
1843,	6	8	10	9	12	8	6	4	9	8	11	7	98	26
1844,	9	8	15	10	16	14	11	3	3	6	6	5	106	41
1845,	5	6	7	11	6	18	6	12	3	4	5	7	90	30
1846,	8	9	9	12	7	11	4	10	9	9	7	10	105	22
Mean of 10 years	7·3	7·7	8·4	9·4	8·7	11·0	7·6	7·1	5·4	6·7	7·7	6·5	93·5	27·3

It will be observed that the quantity of rain in the first two years is smaller than in any of the following, and it may be that the rain-gauge, then employed, was imperfect; I substituted another one for it, which has been in use ever since. June is almost always the wettest month; and from May to July, not only the greatest quantity of rain is precipitated, but also in the heaviest showers during the shortest time. They are mostly thunder-showers, especially from the middle of May to the middle of June, which is our rainy season. These rains occasion the rise of our streams about that time much more than the melting of the snows in the mountains They wash away the loose particles of disintegrated rocks and loose soil, and carry them down towards the Gulf. The quantity of rain precipitated in these thunder-showers, frequently amounts to one and even two inches in the space of twenty or thirty minutes to one hour; but by far the greatest quantity which has fallen at any one time, during this period of ten years, was observed on the 21st August, 1841, when 4·60 inches were collected in 75 minutes, from 1½ to 2¾ P. M.

Observations with reference to the velocity of the current of the Mississippi at this place, the quantity of water passing by during a certain period, and the sedimentary matter suspended in the river water in different seasons, have been undertaken by me, but are not sufficiently advanced to be made public. I may only state, that contrary to the adopted opinion, the velocity of the current of the Mississippi is on an average rather under than over four miles in the hour; and that only at seasons of high water its velocity is increased to over five and even six miles in the hour.

It may not be improper to state here, that the rains of the early summer months have a great and undeniable influence on the health of this region. I have invariably observed that in those seasons when the quantity of rain fallen during the months of May, June and July exceeded a certain amount, say twelve or fifteen inches, the months of August, September and October, but especially September, were rife with all the numberless varieties of intermittents, often of the most malignant character. The tables show that in the years 1839, 1844 and 1845, the number of rainy days in the first named three months were over 30, and the quantity of rain amounted to over 19 inches; when in any of the other seven years, it did not exceed 12 inches. And the autumns of precisely those three years were the most sickly of the whole ten, as the records of our physicians can testify. In the year 1846 on the contrary, when the quantity of rain in the whole year was one of the largest ever observed, and nearly equal to that of 1844, the autumn was comparatively healthy, and the prevailing diseases were of a mild character; and we find in correspondence with this circumstance, and I may say, as the cause of it, the quantity of rain from May to July only 9½ inches.

St. Louis, February 18, 1847.

3. *Meteorological Society in Finland.*—A meteorological association has been lately formed at Helsingfors, as M. Kupffer writes, the principal object of which is to make observations upon the time of flowering and fructification in that high northern latitude. M. Quetelet writing from Brussels on this subject, adds that M. Œrsted recently at that place proposes to establish a similar association (for the observation of periodical phenomena, but especially times of inflorescence) in Denmark.

4. *Auroral Belt.*—A very distinct and brilliant Auroral belt, spanning the heavens from east and west, was seen at various places in the Northern and Middle States, about 10 P. M., April 7, 1847. It lasted from about $9^h\ 40^m$ to $10^h\ 6^m$, and during this time the belt moved southward, the vertex passing from an altitude of about 77° above the N. horizon to an altitude of about 65° above the southern. The width of the belt varied from about 7° at the vertex to 2° or 1° at the extremities. At 10^h, the northern limb touched *Arcturus;* and at this time a westward waving motion began to be noticed in the zone near the meridian. At $10^h\ 6^m$ the zone broke up, revealing within numerous oblique beams. It rallied in part at various times after this, and at $11^h\ 39^m$, a long dim arc could be traced as low down as β and ϵ *Corvi.* Various observations were made here of the precise time when the northern or southern limb touched some bright star; and persons at other places who have secured similar observations, are desired to communicate them. A fuller account may be given hereafter. [New Haven, Ct.] E. C. H.

V. Astronomy.

1. *The new Planet Neptune.*—The planet discovered by Galle, Sept. 23, 1846, in consequence of the indications furnished by LeVerrier, is by the Russian and German astronomers, denominated *Neptune*, in accordance with the first decision of the *Bureau des Longitudes*, and of LeVerrier himself. It seems probable that this name will be generally adopted.

In a communication published in *The Union*, Febr. 9, 1847, Lieut. Maury, Superintendent of the National Observatory, announces that S. C. Walker, Esq., had discussed the observations thus far made on the new planet, on the assumption of a circular orbit. With the approximate elements thus obtained, La Lande's *Histoire Celeste* was examined, in the hope of detecting former observations of the planet. A star of the 7–8th magnitude, observed May 10, 1795, (p. 158, 8th from top) was found to be within 2′ of the computed path of the planet, and not to be contained in Bessel's zones. On the 2d of February, 1847, Mr. Walker notified Lieut. Maury, by letter, of his expectation that the star would not now be seen. Two days after, Professor J. S. Hubbard examined the region in question, and found that this star was actually missing. Mr. Walker then computed the elements of the planet, assuming for the occasion, that it is identical with the missing star. The elements thus obtained, as well as his previous results, will be found below.

On the 16th March, 1847, Prof. Peirce, of Harvard University, communicated to the American Academy of Arts and Sciences, a more extended notice of Mr. Walker's investigations, together with his own highly interesting deductions. This communication has recently been printed, and occupies twelve pages in the *Proceedings* of the Academy. We regret that we cannot introduce the paper entire, but our limited space permits us to give here only the following observations of Prof. Peirce.

"Mr. Walker concludes by remarking that he has stated all the circumstances known to him favorable or unfavorable to the supposition of identity of the star and planet. The decision of the question must be the work of time. In order to establish the priority in determining these elements if the identity should be confirmed, he had computed his Elements III. upon this hypothesis of identity. The three sets of elements are here given, referred to the mean equinox of January 1st, 1847, and to mean time Greenwich.

Elements of Neptune.		Circular Hypothesis. I.	Elliptic Hypothesis. II.	Elements if the missing star was Neptune. Elliptic Hypothesis. III.
Longitude of perihelion,	π	unknown	unknown	0° 12′ 25″·51
" " ascend. node,	Ω	129° 48′ 23″·16	129° 48′ 23″·16	131° 17′ 35″·80
Inclination.	i	1° 45′ 19″·88	1° 45′ 19″·88	1° 54′ 53″ 83
Long. of epoch, Jan. 1, 1847,	ϵ	unknown	unknown	328° 7′ 56″·64
True heliocentric long. on orbit, Sept. 28, 1847,	w	326° 59′ 41″·50	326° 59′ 34″·74	326° 59′ 34″·74
Eccentricity,	e	0·	unknown	0·0038407
Radius vector, Sept. 28, 1847,	r	29·93995	30·00506	30·02596
True sid. orb mot., "	n	21″·65857	21″·65789	21″ 64553
Mean distance,		29·93995	30·200585	30·25042
Mean daily sidereal motion,	μ	21″·65857	21″·37881	21″·32600
Period in tropical years,	T	163y·8259	165y·97030	166y·38134

"Professor Peirce remarked, that the orbits given by Mr. Walker differ so widely from the predictions, that he has been induced to make a careful reëxamination of the observations. He has not only himself verified Mr. Walker's distance of 30, and the consequent angular motion; but Mr. George P. Bond, of the Cambridge Observatory, has also, at his request, verified this distance and motion from the Cambridge observations alone. From these data, without any hypothesis in regard to the character of the orbit, he has arrived at the conclusion, that *the planet Neptune is not the planet to which geometrical analysis had directed the telescope;* its orbit is not contained within the limits of space which have been explored by geometers searching for the source of the disturbances of Uranus; and its discovery by Galle must be regarded as a happy accident. Mr. Adams, in his "Explanation of the Observed Irregularities of Uranus," considered two hypothetical orbits, in one of which the mean distance is 38·4, or just double that of Uranus, and in the other it is 37·6; while M. LeVerrier, in his "Researches into the Motions of the Planet Herschel, called Uranus," after deriving some rough approximations from the consideration of the mean distance 38·4, proceeds to the accurate examination of the three distances 39·1, 37·6, and 36·2. The extension of the investigations to any other mean distances can be made only by assuming a continuous law to pervade the subject of inquiry, and that there is no important change in the character of the resulting perturbations. Guided by this principle, well established, and legitimate, if confined within proper limits, M. LeVerrier narrowed with consummate skill the field of research, and arrived at two fundamental propositions, namely,—

"1st. That the mean distance of the planet cannot be less than 35, or more than 37·9. The corresponding limits of the time of sidereal revolution are about 207 and 233 years.

"2d. 'That there is only one region in which the disturbing planet can be placed, in order to account for the motions of Uranus; that the mean longitude of this planet must have been, on January 1st, 1800, between 243° and 252°.'

"Neither of these propositions is of itself necessarily opposed to the observations which have been made upon Neptune, but the two combined are decidedly inconsistent with observation. It is impossible to find an orbit, which, satisfying the observed distance and motion, is subject at the same time to both of these propositions, or even approximately subject to them. If, for instance, a mean longitude and time of revolution are adopted according with the first, the corresponding mean longitude in 1800 must have been at least 40° distant from the limits of the second proposition. And again, if the planet is assumed to have had in 1800 a mean longitude near the limits of the second proposition, the corresponding time of revolution with which its motions satisfy the present observations cannot exceed 170 years, and must therefore be about 40 years less than the limits of the first proposition. Neptune cannot, then, be the planet of M. LeVerrier's theory, and cannot account for the observed perturbations of Uranus, under the form of the inequalities involved in his analysis.

"It is not, however, a necessary conclusion that Neptune will not account for the perturbations of Uranus, for its probable mean distance of about 30 is so much less than the limits of the previous researches, that no inference from them can be safely extended to it. An important change, indeed, in the character of the perturbations takes place near the distance 35·3; so that the continuous law by which such inferences are justified is abruptly broken at this point, and it was hence an oversight in M. LeVerrier to extend his inner limit to the distance 35. A planet at the distance 35·3 would revolve about the sun in 210 years, which is exactly two and a half times the period of the revolution of Uranus. Now, if the times of revolution of two planets were exactly as 2 to 5, the effects of their mutual influence would be peculiar and complicated, and even a near approach to this ratio gives rise to those remarkable irregularities of motion which are exhibited in Jupiter and Saturn, and which greatly perplexed geometers until they were traced to their origin by Laplace. This distance of 35·3, then, is a complete barrier to any logical deduction, and the investigations with regard to the outer space cannot be extended to the interior."

2. *New Comet*, (Proceed. Amer. Acad.)—A telescopic comet was discovered near the star 18 Andromedæ, on the evening of March 4, 1847, by Mr. Geo. P. Bond, at the Observatory in Cambridge, Mass. Its place March $4^d\ 8^h\ 40^m\ 09^s$, was R. A. $23^h\ 35^m\ 50^s{\cdot}5$, and decl. $+50°\ 1'\ 46''$, referred to mean equin., Jan. 1, 1847. It was quite bright, and nearly visible to the naked eye. On the 8th inst. it was visible to the eye as a star of the 5th or 6th magnitude. The elements of this comet have been computed (1) by Prof. Peirce from places of March 4, 5, 6, and (2) by Mr. Geo. P. Bond, from places of March 5, 12, 19, the latter taking into account the small corrections.

	(1.)	(2.)
Per. pass.	Mch. 31·907 Gr. m. s. t.	Mch. 30·3369
dist.	0·04444	0·0445986
Long. of asc. node,	10° 13′	21° 06′ 46″
" perihelion,	256 33	275 16 22
Inclination,	48 53	48 41 49
Motion,	direct,	direct.

This comet is supposed to be identical with that detected Feb. 6, 1847, in *Cepheus*, by Mr. J. R. Hind, at London.

3. *Expected Return of the Comet of* 1556.—We are indebted to John Taylor, Esq., of Liverpool, for several interesting astronomical notices published by him during the past year in the public prints of that city. Most of them relate to subjects which have already been brought forward in this Journal; but we have not hitherto referred to the approaching expected return of the comet of 1556, with the discussion of which one of these notices is occupied. As long since as 1751, Mr. Richard Dunthorne, of Cambridge, on computing the elements of the comet of 1264, found them so similar to those of the comet of 1556, that he was led to the conclusion that the two were identical, and that its return might be expected about 1848. Subsequent investigations which have been made by different astronomers, confirm this conclusion; and there is, therefore, good reason to look for the reappearance of this comet during the year 1848, although it would not be surprising if this event should happen even a year earlier or later than this date.

4. *Parallax of a Fixed Star in Ursa Major*, (Comp. Ren., Aug. 31 and Dec. 7, 1846.)—A star of the 7th magnitude, No. 1830 of Groombridge's Circumpolar Catalogue, has according to Argelander a proper motion of seven seconds of arc per annum, which is greater than that hitherto recognized in any other star. M. Faye, of Paris, by a course of careful observations on the positions of this star with reference to a star of 9–10th magnitude, (whose R. A. is about 30′ greater, and declination about 40″ less)—assuming, on good grounds, that the parallax of the latter is nearly or quite insensible—has determined in a manner which appears quite satisfactory, that the parallax of the former (viz. 1830 Groombridge) is 1″·06. The distance of this star from our sun is, therefore, about 195000 times the radius of the earth's orbit;—a space which would require three years for light to traverse.

5. *Planetary Nebulous Masses near the Sun.*—It is well known that in total eclipses of the sun, there have been often seen conical protuberances of a red color, projecting from behind the disc of the moon. This phenomenon was very conspicuous in the total solar eclipse of July 8, 1842,* and M. Arago has collected many cases of the same kind and printed them in the *Annuaire* for 1846. M. Babinet has published a memoir on these phenomena,† in which he explains them by the supposition, that there are very near the sun, planetary masses, revolving around that body with great rapidity. These incandescent, flame-red, vapory masses, having the form of circular trains more or less elongated, with the sun for their centre, cause the different appearances, which are mentioned in the accounts of total solar eclipses, as *fiery mountains*, *sheafs of flames*, &c. The greatest elongation hitherto observed in any of these bodies is 5′, which would show that this one must revolve around the sun in about four hours.

This hypothesis, although ingeniously supported by M. Babinet, is open to objection, and many more observations will be needed before it can be considered as any thing more than plausible.

VI. Miscellaneous Intelligence.

1. *Relative Level of Lake Ontario;* by C. Dewey.—In 1845, from June 1st to December 31st, the water of this lake *fell two feet and three inches.* Observations on the level have been continued through 1846, which show that the water gradually rose from February to June, *fifteen* inches, though it was then fifteen inches lower than in June, 1845. From July it gradually fell to November, when it was *two feet* lower than in June, 1845, while it was about the same level as in November, 1845. Through November, owing to the fall rains, it gradually rose, but at the end of 1846, it was the same as in December of the previous year, at least two feet lower than in the summer of the year before.

The difference in the quantity of water that falls in snow and rain, must account for the fall of the lake. The water is below its usual level through all the great lakes to Lake Superior.

2. *Inhalation of Ether in Surgery.*—This new discovery, which promises to relieve the world to a great extent of pain in surgery, has

* See Baily and Airy, Trans. Astr. Soc., Vol. xv, pp. 1, 9.

† Comptes Rendus, Feb. 16, 1846, pp. 281–286, 4to.

found much favor abroad, and we give the following from among the testimonials which have reached us. It is cited from the Athenæum, for Jan. 30, 1847, and credited by this paper to the Lancet, Jan. 16 and 23, the Medical Gazette, Jan. 22, and Medical Times, Jan. 16 and 23.

The practicability and utility of the American discovery of the employment of the vapor of ether in surgical operations is no longer a matter of doubt. Since our first notice of the subject, hundreds of operations have been performed in this country without pain. We would point out, incidentally, the very different nature of the evidence on which we pronounce the verdict of success, from that of the testimony brought forward to support the claim of Mesmerism to be regarded as a means of making surgical operations painless. We allude to this because we see that those who still amuse themselves with mesmeric phantasies regard the state induced by the action of ether as analogous to the mesmeric sleep. Surely, it must by this time be evident to all but prejudiced observers, that had there been a particle of truth in the allegation of painless operation under the influence of mesmeric sleep, medical professors would most gladly have availed themselves of its services.

To return, however, to the ether. The inhalation of gases as a means of treating disease is, it appears, not new in the medical profession. It was carried to a great extent by Dr. Beddoes; but has been comparatively little employed in the recent practice of medicine and surgery. That such gases produced various powerful effects on the nervous system has also been well known: and to this day it is a common practice in our chemical lecture-rooms to administer, by way of amusement to the pupils, nitrous oxyd, or laughing gas, on account of its influence on the nervous system. It has also been known for a length of time, that the vapor of ether, when taken into the system, produces an effect upon the nervous system which has been stated to be analogous to the action of the laughing gas. This, however, is now seen to be a mistake; as the amusing influence of the laughing gas is found to arise out of its action on that system of nerves which supply the muscles of the body—occasioning an increase of their activity; so that persons who have breathed it have a tendency to running, jumping, fighting, laughing, and other motions of the muscular system. The action of ether, on the other hand, is chiefly manifested by its influence on those nerves which are devoted to the function of sensation.

For the application of the vapor of ether to the human system for the purpose of producing insensibility we are indebted to Doctors Morton and Jackson,* of Boston, in the United States; and we believe we may congratulate these gentlemen on having made the most important discovery which has been contributed to medicine since that of vaccination by Jenner. The medical journals quoted at the head of this article report a large number of cases which sufficiently attest the value of this agent—not only in the minor operations of surgery, such as the extraction of teeth,—but also in the most tedious and distressing, and those involving the greatest amount of danger from the shock given to

* Dr. Morton, whose name is here mentioned, received his first information on the subject from Dr. Jackson.

the nervous system. Mr. Lawrence gives an account of one which he characterizes as "one of the most painful surgical operations,"—and which consisted in extirpating the eye-ball for the cure of malignant disease. This was performed with so little pain, that the patient, after recovering from the effects of the ether, did not even know that the operation had commenced.

At the same time that the success of this application has been far greater than could have been anticipated, there have, however, been failures; which prove the necessity of attention on the part of those who employ it. The mode of administering the ether hitherto adopted has been that of introducing into the lungs, by means of a tube, the vapor of sulphuric ether mixed with atmospheric air. Now, although at first sight this would seem a very simple process, there are several points which appear to require attention. In the first place, the apparatus may be so imperfectly constructed, or persons may so mismanage it, that too large or too small a quantity of vapor will be supplied to the system. In the first of the cases, the patient becomes choked—in the last, he does not take a sufficient quantity to produce the effect sought. In the second place, atmospheric air becomes saturated with very different quantities of the vapor of ether at different temperatures. Thus, 100 cubic inches of air saturated with ether at 40°, contain 24 cubic inches of ether; but the same quantity of air at 70° contains 49 cubic inches of the same. This demands attention: but the proper temperature of the room for the best success may be easily ascertained, and regulated with a little care. Another point which may interfere with the action of ether, is the presence of alcohol. Ether is formed from the decomposition of alcohol by sulphuric acid: and unless great care be exercised in its preparation, this substance will be present; and the commercial ether is often largely adulterated with alcohol. The effect of the vapor of alcohol is very different from that of ether—if it be not in the early stages of its action of a directly opposite nature. A fourth point demanding caution, arises from the peculiarly inflammable nature of etherous vapor. Should this agent be employed by careless persons during candle light, it may, from its highly inflammable nature, explode; and from the consequences of that explosion it does not appear evident that the person breathing the vapor would escape—although we have heard of no accident of this kind at present.

The effect of the vapor of ether upon the system seems to be the same as that of an overpowering quantity of alcohol; and as a proof that the effects are the same under other influences, Mr. Lawrence relates a case in which he performed amputation of the leg upon a woman who was intoxicated, and who knew nothing of the matter until she became sober. There is, however, this difference between the action of alcohol and that of the vapor of ether—that with the former the stage of insensibility is preceded by a stage of nervous and vascular excitement, whilst in the latter the insensible state comes on almost immediately. In the numerous cases which have been reported, the ether appears to have had different effects upon the nervous system;—and this has probably been owing to the quantities of the vapor inhaled. Thus, in several cases the effect has been to deprive the patients of the power of feeling and moving; but they have been conscious all the time, and have witnessed every step of the operation performed on them—though without experiencing pain. In one case, this was rather ludicrously illustrated:—the patient during the operation "giving sly winks and facetious nods to those surrounding him. During the intervals of the inhalation his observations were of the most facetious character—forcing from the bystanders involuntary laughter, and converting that which was to the poor fellow a most tragic event into a scene little short of a farce." In other cases, consciousness is less evident, —but not wholly extinguished. One person during the extraction of a tooth imagined that he was contending with a wild beast—which he thought he had overcome when the tooth was extracted. Another, during the amputation of her leg, "thought she had been in a dream; and that we had hurt her leg to see if she could bear the operation which was to be performed the next day." In the majority of cases, however,—and these probably where the ether has been most adroitly administered,—there has been a total loss of consciousness; and the patients on waking up from the slumber produced, have expressed their surprise not only at the operation being over, but at the apparently short time which it has occupied. Thus, in the operation related by Mr. Lawrence, the patient "expressed a fear that he had not had enough of the ether to produce the desired effect. When told that the operation had been performed, he said—'Operation! operation!—what operation?'—and seemed quite puzzled." This is, undoubtedly, the most desirable state to produce.

The question will now occur—"Are any ill effects to be apprehended from the action of this new agent?" As far as we have seen, or been able to inquire, no after consequences have occurred to occasion any fears where the vapor has been administered with proper precautions by an intelligent medical practitioner. Although the effects on the system may be compared to those of a large dose of alcohol, comparatively little of the excitement and consequent exhaustion dependent on the administration of the latter agent are felt with the ether:—so that no patient need have any hesitation in taking it.

There is another interesting field for inquiry to the medical man in relation to the use of ether; and that is in diseases of the nervous system. We cannot but think that an agent so powerful might be applied with success in arresting some of those diseases of that system in which narcotics are found beneficial; and if not capable of curing, it might at least assist the cure by relieving pain.—We have felt it our duty to give our readers this sketch of the history and action of this new remedial agent: in order, on the one hand, to prevent accidents and failure by its use in the management of unskilful persons—and on the other, to remove any unnecessary doubts or alarm which might be felt by those who would seek relief through its employment.

3. *On the Nile;* by Dr. C. T. Beke, (Geograph. Soc., Dec. 28 and Jan. 11.—Athen., Nos. 1001 and 1004.)—The obscurity which has so long hung over the sources of the Nile, is, to a great extent, dissipated by the trouble which Dr. Beke has taken to clear up the ambiguities of conflicting statements, and re-establish facts long misunderstood. A careful sifting of the writings of both ancient and modern travellers in

regard to the sources of the Nile, together with his own intimate acquaintance with the country watered by a great number of the primitive tributaries of the great river, have enabled him to unravel the entanglement which obscured the subject, and to present a statement so clear and satisfactory as to leave little labor for future investigators. The Doctor first ascends the Takazie—the Artoborus of Ptolemy—and minutely describes its various affluents: after which, coming back to the Nile, he ascends it to the junction of the Blue and White Rivers. Going up the Bahr el Azrek, or Blue River, he comes to a spot where M. Caillaud speaks of the Hessen as coming from the S.E.—which Dr. Beke proves to be the Abaï of Abyssinia; and he, at the same time, shows that the river described by Mr. Russegger as the upper course of Bahr el Azrek, is in fact the Dedhesa,—a stream first made known by Dr. Beke, and which he now identifies with the Takui, described by De Barras as the great western arm of the Nile; under which name the Portuguese understood the Blue River,—since the White River, or Bahr el Abiadh, was entirely unknown to them. After describing all the affluents of the Abaï on both sides, Dr. Beke notices a new river which has of late years appeared in the maps under the name of Habahia,—and which has been supposed by some geographers to be either the upper course of the Kilimaney (Quilimané) or of the Bahr el Abiadh; but which Dr. Beke shows clearly to have no separate existence—it being in fact nothing but the Abaï of Abyssinia, called by the Gongas Abbaya. Dr. Beke next discusses the subject of the Maleg—a river which was crossed by Fernandes, in 1613, on his way to Guárea; and shows that the route taken by the Jesuit missionary has been altogether misunderstood by Bruce. Leaving the Abaï, the Doctor next takes up the Dedhesa; and enumerates its tributaries on both sides,—as he had done with the other great rivers, the Takazie and the Abaï. Having thus exhausted the hydrographic basin of the Blue River, the author, before commencing the particular investigation of the course of the White River, enters into a comparison of the two great arms of the Nile—the White and Blue Rivers: and, after minutely examining the evidence, both ancient and modern, on the subject, concludes in these words: "Thus, whether we consider the relative magnitude of the two rivers, the direction of their respective beds, or the volume of their waters—whether we regard the opinions of the ancient geographers, or those of modern travellers, or of natives acquainted with *both* streams (for the evidence of such as only know one is of course inadmissable) the result is the same. In all and every of these points of view, the Bahr el Abiadh, or White River, is the principal stream—and the Bahr el Azrek, the subordinate or affluent."

The author now took up the White River, or main stream of the Nile. Our knowledge of the upper course of this river has been obtained from the exploring expeditions ordered by the present ruler of Egypt. On its right bank it receives, in about the 9th parallel, a large river called the Telfi or Sobat,—which Dr. Beke identifies with the Godjeb; and he then enters into a minute detail of the affluents of this river on both sides. Among these, it will be sufficient to allude to the Baro and Bako, which join it on the right side, and the various streams bearing the common name of Gibbi, which fall into it on the left bank. The Godjeb has been presumed to be the upper portion of the Jub or Gowind, which falls into the Indian Ocean near the line; but subsequent information shows this opinion, which originated in Dr. Beke's own information, to be untenable: indeed, M. D'Abbadie positively considers it to be the head of the Nile. The second Egyptian expedition ascended the main stream of the Nile as far as 4° 42′ 42″ N.—at which point our positive information ceases; but from the information collected by M. d'Arnaud and M. Werne, who accompanied the expedition, Dr. Beke shows the existence of another great arm of the Nile, called the Shoa Berri; which, like the Abaï and Godjeb, joins the main stream from the S.E., and exhibits the remarkable spiral course common to those rivers, with many others of the Abyssinian plateau. As regards the main stream, Dr. Beke, from a comparison of various authorities, both ancient and modern, carries the Nile up to the country Mono-Moëzi; and, in fact, shows the great probability of its being a continuation of Lake N'Yassi, the Maravi or Zambezi of the old maps. In the name Mono-Moëzi, Dr. Beke finds the origin of the name Mountains of the Moon; in which, according to Ptolemy, the Nile has its rise: the word Moëzi meaning *moon* in the language of that country, as well as in those of the whole of Central Africa. The author next proceeds to consider the physical character of the country in which the eastern tributaries of the Nile have their origin; and which he shows to be an elevated table-land, having an abrupt declivity towards the sea-coast, and a very gradual slope landwards down to the Nile, which skirts its base; and the ridge of which has an elevation of from 8,000 to 9,000 feet above the ocean, independent of isolated mountain masses which attain a height of from 11,000 to 15,000 feet.

4. *Water raised by Waves through Valved Tubes*, (Athen., No. 1001.)—A feasible and obvious application of Harvey's grand discovery of the use of valves in raising the blood through the veins, has just been suggested by a correspondent of the *Mechanics' Magazine;* namely, the raising of water from the sea, by the lash of the waves through valved tubes into reservoirs on a high level,—for the acquisition, of course, of an unlimited supply of water power, to be turned to any requisite purpose. The inventor proposes to test the practicability of this kind of Water-Ram on Southsea Beach.

5. *Electric Telegraph;* Fact *v.* Fancy, (Athen., No. 1001.)—A passage in No. 241 of the "Spectator," offers a curious example of a matter treated by an enlightened writer of the time as a piece of fabulous extravagance, yet more than realized in one of the most extraordinary applications of modern science:—"Strada, in one of his prolusions, gives an account of a chimerical correspondence between two friends by the help of a certain loadstone,—which had such virtue in it that if touched by two several needles, when one of the needles so touched began to move, the other, though at ever so great a distance, moved at the same time and in the same manner. He tells us that two friends, being each of them possessed of these needles, made a kind of dial-plate, inscribing it with twenty-four letters—in the same manner as the hours of the day are marked upon the ordinary dial-plate. They then fixed one of the needles on each of these plates in such a manner that it could move round without impediment, so as to touch any of the

twenty-four letters. Upon their separating from one another into distant countries, they agreed to withdraw themselves punctually into their closets at a certain hour of the day, and to converse with one another by means of this invention. Accordingly, when they were some hundred miles asunder, each of them shut himself up in his closet at the time appointed, and immediately cast his eye upon his dial-plate. If he had a mind to write any thing to his friend, he directed his needle to every letter that formed the words that he had occasion for—making a little pause at the end of every word or sentence, to avoid confusion. The friend, in the meanwhile, saw his own sympathetic needle, moving of itself to every letter which that of his correspondent pointed at. By this means, they talked together across a whole continent and conveyed their thoughts to one another, in an instant, over cities or mountains, seas or deserts."

6. *Dilatation of Ice;* (Proc. of the Acad. Sci. at St. Petersburg; L'Institut, No. 680, Jan. 13, 1847.)—Heinrich, in 1807, determined by direct experiment, that the coefficient of dilatation for ice was 0·00245, or $\frac{1}{408}$ its length, between 0° and 80° R. This result has been adopted in the interesting researches on glaciers, by Agassiz, Forbes, and others. Under the direction of M. Struve, recent experiments have been made with great care by Lieut. Schumacher of Denmark, (then at Pulkova.) They embraced one hundred and fifty three measurements, between the 11th of February and 24th of March, 1845, for all temperatures from −1° to −22° R., and from degree to degree. The observations were divided into three series; and the mean of the three afford for the linear dilatation of ice between 0 and 80° R. $\frac{1}{191}$, which is more than double that obtained at Ratisbonne. It has also been found that between the temperatures stated, the dilatation is perfectly uniform.

7. *Measure of a Degree of a Meridian in Finland*, (Proc. of the Acad. Sci. of St. Petersburg; L'Institut, No. 681, Jan. 20, 1847.)—The measure of a degree of the meridian in Finland between the island of Hochland and Torneo is finally terminated after fourteen years of severe labor. The chief merit of the great work is due to M. Woldstedt, who has had almost the sole charge since 1836, and has consequently devoted to it ten years of his life. At Torneo, they met the Swedish savants charged by government with an examination of the country between Pahtawara and Laponia and the frontier of Norwegian Finmark. They have already completed their triangulation to Kautokeino, and will soon begin a second line and extend along the coast of Norway between Kautokeino and the North Cape.

8. *Middendorf's Siberian Explorations.*—M. Middendorf, aided by learned friends, is actively engaged with the account of his important expedition, and the Academy of Sciences has been charged to advise as to the means and style of publication.

M. Keyserling is occupied with the fossils collected on the late Siberian expedition under Middendorf.

9. *Bear River Springs, Rocky Mountains*, (Expl. Exped. of Capt. Fremont, and this volume, page 198.)—The temperature of the Beer springs, as observed by Capt. Fremont, was 65° F., at sunset, that of the air being 62°·5. The elevation above the Gulf of Mexico was 5840

feet, or about 500 feet lower than the Boiling springs which are of a similar nature at the foot of Pike's peak on the Fontaine-qui-bouit. On the morning of the next day, (July 26,) the temperature of the large Beer spring was 56°, and that of the Steamboat spring 87°; and that of the steam hole, near it, 81°·5. Farther south on the great salt lake, about seven miles from Clear creek, ten or twelve hot saline springs were observed by Capt. Fremont, in one of which the thermometer stood at 136° and in another at 132°·5.

10. *Chalk and Coal Fires*, (Athen., No. 1001.)—The practical utility of chalk as an article of fuel has been tested within the last few weeks, according to a Salisbury paper, and with the most satisfactory results. Surrounded with coal, it gives a strong heat, and a clear fire, at half the usual expense; so that to the poor, in the chalk districts, it must be an invaluable boon.

11. *Paris Academy of Sciences.*—The following vacancies occasioned by death have lately been filled: M. Fontanier, the French consul at Singapore, has been elected in place of Dubois-Aymé; Panofka of Berlin, in place of Ideler; M. Faye, the Astronomer, in place of Damoiseau.

12. *A Society of Naturalists* has been formed at Trieste, with special reference to the zoology of the Adriatic. Count Odonel has been appointed President.

13. *New Appointments to Professorships in Harvard and Yale.*—Mr. E. N. Horsford has been elected to fill the chair of the Rumford Professorship of Science applied to the Arts, in Harvard University, and Prof. Jeffries Wyman, M.D., has been chosen Hersey Professor of Comparative Anatomy in the same Institution.

Mr. John P. Norton has been appointed Professor of Agricultural Chemistry and of Vegetable and Animal Physiology, in Yale, and B. Silliman, Jr., Professor of Chemistry applied to the Arts.

14. *Deviation of a Falling Body.*—In the remarks on the *deviation of a falling body to the south*, in our last number, it was not considered that the deviation to be accounted for, is that south from a plumb line. The cause there assigned, viz. the earth's rotation, makes the plumb itself deviate to the south of the line of the earth's attraction, as much as the falling body.

Corrections.—We have been informed by Dr. Engelmann, that since the publication of his notice of the Melonites (p. 124), he has ascertained that Dr. Prout first directed Dr. Brown's attention to the locality mentioned, and the latter discovered the fine slab now in possession of the Academy.

In the figure of the Marsileæ of North America, page 55, of this volume, the body of the capsule of fig. 1, should have been represented as more connected with the stipe so as to make the raphe much longer. All the figures are twice not *half* the natural size.

On page 299, in the notice of Dr. Peter's work on Urinary Calculi, "Pennsylvania" is inserted incorrectly for "Transylvania."

In Volume i, of this series, page 427, under "Electric Excitement of Paper," the word *stove* should be substituted for stone.

15. Obituary.—*Dr. Amos Binney.*—Science has been called upon to lament the loss of one of her most zealous and efficient votaries in America, Dr. Amos Binney of Boston. In New England especially his aid and influence were preëminent.

After concluding his college course at Brown University, he studied Medicine, but never entered upon its practice, his relations in life and his tastes leading him rather to mercantile pursuits, which he prosecuted successfully.

He early manifested a love for natural science, and was one of the first who cultivated the branches of Mineralogy and Conchology among us. But his general researches extended over the whole field of Natural History. He was one of the founders of the Boston Society of Natural History, and his large and valuable collections of minerals and shells formed the basis of its Cabinet. At the time of his death he was its President, and was also chosen to preside over the "Association of American Geologists and Naturalists," at the coming meeting to be holden in Boston in September next.

He contributed several papers on Conchology to the "Boston Journal of Natural History," a work which was modelled under his direction. For several years he had been engaged in a work on the Terrestrial Mollusks of the United States, which he had not quite completed; but which is believed to be in such a state as to be readily terminated by some other hand. To render this work as complete as possible, he had employed a skillful collector for two winters in exploring Florida and the Southwestern States, including Texas. He intended that in fullness of detail and in beauty and accuracy of execution, it should not be surpassed by any other work.

He had amassed what he regarded as a competency, and intended to devote his future days more especially to scientific pursuits. His health having become enfeebled during the last summer, he resolved on a tour to Europe for the double purpose of regaining his health and of visiting scientific men and collections, and also of enlarging his library, already the most valuable private library of Natural Science in America. He sailed for Europe in November last; but his malady rapidly gained the ascendancy over him, and he died at Rome, Feb. 18th, aged forty-three years.

His loss will be felt with peculiar severity by his fellow laborers in the common cause in Boston, where from his wealth, liberality and knowledge of human nature, his influence—always on the right side—was very great.

16. *Bory de St. Vincent*, a military officer of distinction, and also a name well known in science for his various contributions, has lately died in the 66th year of his age.

VII. Bibliography.

1. *Eulogy on John Pickering, LL.D., President of the American Academy of Arts and Sciences, delivered before the Academy*, Oct. 28, 1846. pp. 106. Cambridge University Press.—Never was an eloquent and glowing tribute of admiration and affection to the memory of a great and excellent man better deserved than in the present instance.

It is a beautiful biographical eulogy, replete with interesting facts, relating to the life and labors and achievements of a scholar who has not had his superior, if his equal, in this land; of a jurist and counsellor of a high order of talent and learning; of a patriot and philanthropist whose efforts and aspirations were indeed first for his country and next for his race—with a purity and perseverance never surpassed; and finally, his moral and social character in all the relations of life presents a noble example for the imitation of youth and age.

Judge White has presented his subject with the chastened elegance and dignity of style and composition which, as a scholar of a high order, he never fails to do when he appears as a writer. His fine classical eulogy upon the late Dr. Bowditch is still fresh in our recollection—and the names of BOWDITCH, PICKERING, STORY, and SALTONSTALL, are honor enough for the good old town of Salem, although she can present others of no small celebrity among both the living and the dead.

The eulogium of Judge White upon the late Dr. Bowditch* called forth from us the following remarks. "The eulogium of Judge White is a delightful composition, replete with eloquence and literary beauty, and warm with affectionate respect for the great man whom it commemorates. Being the production of a townsman and cotemporary, it presents graphic sketches of his life and character both in the forming and mature stages, and does equal honor to the head and heart of the writer and to his noble subject." All this is strictly true in the case of Mr. Pickering. In this brief notice it is impossible to say anything definite of his wonderful labors. They fill us with astonishment, not to say with self-reproach, when we see how much was done and well done by this extraordinary man within the allotted period of human life, for he died in his 70th year. We will venture to present the following extract of a letter from a mutual friend, himself a man of high attainments in science and arts. It is dated Aug. 23, 1846, in reply to one from the senior editor.

"It has been your good fortune to have known and been connected with the 'good of old,' and to have enjoyed the society of their descendants—a rare privilege. You could therefore better judge, whether the noble traits in the character of the father† had been diminished in their transmission to the son. I think that those who did not daily mix their walks with his walks would not form a sufficiently high estimation of his character, as a man and influential member of society. His reputation was more decidedly European than American. The studies of his later years called forth the exercise of the highest powers of intellect; yet he went to his books for relaxation, and while incessantly engaged and overtasking his physical strength, always spoke of them as affording amusement. Lepsius addressed him from the foot of the pyramid of Cheops on abstruse points in the Egyptian dynasty history, and he replied with the promptness of one whose knowledge was at instant command. He, in his last hours, was much excited by any new fact, or inferences growing out of investigation now in progress in Egypt, and seemed to feel that a flood of light would soon burst upon us from that quarter. I have for many years enjoyed a familiar intimacy with him, and the great advantage of knowing through him interesting details in connection with his prospects. A few weeks before his death, he placed in my hands papyri from Thebes, which he

---

* Am. Jour., Vol. xxxv, p. 386.

† The late Col. Timothy Pickering, a companion of Washington in the war of the Revolution and the first Secretary of State under the constitution during the administration of Washington, at Philadelphia.

wished unrolled, as he considered, from the ancient language in which they were written, that they might be important."

We presume they were the papyri mentioned by Judge White, which proved to be an Egyptian deed of land in Thebes, duly signed, sealed and recorded in the Greek language.

2. *Botany of the Northern States.*—Prof. A. GRAY, of Cambridge, will publish in a few days, a Manual of Botany of the Northern States, extending to Ohio and Wisconsin. This work, of which we have had a glance whilst passing through the press, will prove an invaluable acquisition to all students of our indigenous plants. On the one hand, the language employed is so studiously simple and popular as to be almost divested of technicality; whilst on the other, it is as rigidly exact and scientific as the more elaborate works of the well-known author. It has the further great recommendation of being so compendious and portable, that it may be carried in the pocket, for reference in the fields. In schools and colleges, where "The Botanical Text-Book" of Prof. Gray is now becoming generally introduced, this Manual, its indispensable accompaniment, cannot fail to be appreciated alike by teachers and students; as the succinct descriptions of all the wild plants, upon the system and classification of the Text-Book, will at all times enable the learner practically to apply its scientific principles for himself.

3. *Palæontology of New York;* by JAMES HALL.—The sheets of the first volume of Mr. Hall's Report on the Palæontology of New York, have reached us at a late hour, and we have barely space to announce the publication of this important work. It has been looked for with much interest, and we believe that its high character will fully satisfy the expectations that have been excited by the distinguished reputation of the author.

4. *Lyceum of Natural History of New York*, Vol. iv, Nos. 8 and 9.—These numbers conclude the fourth volume of the Transactions of the Lyceum of Natural History of New York. It is occupied with a continuation of the elaborate catalogue of Geodephagous Coleoptera of the United States, by M. John L. LeConte of New York. This catalogue is enriched with various annotations, and with detailed descriptions of species of the following genera:—Myas, Stomis, Isopleurus, Percosia, Celia, Amara, Triæna, Acrodon, Bradytus, Curtonotus, Euryderus, Geopinus (n. g.), Agnoderus, Cratacanthus, Piosoma (n. g.), Amphasia, Spongopus (n. g.), Anisodactylus, Eurytrichus (n. g.), Selenophorus, Pangus, Harpalus, Geobænus, Gynandropus, Stenolophus, Acupalpus, Aepus, Eraphius, Anophthalmus, and Lachnophorus.

5. *Journal of the Boston Society of Natural History*, Vol. v, No. 3.—

F. ALGER, Notices of New Localities of rare Minerals, and reasons for uniting several supposed distinct species: p. 297.

H. D. and W. B. ROGERS, On two remarkable Trains of Boulders in Berkshire, Massachusetts: p. 310, with a plate.

J. P. KIRTLAND, M.D., Description of the Fishes of Lake Erie, the Ohio River, and their Tributaries: p. 330, with four plates.

J. LEIDY, Anatomical description of the animal of the Littorina angulifera: p. 344, with figures.

ASA GRAY, Notice of a New Genus of Plants of the Order Santalaceæ: p. 348.

N. M. HENTZ, Descriptions and Figures of the Araneides of the United States: p. 352, with two plates and numerous figures.

J. E. TESCHEMACHER, On the Fossil Vegetation of America: p. 370, with plates.

J. HALL, On the Geological Position of the Cranium of the Castoroides Ohioensis, and J. WYMAN, M.D., Anatomical Description of the same: p. 385, with three plates.

J. BACON, Jr., Polythalamia in sand from the Sahara Desert: p. 402, with figures.

C. T. JACKSON, M.D., Chemical and Mineralogical Fragments: p. 405.

J. B. FORSYTH, On the Habits of Salmo fontinalis: p. 412.

S. CABOT, Jr., M.D., Description of Pyranga roseo-gularis: p. 415.

H. BERGHAUS and A. K. JOHNSTON: The Physical Atlas; a series of maps illustrating the Geographical Distribution of Natural Phenomena;—of races, languages, rain-regions, deserts, mountains, rivers, magnetic phenomena, of volcanic action, and plants and animals over the globe. The Philosophical Magazine closes a detailed notice of this Atlas, a copy of which has not reached us, by saying, "we feel bound both in justice to the editors and our readers, to give it our warmest recommendations."

R. I. MURCHISON: The Silurian Rocks of Parts of Sweden; 48 pp. 8vo. *London*, 1847.

R. PATTERSON: Introduction to Zoology, for the use of schools. 12mo. *London*, 1846.

J. NICOL: Guide to the Geology of Scotland. *Edinburgh*, 1846.

J. C. PRICHARD: Physical History of Man, Vol. v, 8vo. *London*. 18*s*. *cl*.

C. LYELL: Principles of Geology, 7th edit., 1 vol., 8vo. *London*, 1847. 18*s*.

RICHARD OWEN, F.R.S.: Lectures on Comparative Anatomy and Physiology of the Vertebrate Animals. Part I, Fishes; being Vol. ii, of Hunterian Lectures. *London*, 1846.

G. BISCHOF: Lehrbuch der chemischen und physikalischen Geologie. 1. Bds. 1 Abth. gr. 8. *Bonn*, 1846.

Dr. G. A. W. HERRICH-SCHÄFFER: Systematische Bearbeitung der Schmetterlinge von Europa, als Text, Revision und Supplement zu J. Hübner's Sammlung Europäischer Schmetterlinge. 1 Bd.; Die Tagschmetterlinge. Mit 75 illum. Kupfert. gr. 4. *Regensburg*, 1846.

PH. F. v. SIEBOLD: Fauna Japonica—Pisces: elaborant C. J. Temminck et H. Schlegel. Decas xi, fol. *Lugduni-Batav*. 1846. 8½*rxthl*.

SUSEMIHL: Vögel Europa's, 29 Lief. gr. Lex. 8. *Darmstadt*. 1⅓*rxthl*.

Dr. J. J. v. TSCHUDI: Fauna Peruana, viii Lief. (Vögel.) Imp. 4., 2⅓*rxthl*.

F. DOZY ET J. H. MOLKENBOER: Musci frondosi Archipelagi Indici, Fasc. ii. Imp. 4., 3½ Bog. *Lugduni-Batav*. 3⅓*rxthl*.

LEREBOURS and SECRETAIN: Traité de Photographie, 5th edit., 8vo. 1846.

PROCEEDINGS OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA, iii, No. 6, Nov. and Dec., 1846.—Fossil footprints of the Connecticut valley; *C. P. Wickersham*, p. 119.—New genera and species of Insects, (Brachycopris, n. g., having for its type the Copris carolina, Prionus fissicornis, Sphenostethus, n. g. allied to Prionus, Molorchus tenuipes, Enoplium venustum, Heterodromia, n. g., fam. Donaciadæ, Trogus nubilipennis, Ibalia maculipennis;) *S. S. Haldeman*, p. 124.—On the Cicada septendecim; *Miss Morris*, p. 132.—On the situation of the olfactory sense in the terrestrial tribe of the Gasteropodous Molluscs; J. LEIDY,* p. 136.—On an instinct probably possessed by the Herons; *J. Cassin*, p. 137.

PROCEEDINGS OF THE BOSTON SOC. NAT. HISTORY, October, November, December, 1846.—Shells of the Exploring Expedition; *A. A. Gould*.†—Centrarchus fasciatus and C. obscurus of DeKay, identical with Huro nigricans of Cuvier; *L. Agassiz*, p. 184.—Shovel fish of Ohio; *Dr. Cabot*, p. 184.—Moose and Carabou, and American Raven, not identical with European species; *L. Agassiz*,‡ p. 187.—Pyranga roseo-gularis; Dr. *Cabot*,§ p. 187.—Echinus from the millstone grit of Georgia, Pygorhynchus Gouldii; *M. Bouvé*,|| p. 192.

---

* This Journal, p. 434. † Ibid, p. 151, 311. ‡ Ibid, p. 436. || Ibid, p. 436.
§ Ibid, p. 437.

Annals and Magazine of Natural History, Jan. 1847, No. 122.—Organization of the Polygastric Infusoria; *C. Eckhard.*—Three new species of British Coleoptera; *T. V. Wollaston.*—Birds of Calcutta; *C. J. Sundevall.*—A new British Sponge; *Dr. Johnston.*—Zoolog. Soc., Oct. 13. New species of Brachiopoda and Marginella; *G. B. Sowerby.*—Entomol. Soc. New Grasshopper from N. S. Wales; *W. F. Evans.*—New Paussidæ from India; *J. O. Westwood.*—New Holland Cryptocephalidæ; *W. W. Saunders.*—Botan. Soc. of Edinburgh. Dr. Balfour on the Alpine Flora of the British Isles.

Jan. 1847. No. 123.—Formation of the Flints of the Upper Chalk; *J. Toulmin Smith.*—British Rubi; *C. C. Babington.*—On a peculiar organ in the Rays; *C. Robin.*—An Ichthyolite from Sheppey; *R. Owen.*—Development of the Lycopodiaceæ; *K. Müller.*—Drafts for a Fauna Indica; *E. Blyth.*—Habits of the Limpet; *G. Roberts.*—Entomolog. Soc. New Holland Cryptocephalidæ; *W. W. Saunders.*—Two new Goliath Beetles, and some new Scutelleridæ; *J. O. Westwood.*—Insects from Cape Palmas; *Dr. Savage.*

Feb. 1847. No. 124.—New species of Gynautocera from N. India; *E. Doubleday.*—Ornithology of the Island of Tobago; *Sir Wm. Jardine.*—British Rubi; *C. C. Babington.*—Birds of Calcutta; *C. J. Sundevall.*—New species of Actias from N. India; *E. Doubleday.*—New or rare British Animals; *R. M'Andrew* and *E. Forbes.*—Drafts for a Fauna Indica; *E. Blyth.*—Development of the Lycopodiaceæ; *K. Müller.*—Outline of an Arrangement of Stony Corals; *J. E. Gray.*—Zool. Soc. Birds from Malacca; *Mr. Strickland.*—Three Australian Birds; *Mr. Gould.*—Microscop. Soc. On the Intimate Structure of Bone; *Mr. Quekett.*

March, 1847. No. 125.—Reproduction of lost parts in the Articulata; *G. Newport.*—Notes on Buccinum undatum; *A. Hancock.*—On a second form of fructification in Peyssonelia squamaria; *C. Montagne.*—New species of Atya; *G. Newport.*—Birds of Calcutta; *C. J. Sundevall.*—New Lepidoptera; *E. Doubleday.*—On the Irish species of Cephaloptera; *F. M'Coy.*—Drafts for a Fauna Indica; *E. Blyth.*—Linnæan Soc. Notes on the Fauna of N. Zealand and the Aucklands; *A. White.*—On the calcifying functions of the Cowrey and Olive; *L. Reeve.*—Structure and Movements of Bacillaria paradoxa; *G. H. K. Thwaites.*

London Journal of Botany, for *January*, 1847.—Sur le genre Godoya, etc.; *Dr. Planchon.*—Botanical Information, viz: Thorea ramosissima, found in the Thames.—Account of Gutta Percha, a new vegetable production lately used in the arts as a substitute for Caoutchouc, &c. shown to be yielded by a Sapotaceous plant.—Bourgeau's Canary Island Plants.—Proposed Nat. Hist. Journey to Bosnia.—Mitchell's Expedition in the interior of New Holland.—Letter from Mr. Gardner on the Botany of Ceylon.—Notes of a Continental Tour, continued, (Moscow to Constantinople and Florence.)—Review of Gardner's Travels in Brazil.—February, 1847.—Notices of Lindley's "Orchidaceæ Lindenianæ;" of *Martins*, "Voyage Botanique le long des Côtes Septentr. de la Norvège;" of *Gardner*, "On the structure and affinities of Podostemaceæ;" of *C. H. Schultz*, on Hypochærideæ; of *Parlatore's* "Flora Palermitana" and "Monogr. delle Fumariée;" of the "Genera Pl. Floræ Germanicæ," continued by *Putterlich* and *Endlicher*, (up to fasc. 24); of *Miers*, "Illustrations of S. American Plants," part 1; of *Gray's* "Chloris Boreali-Americana;" *Sullivant's* Musci Alleghanienses and "Contributions to the Bryology and Hepaticology of North America."—Catalogue of Mr. *Geyers'* Upper Missouri and Oregon Collection of Plants, up to Rhamneæ inclusive.—Journal of the Voyage to the Niger; *Dr. Vogel*—continued.—"Floræ Tasmaniæ Spicilegium;" *Dr. J. D. Hooker*—continued.

Comptes Rendus, Paris. Nov. 23.—Chemical Researches on Dyeing; *Chevreul.*—On the application of the new formula of interpolation to the determination of the orbits described by celestial bodies, and on the direct introduction of observed longitudes and latitudes in Astronomical formulas; *A. Cauchy.*—On the isolation of Fluorine, and composition of Fluorides; *Louyet*—On Gun-cotton; *Gaudin, Fordos* and *A. Gélis, Becker, Dumas.*—Nov. 30. On the Potato Disease; *Payen.*—On the alteration of Beet-sugar; *Payen.*—Gun-cotton; *Payen, Piobert, Pelouze, Morel.*—On the introduction of phosphate of lime into organic beings; *Dumas.*—Relation between the nitrification and fertilization of land; *Kuhlmann.*—Dec. 7. Potato and Beet Disease; *Gaudichaud.*—On the Silicates; *Laurent.*—On Fluorine; *Quet* and *Colin.*—On Gun-cotton in blasting; *Combes* and *Flandin.*—Explosion of Gun-cotton; *Figuier* and *Poumarède.*—Application of Gun-cotton to Machinery; *Riotte.*—Dec. 14. On the maxima of effects of the explosion of Gun-cotton; *Payen.*—On different substances called Gun-cotton; *Gaudichaud.*—On Metallic Polarization; *Jamin.*—Dec. 21. On Hydrates; *Fremy.*—On pyroxyline; *Vankerckhoff.*

INDEX TO VOLUME III.

ADDITIONAL ERRATA.

P. 370, 8 lines from bottom, after "copper," insert "and nitric acid."
P. 371, in note, for "Aq" in formula, read "Ag."
P. 376, 9 lines from bottom, for "fine," read "fire."

THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. I.—*On Terrestrial Magnetism;* by WILLIAM A. NORTON, Professor of Mathematics and Natural Philosophy in Delaware College.

I PROPOSE in the present article to show that, adopting certain fundamental conceptions with respect to the terrestrial magnetic forces, the magnetic may be deduced from the thermal elements of the earth. The first investigations tending to establish the existence of a physical connection between the heat and magnetism of the earth, seem to have been made by Sir David Brewster. In 1820 he announced the "discovery of two poles of maximum cold on opposite sides of the north pole of the earth," and in the vicinity of the two magnetic poles; and maintained the probability of some physical connection between the poles of maximum cold, and the magnetic poles. He also proved "that the circle of maximum heat, like the magnetic equator, did not coincide with the equinoctial line; that the isothermal lines and the lines of equal magnetic intensity, had the same general form surrounding and enclosing the magnetic poles and those of maximum cold; and that, by the same formula, *mutatis mutandis,* we could calculate the temperature and the magnetic intensity of any point of the globe." This subject has since been studied by several philosophers; and particularly by Captain Duperrey, and M. Kupffer of Kasan. The original memoirs of these authors I have not seen. The following is the substance of the account which Sir David Brewster gives of their investigations. In the years 1822–1825, Captain Duperrey made an extended system of magnetic observations in the vicinity of the equator, by which he was enabled to trace the magnetic equator, with peculiar accuracy, through an extent of 247° of longitude. In his paper on the magnetic equator, subsequently published, he announced that he had discovered that "the points of this great circle, or those where the magnetic intensity is a minimum, are also the warmest points of each meridian," and thus that "the thermal and magnetic equator are connected, as Sir David Brewster had already proved to be the case with the thermal and magnetic poles ;" also, "that in comparing the isothermal and isodynamic lines, he had found a remarkable analogy in their curvatures and particularly in the direction of their concavities, and convexities." M. Kupffer, in certain memoirs read before the Russian Academy about the year 1829, attempted to establish that terrestrial magnetism resides at the surface of the globe, and thence inferred the existence of a connection between the magnetic and thermal phenomena of the earth : conceiving that the intensity of the earth's magnetism would vary directly or inversely as the temperature, according as it was of the nature of permanent or induced magnetism.

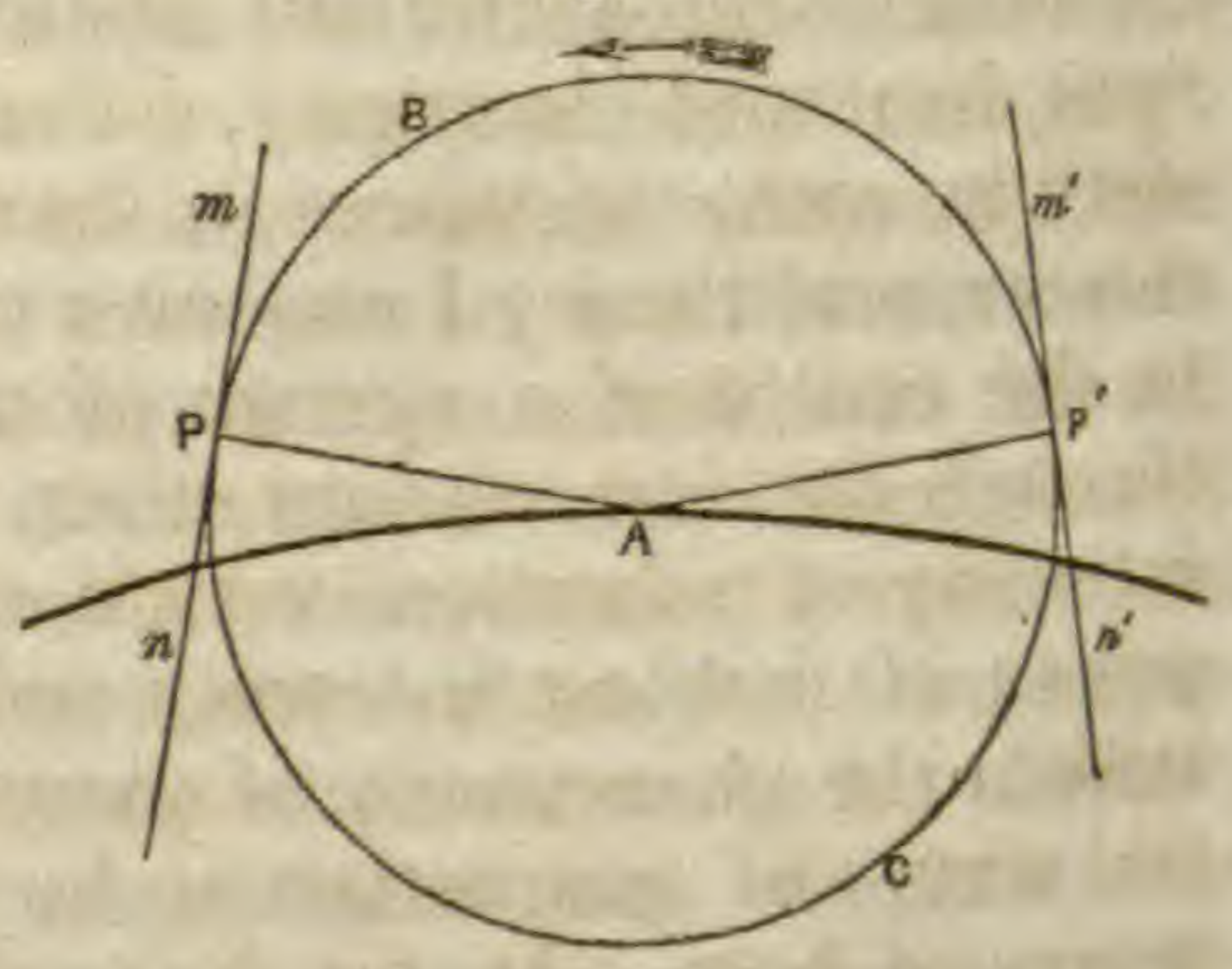
Several conjectures have been formed as to the nature of the connection between the temperature and magnetism of the earth. Dr. Traill has expressed the opinion that "the disturbance of the equilibrium of the temperature of our planet, by the continual action of the sun's rays on its intertropical regions, and by the polar ices, must convert the earth into a vast thermo-magnetic apparatus." Christie has suggested that "difference of temperature may be the primary cause of the polarity of the earth, though its influences may be modified by other circumstances." Œrsted conceives that the sun, by producing evaporation, deoxydation, &c., as well as by increasing the temperature, is the exciting cause of electrical currents, which perpetually traversing the earth's surface in a direction nearly parallel to the equator, give to the earth "a constant magnetic polarity." Perhaps the more generally received theory of the present day concerning the physical nature of the earth's magnetism, is that it consists of thermo-electric currents circulating at or near the earth's surface, induced by the heat of the sun. Prof. Barlow, who adopts this view, conceives that only one link is wanting to complete the explanation of terrestrial magnetism, viz. the discovery of the metallic thermo-magnetic apparatus. Brewster remarks upon this, that "if it could be shown that the action of solar heat is capable of developing magnetism in particles such as those which are known to constitute our globe, the great difficulty would be removed."

In seeking for the explanation of the connection between the magnetic and thermal phenomena of the earth, philosophers seem hitherto to have regarded the heat as only modifying in some inexplicable manner the intensity of the magnetism of the terrestrial particles; or as bearing towards it the relation of cause and effect. But there is another view to be taken of the matter. We may regard the two principles of heat and magnetism as similar in their ultimate physical nature, as every where subsisting together, and that the causes which produce a variation of temperature at the surface of the earth, as we pass from one point to another, occasion at the same time and in like manner a variation of the magnetic intensity of the particles. So that the temperature at each particular place may be taken as the approximate measure of the molecular magnetic intensity there. The conception that I have formed of the probable physical nature of the imponderables, of which I have given an exposition in a paper read before the American Philosophical Society in December last, has led me to take this view of the physical relations subsisting between the heat and magnetism of the earth. This conception is, essentially, that all the phenomena of the imponderables are but different effects of different vibratory motions of the particles of matter, and of the ethereal undulations produced by these vibrations;—the vibrations answering to the different principles of light, heat and electricity, differing in time and intensity, and possibly in some instances in direction, of vibration. Agreeably to this general theory I conceive each particle of the earth's mass to be the centre of a system of undulatory movements propagated through the surrounding ether, and of every variety of time and intensity of vibration within certain limits. To the waves or pulses of feeblest intensity and shortest time of vibration I attribute the phenomena of magnetism; or, at all events, I suppose the waves of magnetism to lie at the opposite extreme from the waves of heat. It thus happens that all the particles of the magnetic needle receive the impulsive actions of the waves of magnetism propagated from the particles of matter at the earth's surface, and at certain depths below the surface;—from how great a depth will depend upon the degree of transparency, to these waves, of the matter of the earth. That the principle of magnetism is incoercible, or that it passes freely through opake bodies of ordinary thickness, has been fully established by the experiments of M. Haldat: and that all the particles of the magnetic needle are subject to the action of the magnetic force of the earth, is evident from the fact that the directive force of the needle is proportional to its mass. Why it is that magnets alone are sensibly influenced by the impulsive actions of the ethereal pulses, I cannot now stop to consider. These theoretical views, I do not here present for the purpose of advocating them, but simply because they furnish a simple and comprehensive conception of the terrestrial magnetic forces and of their relations to the earth's temperature. The mechanical theory of terrestrial magnetism which it is the main design of the present article to exhibit, and apply, although suggested by these views, is not necessarily dependent upon them. The quantitative results arrived at, simply establish the existence of the forces supposed and of the relations conceived to subsist between them and the temperature of the earth. Different views may be entertained of the physical origin of these forces; or, we may rest upon the forces themselves as so many primary properties of matter.

The mechanical theory of the magnetism of the earth, of which I propose to give an exposition, is based upon the following fundamental principles. These were obtained inferentially from the physical theory of terrestrial magnetism which has been briefly explained: but for our present purpose, they may be regarded as mere assumptions, to be tested by the conclusions and results to which they lead.

1. Every particle of matter at the earth's surface, and to a certain depth below the surface, is the centre of a magnetic force exerted tangentially to the circumference of every vertical circle that may be conceived to be traced around it. Thus, if A, fig. 1, be a particle of the earth's mass at or near the surface, P a particle of a magnetic needle, and BPC a circle traced in a vertical plane around A as a centre and passing through P, P will be urged by a force whose line of direction is the tangent mPn. Whether there are probably tangential forces lying also in oblique planes, I do not here consider. If there are such forces it appears from the results of the investigation that they may be disregarded in the present inquiry. According to the views which have been offered of the probable physical nature of magnetism, the tangential forces here supposed are due to the transversal vibrations of the ethereal waves of magnetism propagated from the point A, and originated by certain vibratory movements of the particle at A.

Fig. 1.



2. The direction of this force will be different according as it solicits the north or south end of the needle; and it is always such, that to the north of the acting particle the north end of the needle is urged downwards and the south end upwards, and that to the south of the same particle the north end is urged upwards and the south end downward. Thus, in fig. 1, if P be to the north of A and P′ to the south of it, at P the north end of a magnetic needle will be solicited to move in the direction Pn, and the south end in the direction Pm; and at P′ the north end will be solicited in the direction $P'm'$, and the south end in the

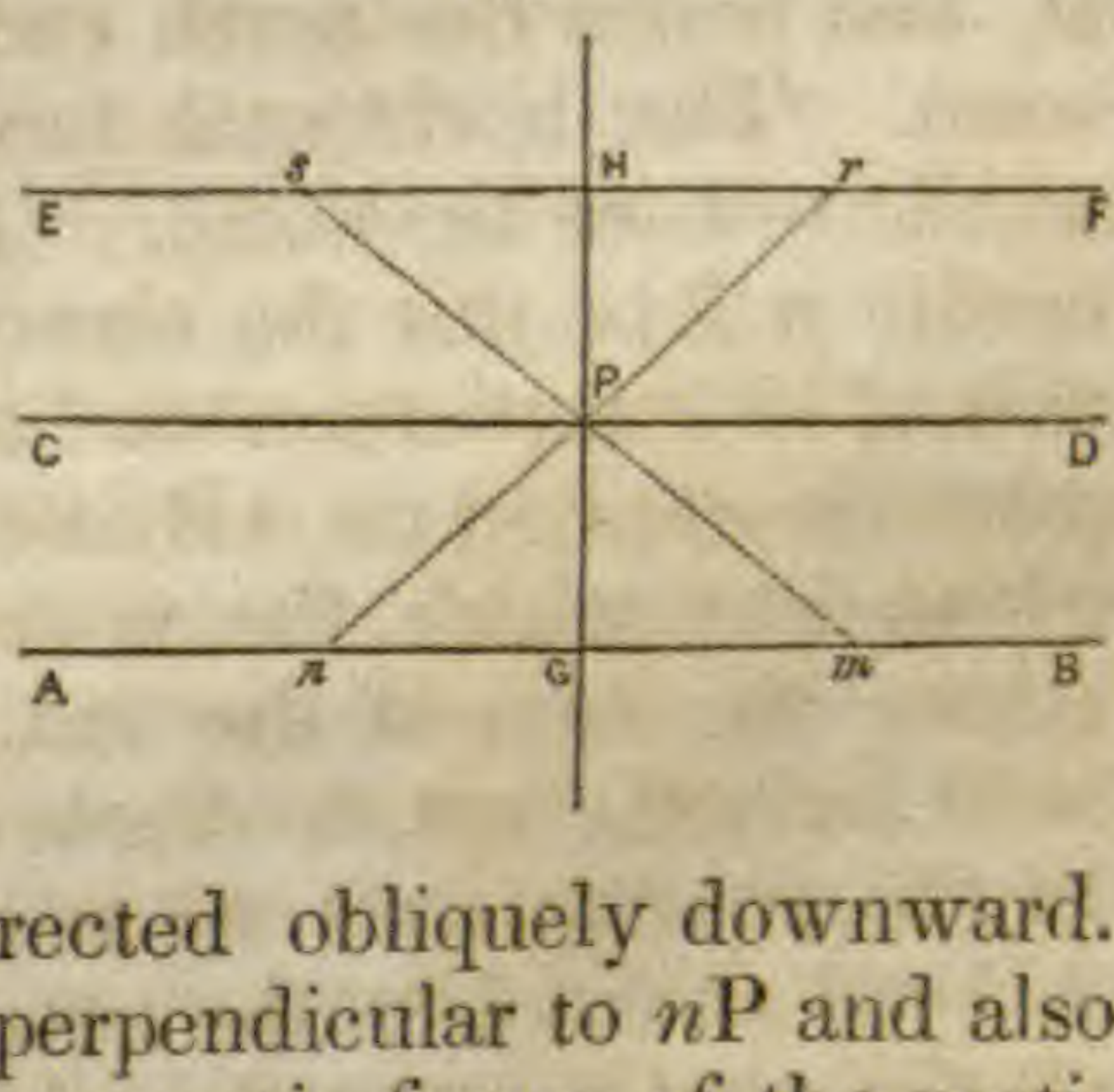
direction $P'n'$. This amounts to saying that the magnetic force of A in its action upon the north end of the needle is directed tangentially in the circle from right to left, as shown by the arrow, and in its action upon the south end of the needle is directed from left to right.

Upon the undulatory theory of magnetism these differences of action are attributable to ethereal waves whose transversal forces of vibration lie in opposite directions, and to certain differences in the magnetic states of the two ends of the needle.

3. The intensity of the magnetic force of a particle of the earth, at a given distance, is assumed to be approximately proportional to its temperature, or amount of sensible heat. This assumption was made under the idea that the sun was the source, at the same time of waves of heat, light and magnetism, and that the molecular forces of vibration due to the different kinds of waves would probably vary according to the same law in passing from one point to another on the earth's surface.

The magnetic force of a particle at the earth's surface, and for a certain depth below the surface, will have a certain mean intensity about which the actual intensity will vary during the day and year, by an amount decreasing with the depth. Beyond a certain depth, the magnetic intensity, like the temperature, will remain the same throughout the year, and will have a value greater than the surface mean in proportion as we descend lower. Lines conceived to be traced on the earth's surface connecting the points where the annual mean magnetic intensity of the particles near the surface is the same, will, according to the present view, coincide with the isogeothermal lines, and very nearly therefore with the isothermal lines. Let then, AB, CD, EF, fig. 2, represent portions of three isogeothermal lines, regarded as parallel to each other, and GPH an arc of a great circle crossing these lines perpendicularly. If we take four points *m*, *n*, *r*, *s*, similarly situated with respect to GPH, the action of the particle *m* upon the north end of a magnetic needle will be perpendicular to *m*P and directed obliquely downward. The action of the particle *n* will be perpendicular to *n*P and also directed obliquely downward. The magnetic forces of the particles *r*, *s*, will be respectively perpendicular to *r*P and *s*P and directed obliquely upward. Now it is evident that while one effect of the action of *m* will be to urge the north end of the needle toward C, the particle *n* will have an equal tendency to urge it toward D. In like manner, the components of the forces of *r* and *s*, which solicit the north end of the needle in the directions PC

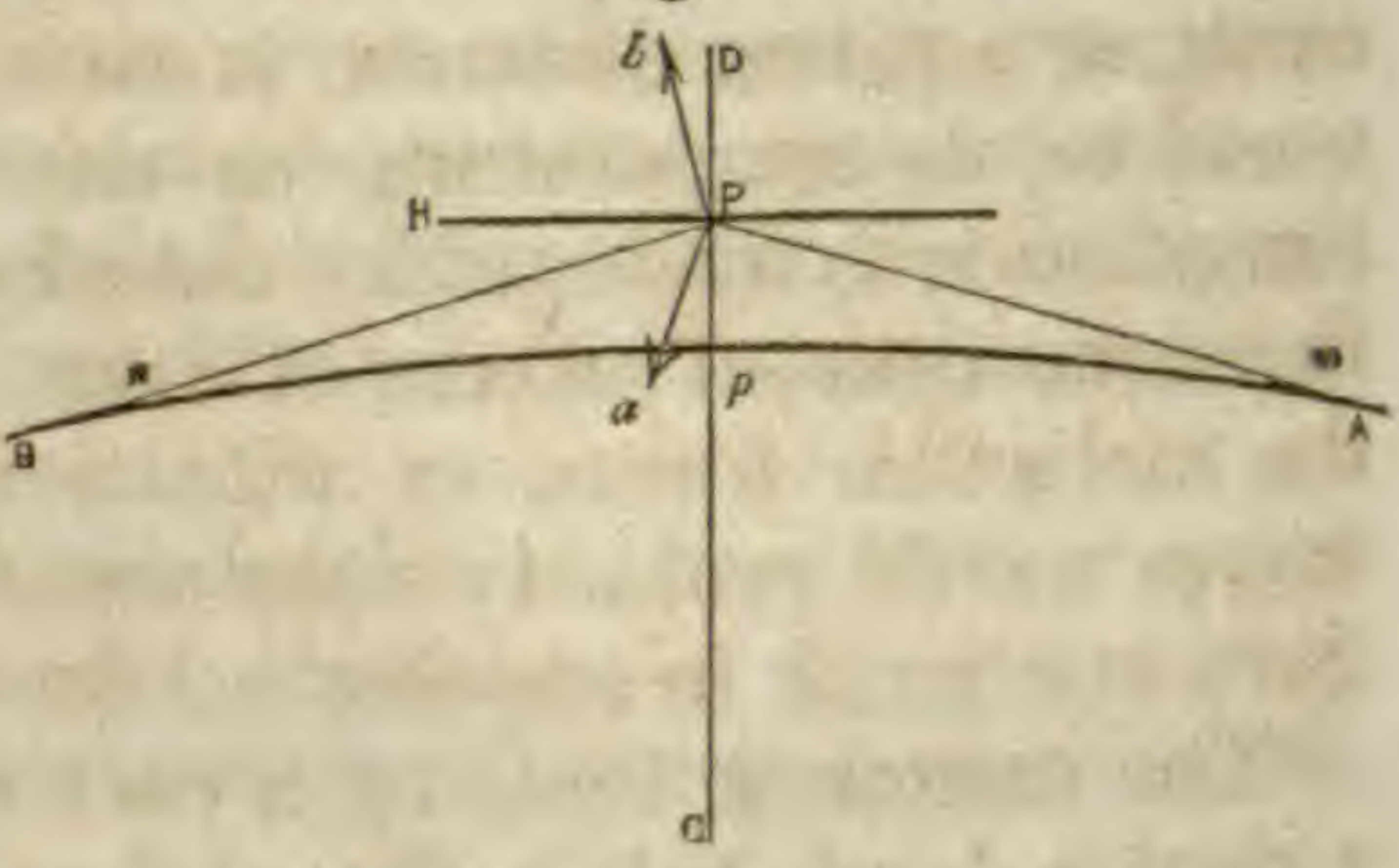
Fig. 2.



and PD, destroy each other. The same may be shown with regard to the actions upon the south end of the needle. It follows, therefore, that the needle will place itself at right angles to CPD, the isogeothermal line passing through P the station of the needle. This is a consequence from our theory which, like the formulæ soon to be investigated, is to be tested by making comparisons with observations.

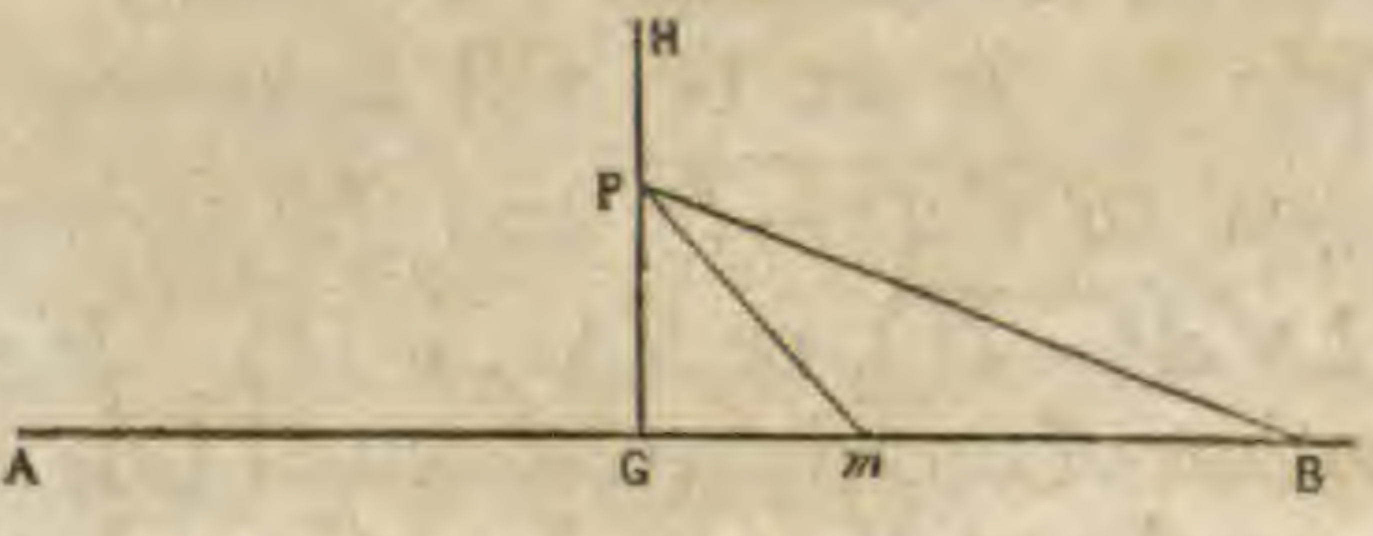
Let us now deduce from the general principles which have been laid down, the horizontal and vertical components of the directive force of the needle. Let A*p*B, fig. 3, represent a great circle of the earth, answering to *m*P*s*, or *n*P*r* in fig. 2, C*p* its radius, P the north end of a magnetic needle, and *m* *n* two particles of the earth situated at equal distances to the north and south of P. The action of *m* situated to the south of P, will be in the direction P*a* perpendicular to *m*P, and that of *n* will have the direction P*b* perpendicular to *n*P. The force P*a* may be decomposed into two forces having the directions PC and PH; and the force P*b* may be decomposed into two having the directions PD and PH. The sum of the two horizontal components will be the effective horizontal force due to the actions of *m* and *n*, and the difference of the two vertical components will be the effective vertical force due to the action of the same particles. Since the temperature of *m* is higher than that of *n*, the component directed from P to C is greater than that directed from P to D, and hence the north end of the needle will be urged downward. The horizontal force will solicit the north end of the needle toward the north. The actions upon the south end of the needle will be just the reverse. Now if we suppose the same process of decomposition to be gone through with for each pair of particles situated on AB at equal distances from P, up to a certain distance at which the molecular actions become insensible, by taking the sum of the individual forces along PC and PH, we shall have the entire effects of the arc AB in these two directions. In the same manner we may obtain the effects of any arc below AB and situated in the same plane; and thus the entire effect of all the matter situated in this plane which exerts any action upon the needle. Since the curvature of the arc AB is very slight, and P is very near to it, it is only the particles situated quite near to *p* that will have any material action in the horizontal direction. For arcs below the earth's surface the portion that furnishes the horizontal force will be greater as the depth increases, but will still, doubtless, be small in comparison with the more distant

Fig. 3.



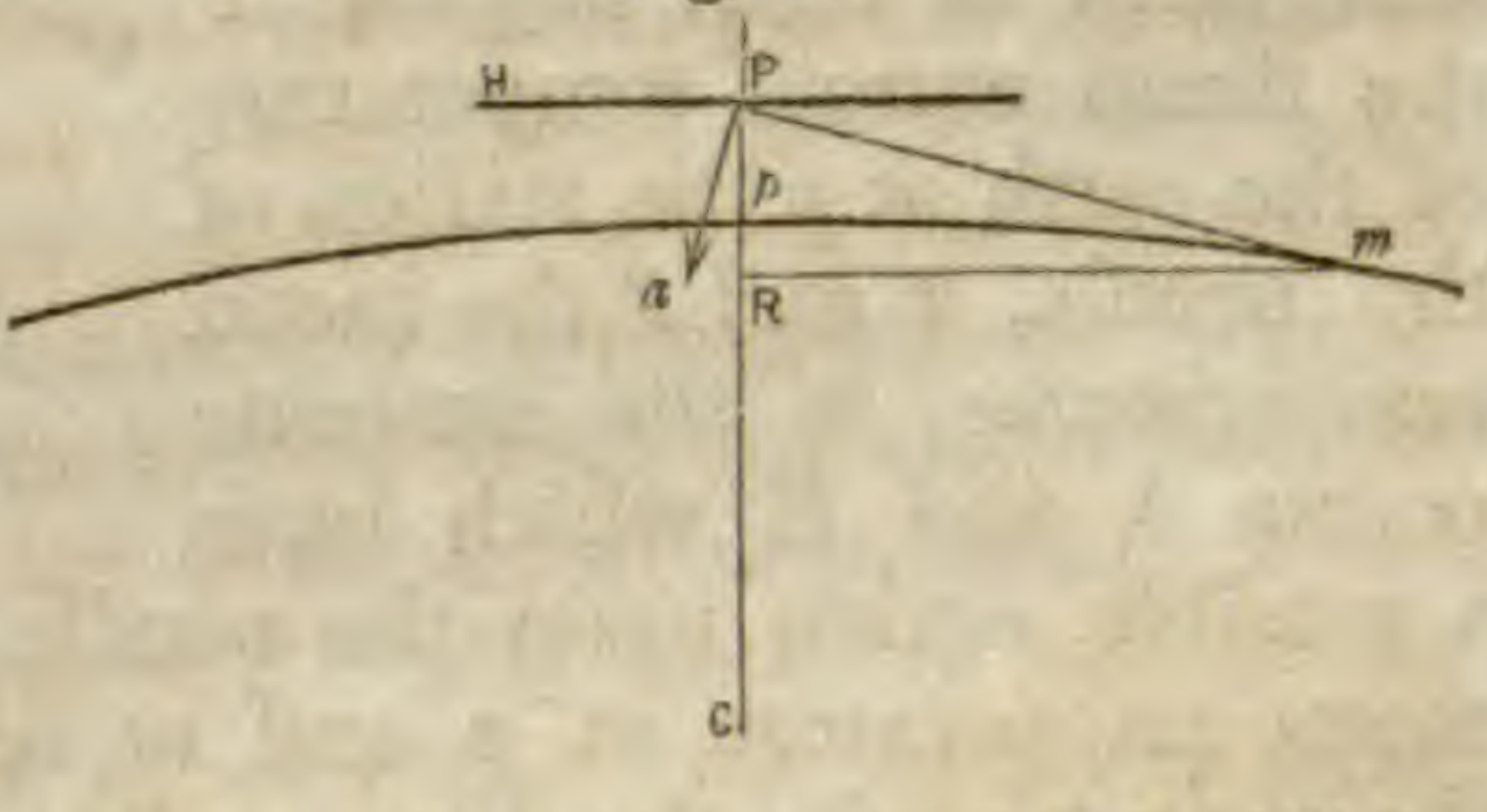
parts which act nearly in the vertical direction upon the needle. If, as we have supposed, the principle of magnetism be analogous in its nature to light and heat, then it must be more or less absorbed in its passage from the lower arcs to the surface; and there may be a gradual decrease in the extent of the arc which exerts a sensible action upon the needle, as the depth of the arc increases, until at the lower surface of the stratum of sensible action it becomes reduced to zero.

Fig. 4.



Formulas for the horizontal and vertical components of the directive force suited to our present enquiry, may be easily investigated. Let AB, fig. 4, be an isogeothermal line, and GH an arc of a great circle crossing this line perpendicularly and passing through P the station of the needle. The magnetic intensity of the particles of AB is every where the same. Take any particle m and designate the distance Pm, in a right line, by r. Either end of a needle at P will be solicited by a force perpendicular to Pm, and in the vertical plane through Pm. This force will be, for different isogeothermal lines, directly proportional to the magnetic intensity of m, and therefore to its mean annual temperature (t); and will, for the same isogeothermal line, vary from one particle to another with the distance r. Its expression will therefore be of the form $At.\varphi$*(r); A being an indeterminate constant. Now, let mp, fig. 5, represent the great circle immediately below mP in fig. 4, and lying either on the earth's surface or beneath it. We shall have force Pa(due to m)$=At.\varphi(r)$. The component of Pa in the direction of the radius or vertical PC will be equal to $Pa.\cos aPC = Pa.\sin mPR = Pa.\varphi'(r, h, R)$; R being the radius of the circle, which may be taken equal to the radius of the earth, and h the height Pp of the needle above the circle. We have therefore for the action of m in the direction of the vertical PC, the expression $At.\varphi(r).\varphi'(r, h)$; and when the height h is regarded as constant, we have $At.\varphi(r).\varphi'(r)$, or $At.f(r)$. To obtain the entire effect in the vertical direction of all the particles in the line GB, fig. 4, let GB be denoted by k, any portion Gm of it by x, and PG by l. The action of an elementary portion of GB will have for its expression $At.f(r)dx$

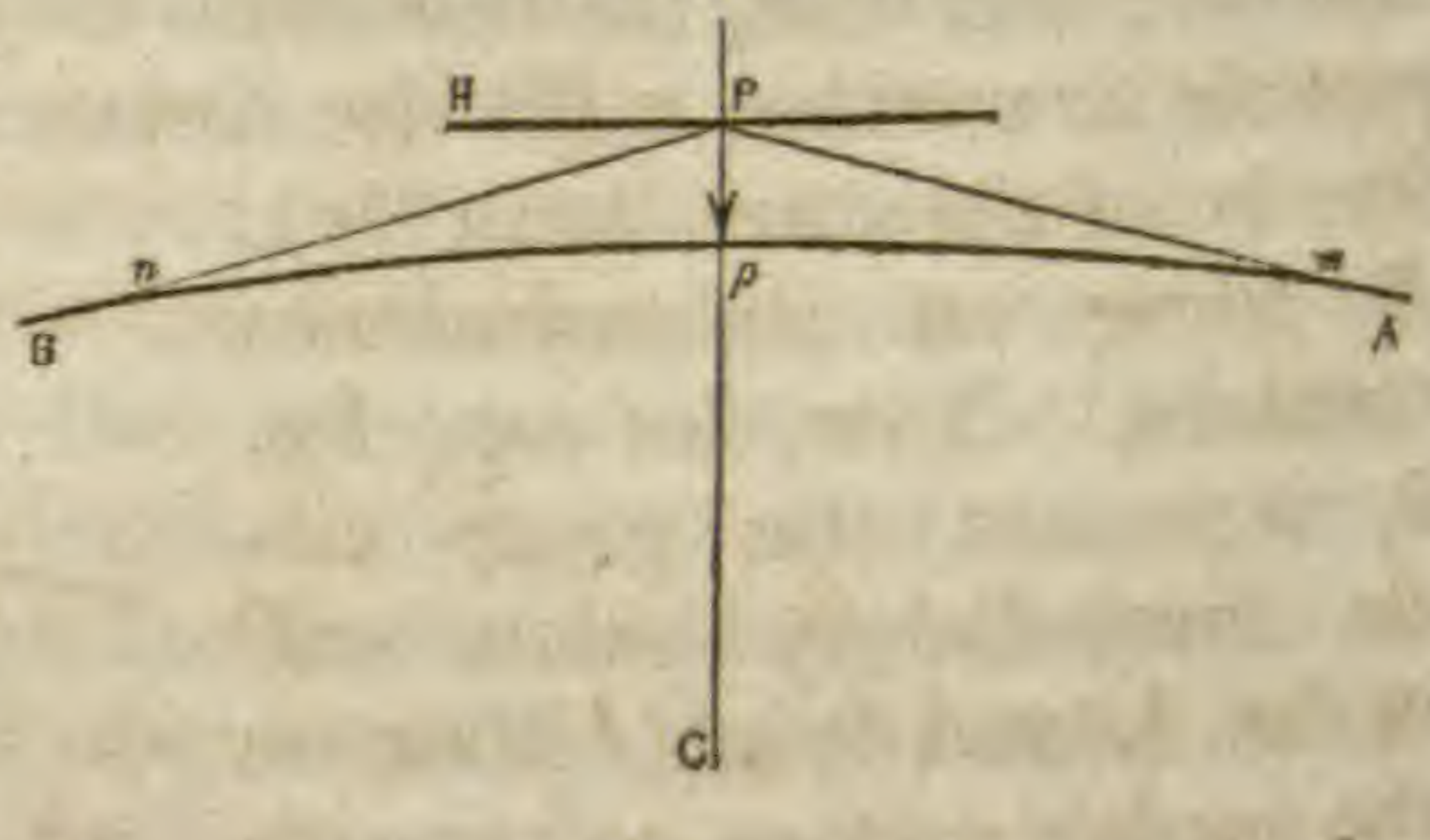
Fig. 5.



* The letters φ, f, F, with and without accents, are used in these investigations to designate different functions, and are therefore to be read "a function of."

$=\mathrm{A}tf(\sqrt{l^2+x^2})dx$. Integrating this between the limits 0 and k, we have, vertical action of GB$=\mathrm{A}t\,.\,\mathrm{F}(l,k)$. Whence, vertical action of AB$=2\mathrm{A}t\,.\,\mathrm{F}(l,k)$. If k may be taken sensibly the same for different isogeothermal lines, this expression will become $2\mathrm{A}t\,.\,\mathrm{F}(l)$. It is to be supposed, however, that the last particle of GB, which has a sensible action upon the needle at P, is at the same distance from this point whatever may be the distance of AB from it. The value of k will therefore be less, in proportion as the distance l is greater. Supposing the most remote particle to be at B, and denoting its distance PB by d, k will be equal to $\sqrt{d^2-l^2}$, and the above expression will become $2\mathrm{A}t\,.\,\mathrm{F}(l,\sqrt{d^2-l^2})$, or $2\mathrm{A}t\,.\,\mathrm{F}'(l)$. It follows therefore that the entire action of any isogeothermal line AB in the vertical direction upon a needle at P, may be reduced to a single force, proportional to the temperature, and varying from one isogeothermal line to another, with the distance PG of this line from the station of the needle. The entire effect of any single lamina of matter will therefore be the same as if the action was confined to the particles lying in the arc GPH; the effective force of each particle being proportional to its temperature, and also a certain function of its distance from the needle.

Fig. 6.



This being understood, let AB, fig. 6, represent an arc crossing the parallel isogeothermal lines at right angles, T the mean annual temperature of the earth at p the station of the needle, t and t' the mean temperatures at the extreme points A and B which have a sensible action upon the needle, u the difference between the mean temperature at p and at any point m, y the arc pm, a the arc pA, and r the distance Pm. pm or y may be regarded as depending for its value upon Pm, Pp, and Cp; of which Pp and Cp are constant for the same arc. Thus for any one arc, (representing, according to what has been shown, a single lamina,) $y=\varphi(r)$. If we regard the variation of temperature as uniform for the extent of the arc AB

$$u:t-\mathrm{T}::y:a.\cdot.u=(t-\mathrm{T})\frac{y}{a}=(t-\mathrm{T})\frac{\varphi(r)}{a}.$$

Thus, temperature at $m=\mathrm{T}+(t-\mathrm{T})\frac{\varphi(r)}{a}$.

Whence, putting $v=$ vertical force due to an element dy at m, and taking the expression for the action of an isogeothermal line, and incorporating the 2 with the constant A,

$$dv = A\left(T+(t-T)\frac{\varphi(r)}{a}\right)F'(r)dy = A\left(T+(t-T)\frac{\varphi(r)}{a}\right)F'(r)d\varphi(r)$$

$$= AT \,.\, F'(r)d\varphi(r) + A(t-T)\frac{\varphi(r)}{a}F'(r)d\varphi(r).$$

Integrating, $v = AT\int F'(r)d\varphi(r) + A(t-T)\int\frac{\varphi r}{a}F'(r)d\varphi(r).$

Integrating between the limits Pp and PA, to obtain the force due to the arc pA, the two integrals will become two functions of Pp and PA. Now, for any supposed value of Pp, PA will be the same at every different place on the earth, and therefore the values of these integrals will be every where the same. If we denote them by M and N, we have

$$v = ATM + A(t-T)N = AM \,.\, T + AN(t-T).$$

By the same process we obtain for the vertical force due to the arc pB $\quad v' = AM \,.\, T + AN(t'-T).$

Hence the expression for the effect of the whole arc, AB, is

$$v - v' = AN(t-t') = c(t-t') \quad . \quad . \quad . \quad (1.)$$

If we consider the action of a second lamina, the value of c may be different, but $t-t'$ will remain very nearly the same, except at considerable depths where the rate of variation of the temperature may be different, or the arc AB may be diminished by the absorption of the ethereal waves in their passage to the surface. If we neglect these possible variations of $t-t'$, and add together the actions of the different laminæ, we obtain for the actual vertical force

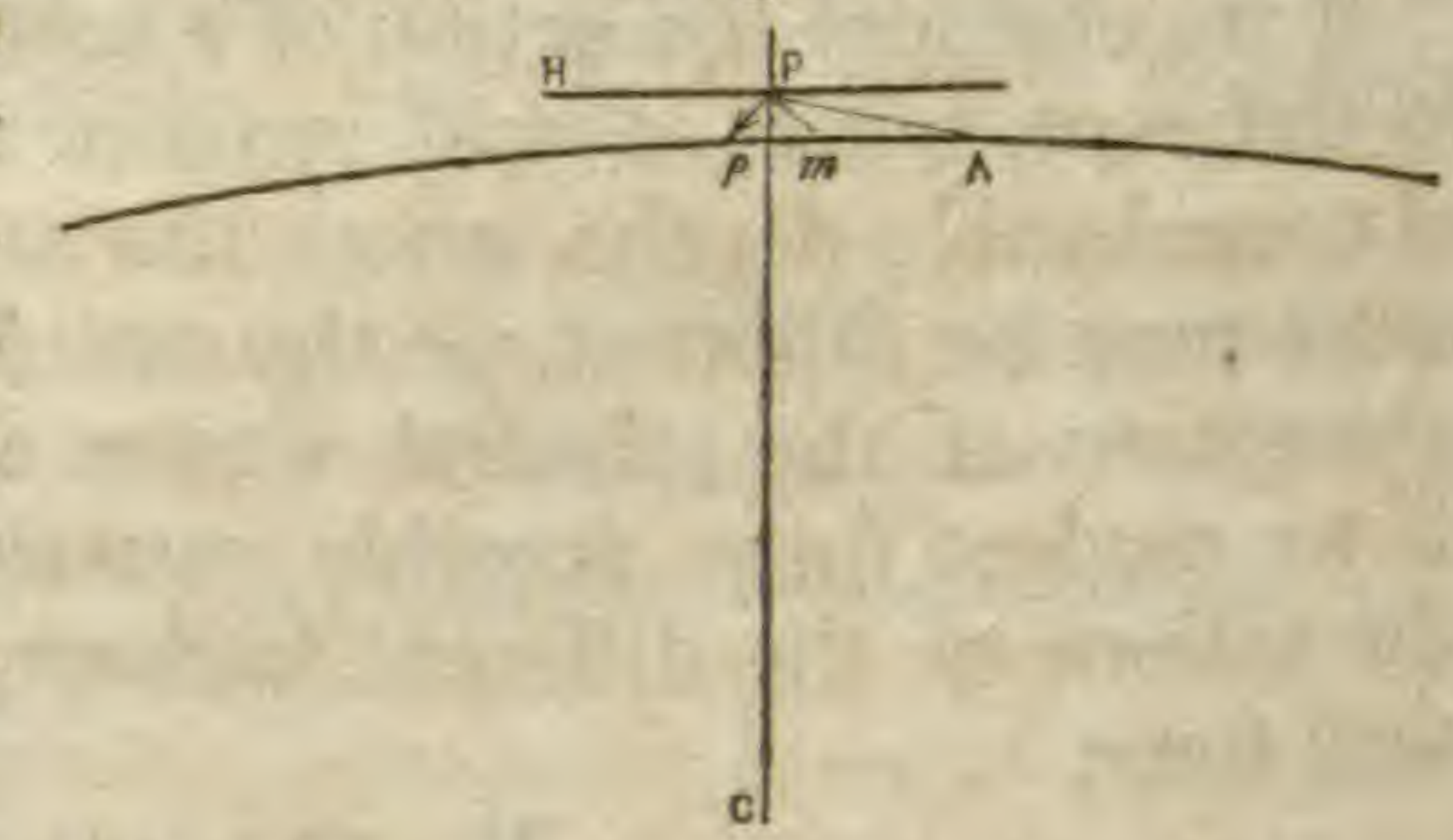
$$V = C(t-t') \quad . \quad . \quad . \quad (2.)$$

in which C is the sum of the values of c for the different laminæ. If we take account of the variations of $t-t'$, we shall have the actual force equal to the sum of a series of expressions of the form $c(t-t')$ in which both c and $t-t'$ will be more or less different. It would seem, however, that the changes in the value of $t-t'$, from absorption or other causes, must be very slight. In fact if the absorption be always a certain fractional amount of the intensity, there will be no change of $t-t'$ from this cause. It will only be necessary to regard c as varying. And if the absorption be always the same fractional amount whatever may be the intensity, c and therefore C will have the same value at different places.

The supposition made in the investigation of formula (2), that the variation of temperature is uniform for the extent of the arc AB, is not strictly true. From the equator to the latitude 45°, and even beyond this, the rate of diminution of the temperature for every degree of latitude continually increases. The effect of this will be to make the vertical component somewhat greater, except in the higher latitudes, than formula (2) would give it, (that is, supposing C to be dètermined à priori. If C be determined from observations made at the point of maximum variation of temperature, the values of V given by equation (2) will be too small south of this point and too great north of it.)

To obtain a formula for the horizontal component of the directive force, we may proceed in the same manner as for the vertical component, except that we now multiply the force Pa, fig. 5, by the cosine of the angle aPH instead of aPC. We shall therefore have for the entire action of the isogeothermal line AB, fig. 4, the expression $A't \cdot F''(l)$. Hence, that of all the isogeothermal lines, or of the whole acting surface, will be reduced to that of the single arc which crosses these lines at right angles; the magnetic intensity of the different points of this arc being proportional to the temperature, and the effective forces upon the needle varying according to some function of the distance. Now, as in the present enquiry all the active particles lie quite near to P, their temperatures may be considered the same and equal to that of the earth at the station of the needle: or, if there is a sensible variation at the lower layers, the augmentation towards the south will be compensated for by an equal diminution towards the north. Hence, designating the arc pm, fig. 7, by y, and the distance Pm by r, the expression for the horizontal force due to this arc is

Fig. 7.



$$\int dh = \int A'T \cdot F''(r)dy = A'T \int F''(r)d\varphi(r).$$

Integrating between the limits $r = Pp$ and $r = PA$, and designating the value of the integral by P, we have

$$H' = A'T \cdot P;\ 2H' = 2A'P \cdot T$$

and thus finally the total horizontal force

$$H = C'T \quad . \quad . \quad . \quad (3.)$$

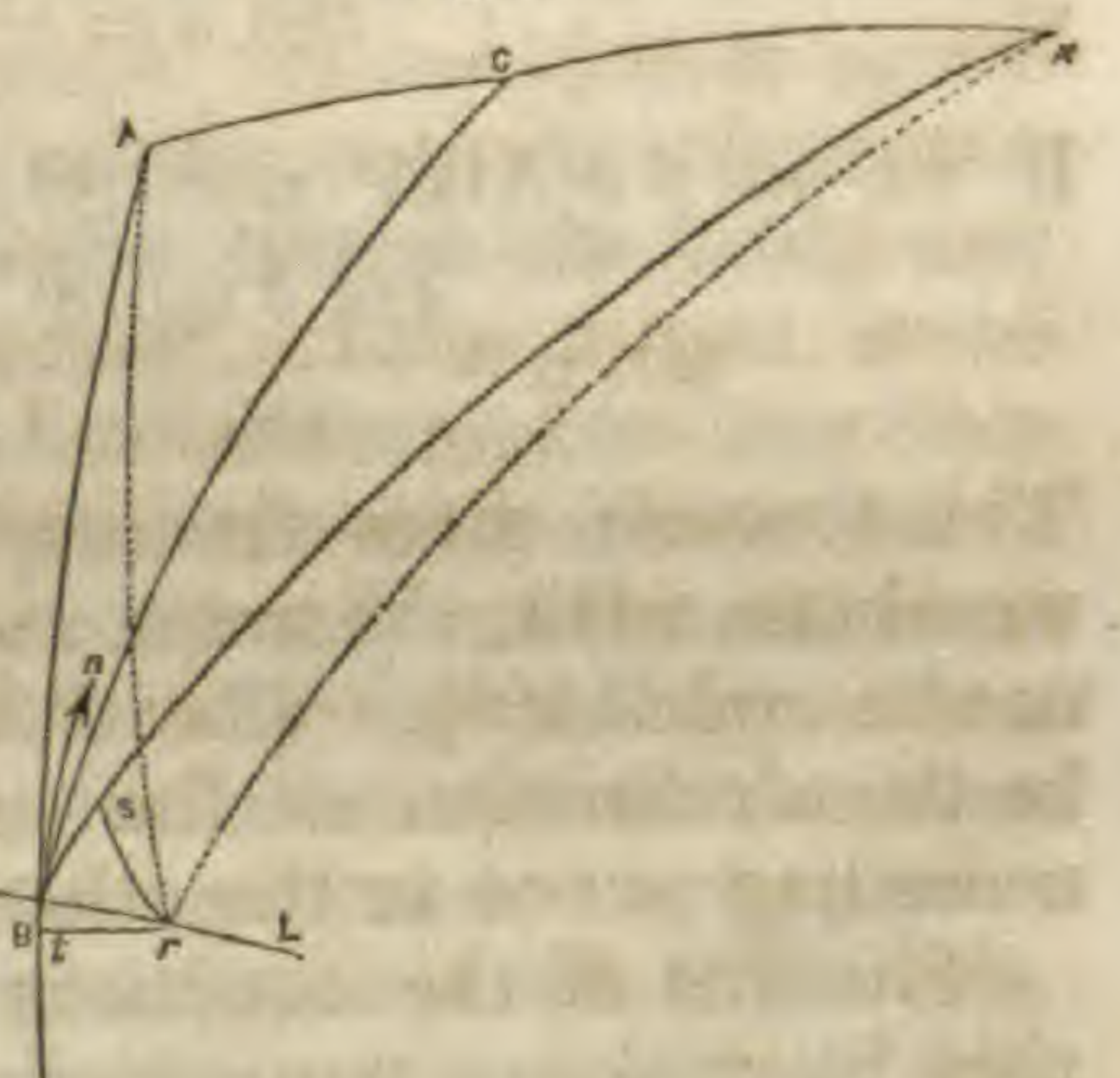
This is the expression for the entire effect of a single lamina. For different laminæ C′ may be different; and beyond a certain depth T will increase. If the supposed absorption of the magnetic emanations be a certain constant fractional amount of the magnetic intensity of the molecules, C′ will be every where the same. If we take the sum of all the equations (3) answering to the different laminæ, we shall have an equation of the same form for the horizontal component of the directive force, or the horizontal intensity at P. It is only by comparing the results furnished by this equation, with observations, that we can ascertain with certainty whether T is to be taken sensibly different from the mean surface temperature, and whether C′ may be regarded as truly constant for all places.

It remains to investigate a formula for the declination of the needle. We have already seen that the magnetic needle is every where at right angles to the line of equal molecular magnetic intensity traced upon the earth through its station; which line we have assumed to be the same as the isogeothermal line passing through the same point. We have therefore only to seek for a formula which shall make known the direction of the isogeothermal line at a given place and place the needle at right angles to this line of direction. Such a formula may be derived from Brewster's formula for the determination of the mean annual temperature of a place. This is

$$T=(t-\tau)(\sin^n\delta\,.\,\sin^n\delta')+\tau \quad . \quad . \quad (4.)$$

where t is the maximum equatorial temperature, τ the minimum temperature at each of the two poles of maximum cold, and δ, δ' the distances of the place from the two cold poles. Let C, fig. 8, represent the north pole of the earth, A and A′ the two poles of greatest cold, B a given place, BL the direction of the isogeothermal line through B. $BA=\delta$, and $BA'=\delta'$. For the isogeothermal line, since T is constant, $dT=0$. Hence, if we differentiate equation (4), and put the differential equal to zero, we shall have a relation between $d\delta$ and $d\delta'$, the variations of δ and δ' in passing from the point B to its consecutive point r on the isogeothermal line. Thus, putting $t-\tau=c$, we have

Fig. 8.



$$dT=c(n\sin^{n-1}\delta\cos\delta\sin^n\delta' d\delta+n\sin^{n-1}\delta'\cos\delta'\sin^n\delta d\delta').$$

Multiplying and dividing by $\sin^{-n+1}\delta\sin^{-n+1}\delta'$,

$$dT=\frac{c(n\cos\delta\sin\delta' d\delta+n\cos\delta'\sin\delta d\delta')}{\sin^{-n+1}\delta\sin^{-n+1}\delta'}=0.$$

Hence, $$\cos\delta\sin\delta' d\delta+\cos\delta'\sin\delta d\delta'=0$$

And, $$\frac{d\delta}{d\delta'}=-\frac{\sin\delta\cos\delta'}{\cos\delta\sin\delta'} \quad . \quad . \quad . \quad (5.)$$

If we drop the perpendiculars rs and rt upon BA′ and BA produced, we have $Bt=d\delta$, and $Bs=d\delta'$. Put $Br=k$, angle $rBt=a$, and angle $rBs=a'$. If in the angle A′BD we conceive two arcs to be drawn through B respectively perpendicular to BA′ and BD, the isogeothermal line will lie some where between these two perpendiculars; for it is only in this situation that in passing from

B to r it can happen that δ will be increased and δ' diminished, and therefore that $\sin^n\delta \sin^n\delta'$, in formula (4), can remain the same. Now $Bs = Br \cos rBs$, or $d\delta' = k \cos a'$; and $Bt = Br \cos rBt$, or $d\delta = k \cos a$. Hence $\frac{d\delta}{d\delta'} = \frac{\cos a}{\cos a'}$; and, by equation (5), neglecting the minus sign; putting also u=angle A′BD,

$$\frac{\sin\delta\cos\delta'}{\cos\delta\sin\delta'} = \frac{\cos a}{\cos a'} = \frac{\cos a}{\cos(u-a)},$$

or,

$$\frac{\sin\delta\cos\delta'}{\cos\delta\sin\delta'} = \frac{\cos a}{\cos u\cos a + \sin u\sin a} = \frac{1}{\cos u + \sin u\tan a}.$$

Whence,
$$\tan a = \frac{\sin\delta'\cos\delta - \sin\delta\cos\delta'\cos u}{\sin\delta\cos\delta'\sin u},$$

or,
$$\tan a = \frac{\cot\delta\tan\delta'}{\sin u} - \cot u.$$

If we put β=ABA′ $u = 180 - \beta$, and

$$\tan a = \frac{\cot\delta\tan\delta'}{\sin\beta} + \cot\beta \quad . \quad . \quad . \quad (6.)$$

This formula gives the angle DBL. Subtracting this from 90° we obtain nBA, the angle included between the direction of the needle and BA(δ). The difference between this and ABC will be the declination of the needle, which will be east or west, according as one or the other of these angles is the greater.

The first of the equations above gives the following, which may be used as a tentative formula in place of equation (6):—

$$\frac{\cos a}{\cos(u-a)} = \frac{\tan\delta}{\tan\delta'} \quad . \quad . \quad . \quad . \quad (7.)$$

To make use of formula (6) we must know δ, δ', and β. These may be obtained by solving the two spherical triangles ACB, A′CB. The latitude and longitude of the place B, and the latitudes and longitudes of the two poles A and A′ being given, we readily find CB, AC, and A′C, and the angles ACB, A′CB.

The formulæ which have now been investigated, viz. (2), (3), and (6), serve for the determination of the vertical and horizontal intensities at any place, and the declination of the needle. By taking the square root of the sum of the squares of the horizontal and vertical intensities, we shall have the directive force or total magnetic intensity of the place; and by dividing the vertical by the horizontal intensity we shall have the tangent of the dip.

These formulæ I have compared with a large number of observations made in various parts of the northern hemisphere, and will proceed to give an exposition of the details of the calculations, and of the results obtained.

(*To be continued.*)

Art. II.—*General Geological Distribution and probable Food and Climate of the Mammoth;* by Prof. R. Owen.*

The remains of the Mammoth occur on the Continent, as in England, in the superficial deposits of sand, gravel, and loam, which are strewed over all parts of Europe; and they are found in still greater abundance in the same formations of Asia, especially in the higher latitudes, where the soil which forms their matrix is perennially frozen.† Remains of the Mammoth have been found in great abundance in the cliffs of frozen mud on the east side of Behring's Straits, in Eschscholtz's Bay, in Russian America, 66° N. lat.; and they have been traced, but in scantier quantities, as far south as the states of Ohio, Kentucky, Missouri, and South Carolina. But no authentic relics of the Elephas primigenius have yet been discovered in tropical latitudes,‡ or in any part of the southern hemisphere. It would thus appear that the primeval Elephants formerly ranged over the whole northern hemisphere of the globe, from the 40th to the 60th, and possibly to near the 70th degree of latitude. Here at least, at the mouth of the river Lena, the carcass of a Mammoth has been discovered, preserved entire, in the icy cliffs and frozen soil of that coast. To account for this extraordinary phenomenon, geologists and naturalists, biased more or less by the analogy of the existing Elephants, which are restricted to climes where the trees flourish with perennial foliage, have had recourse to the hypothesis of a change of climate in the northern hemisphere, either sudden, and due to a great geological cataclysm,§ or gradual, and brought about by progressive alterations of land and sea.||

* Extracted from Prof. Owen's British Fossil Mammalia, 8vo. London, 1846.

† Hedenström, in his "Survey of the Laechow Islands," on the north-eastern coast of Siberia, remarks, "that the first of these islands is little more than one mass of these bones; and that although the Siberian traders have been in the habit of bringing over large cargoes of them (tusks) for upwards of sixty years, yet there appears to be no sensible diminution."

‡ The fossil elephantine remains discovered in India, belong to a species more nearly allied to the Elephas indicus.

§ Cuvier, "Discours sur les Révolutions de la Surface du Globe." It is obvious that the frozen Mammoth at the mouth of the Lena, forms one of the strongest, as well as the most striking, of the celebrated anatomist's assumed "proofs that the revolutions on the earth's surface had been sudden." Cuvier affirms that the Mammoth could not have maintained its existence in the low temperature of the region where its carcass was arrested, and that at the moment when the beast was destroyed, the land which it trod became glacial. "Cette gelée éternelle n'occupait pas auparavant les lieux où ils out été saisis; car ils n'auraient pas pu vivre sous une pareille température. C'est donc le même instant qui a fait périr les animaux, et qui a rendu glacial le pays qu'ils habitaient. Cet événement a été subis, instantané, sans aucune gradation, &c."—*Ossemens Fossiles*, 8vo, ed. 1834, tom. i, p. 108.

|| Lyell, "Principles of Geology," in which the phenomena that had been supposed "to have banished for ever all idea of a slow and gradual revolution,"* were first attempted to be accounted for by the gradual operation of ordinary and existing causes.

* Jameson's "Cuvier's Theory of the Earth," 8vo, p. 16, 1813.

I am far from believing that such changes in the external world were the cause of the ultimate extinction of the Elephas primigenius; but I am convinced that the peculiarities in its ascertained organization, are such as to render it quite possible for the animal to have existed as near the pole as is compatible with the growth of hardy trees or shrubs. The fact seems to have been generally overlooked, that an animal organized to gain its subsistence from the branches or woody fibre of trees, is thereby rendered independent of the seasons which regulate the development of leaves and fruit; the forest food of such a species becomes as perennial as the lichens that flourish beneath the winter snows of Lapland; and, were such a quadruped to be clothed, like the Reindeer, with a natural garment capable of resisting the rigors of an arctic winter, its adaptation for such a climate would be complete. Had our knowledge of the Mammoth, indeed, been restricted, as in the case of almost every other extinct animal, to its bones and teeth, it would have been deemed a hazardous speculation to have conceived, a priori, that the extinct ancient Elephant, whose remains were so abundant in the frozen soil of Siberia, had been clad, like most existing quadrupeds adapted for such a climate, with a double garment of close fur and coarse hair; seeing that both the existing species of Elephants are almost naked, or, at least, scantily provided when young with scattered coarse hairs of one kind only.

The wonderful and unlooked for discovery of an entire Mammoth, demonstrating the arctic character of its natural clothing, has, however, confirmed the deductions which might have been legitimately founded upon the localities of its most abundant remains, as well as upon the structure of its teeth, viz., that, like the Reindeer and Musk Ox of the present day, it was capable of existing in high northern latitudes.

The circumstances of this discovery have been recorded by Mr. Adams in the 'Journal du Nord,' printed at Petersburg in 1807, and in the 5th volume of the 'Memoirs of the Imperial Academy of Sciences at St. Petersburg,' of which an excellent English translation was published in 1819.

Schumachoff, a Tungusian hunter and collector of fossil ivory, who had migrated in 1799 to the peninsula of Tamut, at the mouth of the river Lena, one day perceived amongst the blocks of ice a shapeless mass, not at all resembling the large pieces of floating wood which are commonly found there. To observe it nearer, he landed, climbed up a rock, and examined this new object on all sides, but without being able to discover what it was. The following year he perceived that the mass was more disengaged from the blocks of ice, and had two projecting parts. Towards the end of the next year, (1801,) the entire side of the animal and one its tusks were quite free from the ice. On his return to the borders of the Lake Oncoul, he communicated this extraordinary discovery to his wife and some of his friends, but their reception of the news filled him with grief. The old men related how they had heard their fathers say, that a similar monster had been formerly discovered on the same peninsula, and that all the family of the person who had discovered it had died soon afterwards. The Mammoth was consequently regarded as an augury of future calamity, and the Tungusian was so much alarmed that he fell seriously ill; but becoming convalescent, his first idea was the profit he might obtain by selling the tusks of the animal, which were of extraordinary size and beauty. The summer of 1802 was less warm and more stormy than usual, and the icy shroud of the Mammoth had scarcely melted at all. At length, towards the end of the fifth year, (1803,) the desires of the Tungusian were fulfilled; for, the parts of the ice between the earth and the Mammoth having melted more rapidly than the rest, the plane of its support became inclined, and the enormous mass fell by its own weight on a bank of sand. Of this, two Tungusians who accompanied Mr. Adams were witnesses. In the month of March, 1804, Schumachoff came to his Mammoth, and having cut off the tusks, exchanged them with a merchant, called Bultunoff, for goods of the value of fifty rubles.

Two years afterwards, or the seventh after the discovery of the Mammoth, Mr. Adams visited the spot, and "found the Mammoth still in the same place, but altogether mutilated. The prejudices being dissipated because the Tungusian chief had recovered his health, there was no obstacle to prevent approach to the carcass of the Mammoth; the proprietor was content with his profit from the tusks; and the Jakutski of the neighborhood had cut off the flesh, with which they fed their dogs during the scarcity. Wild beasts, such as white bears, wolves, wolverines, and foxes, also fed upon it, and the traces of their footsteps were seen around." The skeleton, almost entirely cleared of its flesh, remained whole with the exception of one foreleg, (probably dragged off by the bears.) The spine, from the skull to the os coccygis, one scapula, the pelvis, and the three remaining extremities, were still held together by the ligaments and by parts of the skin. The head was covered with a dry skin; one of the ears, well preserved, was furnished with a tuft of hair. The point of the lower lip had been gnawed; and the upper one, with the proboscis, having been devoured, the molar teeth could be perceived. The brain was still in the cranium, but appeared dried up: the parts least injured were one forefoot and one hindfoot: they were covered with skin, and still had the sole attached. According to the assertion of the Tungusian discoverer, the animal was so fat, that its belly hung down below the joints of the knees. This Mammoth was a male, with a long mane on the neck; the tail was much mutilated, only eight, out of twenty-eight or thirty caudal vertebræ, remaining; the proboscis was gone, but the places of the insertion of its muscles were visible on the skull. The skin, of which about three-fourths were saved, was of a dark grey color, covered with a reddish wool, and coarse long black hairs. The dampness of the spot where the animal had lain so long, had in some degree destroyed the hair. The entire skeleton, from the fore part of the skull to the end of the mutilated tail, measured sixteen feet four inches; its height was nine feet four inches. The tusks measured along the curve nine feet six inches, and in a straight line from the base to the point, three feet seven inches.

Mr. Adams collected the bones, and had the satisfaction to find the other scapula, which had remained, not far off. He next detached the skin on the side on which the animal had lain, which was well preserved; the weight of the skin was such, that ten persons found great difficulty in transporting it to the shore. After this, the ground was dug in different places to ascertain whether any of its bones were buried, but principally to collect all the hairs which the white bears had trod into the ground while devouring the flesh; and more than thirty-six pounds' weight of hair were thus recovered. The tusks were repurchased at Jatusk, and the whole expedited thence to St. Petersburg; the skeleton is now mounted in the museum of the Petropolitan Academy.*

It might have been expected that the physiological consequences deducible from the organization of the extinct species, which was thus in so unusual a degree brought to light, would have been at once pursued to their utmost legitimate boundary, in proof of the adaptation of the Mammoth to a Siberian climate; but, save the remark that the hairy covering of the Mammoth must have adapted it for a more temperate zone than that assigned to existing Elephants,† no further investigations of the relation of its organization to its habits, climate, and mode of life,

---

* A part of the skin and some of the hair of this animal, were sent by Mr. Adams to Sir Joseph Banks, who presented them to the Museum of the Royal College of Surgeons. The hair is entirely separated from the skin, excepting in one small part, where it still remains firmly attached. It consists of two sorts, common hair and bristles; and of each there are several varieties, differing in length and thickness. That remaining fixed on the skin is thick-set and crisply curled; it is interspersed with a few bristles, about three inches long, of a dark reddish color. Among the separate parcels of hair are some rather redder than the short hair just mentioned, about four inches long, and some bristles nearly black, much thicker than horse-hair, and from twelve to eighteen inches long. The skin when first brought to the Museum, was offensive to the smell. It is now quite dry and hard, and where most compact is half an inch thick. Its color is the dull black of the living Elephant.

† "La longue toison dont cet animal était convert semblerait même démontrer, qu'il était organisé pour supporter un degré de froid plus grand que celui qui convient à l'éléphant de l'Inde."—*Pictet, Paleontologie,* 8vo, tom. i, p. 71, 1844.

appear to have been instituted; they have in some instances, indeed, been rather checked than promoted.

Dr. Fleming has observed, that "no one acquainted with the gramineous character of the food of our Fallow-deer, Stag, or Roe, would have assigned a lichen to the Reindeer." But we may readily believe that any one cognizant of the food of the Elk, might be likely to have suspected cryptogamic vegetation to have entered more largely into the food of a still more northern species of the deer tribe. And I can by no means subscribe to another proposition by the same eminent naturalist, that "the kind of food which the existing species of Elephant prefers, will not enable us to determine, or even to offer a probable conjecture concerning that of the extinct species." The molar teeth of the Elephant possess, as we have seen, a highly complicated and a very peculiar structure, and there are no other quadrupeds that derive so great a proportion of their food from the woody fibre of the branches of trees. Many mammals browse the leaves; some small rodents gnaw the bark; the Elephants alone tear down and craunch the branches, the vertical enamel plates of their huge grinders enabling then to pound the tough vegetable tissue and fit it for deglutition. No doubt the foliage is the most tempting, as it is the most succulent part of the boughs devoured; but the relation of complex molars to the comminution of the coarser vegetable substance is unmistakeable. Now if we find in an extinct Elephant the same peculiar principle of construction in the molar teeth, but with augmented complexity, arising from a greater number of the triturating plates and a greater proportion of the dense enamel, the inference is plain that the ligneous fibre must have entered in a larger proportion into the food of such extinct species. Forests of hardy trees and shrubs still grow upon the frozen soil of Siberia, and skirt the banks of the Lena as far north as latitude 60°. In Europe, arboreal vegetation extends ten degrees nearer the pole, and the dental organization of the Mammoth proves that it might have derived subsistence from the leafless branches of trees, in regions covered during a great part of the year with snow.

We may therefore safely infer from physiological grounds, that the Mammoth would have found the requisite means of subsistence at the present day, and at all seasons, in the sixtieth parallel of latitude; and relying on the body of evidence adduced by Mr. Lyell in proof of increased severity in the climate of the northern hemisphere, we may assume that the Mammoth habitually frequented still higher latitudes at the period of its actual existence. "It has been suggested," observes the same philosophic writer, "that, as in our own times, the northern animals migrate, so the Siberian Elephant and Rhinoceros may have wandered towards the north in summer." In making such excursions during the heat of that brief season, the Mammoths would be arrested in their northern progress by a condition to which the Reindeer and Musk Ox are not subject, viz. the limits of arboreal vegetation, which, however, as represented by the dominating shrubs of Polar lands, would allow them to reach the seventieth degree of latitude.* But, with this limitation, if the physiological inferences regarding the food of the Mammoth from the structure of its teeth be adequately appreciated and connected with those which may be legitimately deduced from the ascertained nature of its integument, the necessity of recurring to the forces of mighty rivers hurrying along a carcass through a devious course, extending through an entire degree of latitude, in order to account for its ultimate entombment in ice, whilst so little decomposed as to have retained the cuticle and hair, will disappear. And it can no longer be regarded as impossible for herds of Mammoth to have obtained subsistence in a country like the southern part of Siberia where trees abound, notwithstanding it is covered during a great part of the year with snow, seeing that the leafless state of such trees during even a long and severe Siberian winter, would not necessarily unfit their branches for yielding sustenance to the well-clothed Mammoth.

With regard to the extension of the geographical range of the Elephas primigenius into temperate latitudes, the distribution of its fossil remains, teaches that it reached the fortieth degree north of the equator. History, in like manner, records that the Reindeer had formerly a more extensive distribution in the temperate latitudes of Europe than it now enjoys. The hairy covering of the Mammoth concurs, however, with the localities of its most abundant remains, in showing that, like the Reindeer, the northern extreme of the temperate zone was its metropolis.

Attempts have been made to account for the extinction of the race of northern Elephants, by alterations in the climate of their hemisphere, or by violent geological catastrophes, and the like extraneous physical causes. When we seek to apply the same hypothesis to explain the apparently contemporaneous extinction of the gigantic leaf-eating Megatherian of South America, the geological phenomena of that continent appear to negative the occurrence of such destructive changes. Our comparatively brief experience of the progress and duration of species within the historical period, is surely insufficient to justify, in every case of extinction, the verdict of violent death. With regard to many of the larger Mammalia, especially those which have passed away from the American and Australian continents, the absence of suffi-

* In the extreme points of Lapland, in 70° north latitude, the pines attain the height of sixty feet; and at Enontekessi, in Lapland, in 68° 30′ north latitude, von Buch found corn, orchards, and a rich vegetation at an elevation of 1356 feet above the sea.—*Lindley, Intr. to Botany*, pp. 435, 490.

cient signs of extrinsic extirpating change or convulsion, makes it almost as reasonable to speculate with Brocchi,* on the possibility that species like individuals may have had the cause of their death inherent in their original constitution, independently of changes in the external world, and that the term of their existence, or the period of exhaustion of the prolific force, may have been ordained from the commencement of each species.

ART. III.—*Note upon Carex loliacea*, Linn., *and C. gracilis*, Ehrh.; by A. GRAY.

UNDER the name of *Carex loliacea*, two distinct species have long been confounded, which, although they have been of late to some extent distinguished, yet their history and synonymy still require elucidation.

Linnæus established his *C. loliacea* upon a Swedish plant, indicated in the *Flora Suecica*, No. 840, to which the specific name was first applied in the *Species Plantarum*, with the phrase: "C. spiculis subovatis sessilibus remotis androgynis, capsulis ovatis teretiusculis muticis divaricatis." He further describes it as having from four to eight small ovate spikelets scattering at the apex of the culm, and the perigynia "ovate, obtuse, pointless, and rounded on the lower side;" and proceeds to compare it with C. muricata, (which as to the *Flora Suecica*, is stated by Wahlenberg to be the C. stellulata, *Good.*,) from which it is said to differ in its smaller size, and in the less divaricate obtuse fruit. I suppose that there is no authentic specimen preserved in the Linnæan herbarium.

In the year 1802, Schkuhr figured† and described what he, with much hesitation, took for C. loliacea, remarking however that this Linnæan species was a very doubtful plant, and that what he had taken for it was probably only a variety of C. muricata; which seems to have been the case.

In the next year the real C. loliacea was, as I suppose, correctly taken up by Wahlenberg, a botanist most likely to know the Linnæan plant, who well characterized it as follows: "C. spiculis *basi masculis* subdistantibus ternis paucifloris, squamis brevibus, *capsulis subovali-ellipticis utrinque convexiusculis obtusis obtusangulis* divaricatis, ore integerrimo, bracteolis setigeris, foliis angustissimis."‡

In 1805, Willdenow gave a new phrase, viz. "C. spica androgyna composita, spiculis subquaternis inferne masculis subapproximatis, stigmatibus binis, *fructibus ellipticis obtusis nervosis com-*

---

* Cited by Lyell, "Principles of Geology," (1835,) vol. iii, p. 104.
† Reidgr. t. Ee, No. 91. ‡ Wahlenb. in Act. Holm. 1803. p. 147.

pressis erectis."* This character was evidently drawn from the specimen in his herbarium marked fol. 2, the source of which is not recorded, and from which Kunth has also recently derived an additional description of C. loliacea; while the fol. 1, holds a Swedish specimen of a different plant, sent by Swartz under the name of C. loliacea, which (judging from a memorandum made on inspection several years ago) is most probably the C. tenella of *Schkuhr*. This C. tenella, Willdenow remarks, is the same as C. loliacea, but is incorrectly delineated and described by Schkuhr as having the spikelets masculine at the summit. Here is the beginning of the confusion, soon further complicated by Schkuhr himself, in which these two very distinct species have ever since been involved.

Schkuhr established and figured his *C. tenella*, in the first part of his work on Carices, in 1802, (No. 15, t. Pp, f. 104,) upon a plant which he found in the herbarium of a friend, who was entirely ignorant of its source, or even whether he had collected it himself or received it from a correspondent. This friend, as he elsewhere states, was Hedwig. Schkuhr's herbarium shows that he subsequently received the same species from Sweden, through Thunberg, ticketed "C. loliacea, *Linn.* In Nordlandia Norvegiæ rarius, per Nordlandiam Sueciæ copiose." In the same work, Schkuhr also figured (t. E, f. 24) a plant of unrecorded origin, which he took for the C. gracilis of "*Ehrhart, Gram.* [*Phytophylac?*] 78." The specimen which Schkuhr figured is not preserved in his herbarium; but in a paper fixed to the folio under this name, marked "Saamen," I found the very perigynium and achenium (*i. e.*) separately delineated in his figure. The perigynium is distinctly beaked, the staminate flowers are plainly depicted as occupying the summit of the spikelets, and the whole figure so nearly agrees with the smaller states of *C. rosea*, that I can scarcely doubt it was derived from that plant. In place of the specimen actually figured, the herbarium of Schkuhr contains one with a printed ticket, "C. gracilis, *Ehrh.:* Upsal," which is probably an authentic specimen from Ehrhart's original collection, but which, as it certainly is not the plant which Schkuhr has depicted, I suppose to have been received at a later period, and that the specimen which served for the figure in question was then discarded.

On obtaining possession of this authentic specimen (as I take it to be) of Ehrhart's *C. gracilis*, Schkuhr could not fail to perceive that it was precisely the same species with his own C. tenella, and with what had already been sent him from Sweden under the name of C. loliacea. Accordingly, in his Supplement, (1806,) he united the two, (but without explaining the

* Wild. Sp. Pl. 4, p. 237.

mistake he had made in figuring as C. gracilis, something different from the Ehrhartian plant;) and, following the cue which had been given him by Swartz, Willdenow, and Thunberg, erroneously referred them both to C. loliacea, *Linn.* Under that species, consequently, these two synonyms have been generally cited ever since, notwithstanding the discrepancy in the position of the staminate flowers, which in C. gracilis, *Ehrh.*, (C. tenella, *Schk.*,) are *correctly* described by Schkuhr as at the apex; while those of C. loliacea are rightly characterized by Wahlenberg and Willdenow, and indeed by all succeeding writers, as occupying the base of the spikelets: and the difference in the perigynia, &c. of the two species is not less decisive. Yet even Wahlenberg has unguardedly adduced the synonym in his Flora Lapponica; where he has given a further and most excellent account of the genuine C. loliacea, particularly contrasting it with his own C. tenuiflora, which is indeed the nearest related species. He notices the "*squamæ albicantes, omnium tenuissimæ*," and well describes the perigynia as follows: "Capsulæ in singula spicula 3 vel 4, ita obtusæ ut apice fere rotundatæ, utrinque convexiusculæ nervosæ, ob formam suam seminibus *Lolii temulenti* haud dissimiles, ut nomen omnino bonum."*

While the C. loliacea, *Linn.*, is, so far as I am aware, restricted to the north of Europe, the C. gracilis, *Ehrh.* has apparently a wider range and is much more abundant in the new world than in the old. It is the well-known *C. disperma*, of Dewey; who, while he noted its resemblance to C. loliacea, *Schk.*, (tenella, *Schk.*,) conceived it to be distinct by its terminal staminate flowers—a point in which it does indeed differ from the true C. loliacea, but not from the plant which Schkuhr mistook for it.

The two plants are so distinct in appearance and character, that the wonder is they should have been so long confounded. But I know of only two botanists who have distinguished them, namely, Nylander and Mr. Tuckerman. As to the former, my information is indirect. Ruprecht, in his recent critical enumeration of the plants which grow around St. Petersburg, has a "*Carex tenella*, Schkuhr, et Fl. Petropol. Bene diversa est a C. loliacea, L., utrasque exposuit cl. Nylander in *Spic. Fl. Fenn.*, ii, No. 92 et 93."† I have no acquaintance with the work of Nylander here cited, nor do I know its date; but I possess, through the kindness of Dr. Fischer, specimens ticketed "*Carex pulchella*, Nylander: ad oppidum Sardavalæ, Finlandiæ," which exactly accord with the American C. disperma, and, so far as recollection

---

* Wahl. Fl. Lapp., p. 232.—In his Flora Suecica, he further adds, that the "capsules are a line and a half long," which is fully one-third longer than are those of C. gracilis.

† In Historiam Stirp. Fl. Petropol. Diatribæ, p. 84. 1845.

and memoranda may be trusted, with the "C. gracilis, *Ehrh.*, Upsal," in Schkuhr's herbarium.

Mr. Tuckerman, in his *Enumeratio Caricum*, (1843,) p. 19, rightly remarks, that the C. loliacea of Schkuhr is scarcely that of Wahlenberg and Fries; and he inclines to the opinion, that the specimen from which Schkuhr figured his C. tenella, out of Hedwig's herbarium, was received by Hedwig from Muhlenberg, and therefore may directly represent the American plant. This is not unlikely; but Mr. Tuckerman does not appear to have been aware that this species is also a native of the north of Europe, and had been gathered at least as early as the year 1780. He justly remarks, also, that it is scarcely credible that Schkuhr's figures 24 and 104, can belong to the same species. I have already given what I believe to be the explanation of this incongruity.

It would therefore appear that the synonymy of the two species in question should stand as follows:

1. C. loliacea, *Linn.; Wahl.; Fl. Dan.*, t. 1403; *Kunth*, (excl. syn. C. tenella and C. gracilis, *Schk.*,) not of *Schk. Car. No.* 14, f. 91, nor *Suppl. No.* 47, p. 18.

2. C. gracilis, Ehrh.; not of *Schk. Car.*, f. 24, nor of *R. Br.* C. tenella, Schk. Car., f. 104. C. loliacea, *Schk. Car. Suppl.*, p. 18; not of *Linn.*, *etc.* C. disperma, *Dewey;* not of *Kunze, Car.*, t. 33.*

Art. IV.—*Description of Three New Carices, and a New Species of Rhynchospora;* by John Carey.

Carex Grayii: spica mascula solitaria pedunculata; spicis fœmineis 2 globosis densi-(25–30-) floris exserte pedunculatis; stigmatibus 3; perigyniis deflexo-patentibus ovatis ventricosis multi-nervosis rostratis ore bifidis squamam ovatam hyalinam mucronatam triplo longioribus.—C. intumescens, var. β. globularis, *A. Gray, in Ann. Lyc. Nat. Hist. N. Y.*, iii, 236.

Hab. Ad ripas fluminum "Mohawk" et "Wood-creek," Nov. Ebor. occident. detexit cl. A. Gray, M.D.

Culm 3 feet high, robust, triquetrous, smooth and leafy. Leaves taller than the culm, 4–5 lines broad, rough on the margin. Sterile spike 1½–2 inches long: fertile spikes globular, occasionally single, but generally 2, quite distinct and separate, 1½ inch in diam-

* The figure which Prof. Kunze has given as *C. disperma*, from specimens gathered on the Black Mountain of North Carolina by Rugel, is an entirely different species; namely, the C. rosea, var. radiata, *Dewey*, (C. neglecta, *Tuckerm.*,) or very near it—a plant which I have myself gathered on the mountains of Carolina, very far south of the known range of the species for which this excellent Caricologist has unaccountably mistaken it.

eter. Perigynia crowded, deflexed, smooth and shining, 9 lines in length, 25–30 nerved, tapering into a long perfectly glabrous beak. Achenium obtusely triangular, minutely dotted under a lens, crowned with the long continuous style.

Dr. Gray, who first detected this plant on the banks of the Mohawk at Utica, and described it as a variety of C. intumescens, *Rudge*, remarks, that it "is characterized by its larger and coarser habit, and by its globose, many-flowered pistillate spikes. It flowers a month later than the ordinary form of the species, and when young might readily be mistaken for C. lupulina." To this may be added, that C. intumescens, owing to the scarcely exserted peduncles, has the loose, few- (5–8-) flowered spikes closely approximate, so as to be almost indistinguishable; and the perigynia are erect, much shorter, (6–7 lines long,) slightly serrulate towards the apex of the beak, and only 15–20-nerved. Though closely resembling C. intumescens, these constant characters and a marked difference in aspect, appear to entitle this plant to rank as a species.*

Carex platyphylla: spicis 4; mascula 1 erecta gracili pedunculata; fœmineis 3 erectis filiformibus laxe 3–4-floris incluse pedunculatis, suprema masculæ approximata, cæteris remotis folioso-bracteatis; bracteis spicas paulo superantibus; stigmatibus 3; perigyniis triquetris ovalibus striatis brevissime rostellatis squamam ovatam hyalinam acutam vel mucronatam subæquantibus, ore obliquo integro.

Hab. In declivibus umbrosis, Nov. Angl. et Nov. Ebor.

Culms numerous, leafless, 8–12 inches long, slender, somewhat ancipital, smooth, diffusely spreading and prostrate in fruit. Leaves all radical, ½–1 inch in breadth, 4–6 inches long, flat, pale green or whitish, striate throughout with very fine and close nerves, three of them more conspicuous. Fertile spikes generally 3, erect, ½–¾ of an inch in length, with a few distant alternate flowers, subtended by leafy sheathing bracts, which are not much longer than the spikes. Perigynia triquetrous, finely striate, narrowed at the apex, with a minute oblique point: scale of a light chestnut color, with a green keel and scarious margins.

This plant, though not uncommon in shady ravines, has been hitherto confounded either with the large leaved form of C. anceps, *Muhl.*, or with C. retrocurva, *Dew.*, from both of which, however, it is quite distinct. It forms, with C. plantaginea, *Lam.*, and C. Careyana, *Dew.*, a well marked subsection, (*Plantagineæ*,) which may be characterized by the few-flowered, erect fertile spikes, the upper usually close to the barren one, all on

* Since the foregoing description was in type, I have seen specimens from Columbus, Ohio, collected by Mr. Sullivant.

short peduncles nearly included within the small sheathing bracts, or the lower partly exserted; and by the triquetrous fruit; numerous, leafless, diffuse, and at length prostrate culms; and broad radical leaves. In the varying forms of C. anceps, the perigynium is constantly more obtuse on the angles, and more obovate in outline; and the bracts are always long and leafy, the upper exceeding the culm. In C. digitalis, *Willd.*, and the closely allied C. retrocurva, the leaves and bracts are also long and grassy, commonly exceeding the culms, and the lower spikes are generally on much-exserted, filiform, more or less pendulous peduncles. The perigynium of the present species, the smallest of the group here indicated, closely resembles that of C. digitalis.

Carex sychnocephala: spicis androgynis inferne masculis crebris arcte capitato-aggregatis folioso-bracteatis; stigmatibus 2; perigyniis compressis e basi ovato-lanceolata abrupte contracta subsessili longe sensimque rostratis apice bifidis margine scabris squamam hyalinam lanceolatam abrupte mucronatam paulo longioribus.—C. cyperoides, *Dew.*, *in Am. Jour. of Sc. and Arts*, iii, 171, non *L.*

Hab. In Nov. Ebor. Comitat. "Jefferson," ubi legerunt cl. I. B. Crawe, M.D., et cl. W. A. Wood, M.D.

Culm about a foot high, leafy, smooth; spikes sessile, densely clustered, forming a compound capitate spike subtended by 3 long unequal foliaceous bracts much exceeding the spike. Perigynium tapering from an abruptly contracted ovate base into a long and slender scabrous bifid beak, a little exceeding the lanceolate abruptly mucronate scale. Achenium ovate, compressed, crowned with the lengthened style.

This plant, which has a great resemblance to C. cyperoides, *Linn.*, differs from that species in the nearly sessile perigynium, which tapers from a much wider and contracted (not attenuated) base into a shorter beak, of which the teeth are also shorter than in the European plant. The perigynia are more crowded on the rachis than in C. cyperoides, the spikes of which, owing to the greater length of the beaks, have a more comose appearance than in our plant. The scale is shorter, abruptly mucronate, and not gradually tapering as in C. cyperoides; and the achenium is ovate, not ovate-oblong, as in that species.

I may here mention that, amongst the undetermined species of Carex in the rich herbarium of my friend, Prof. Gray, I find C. vulpina, *L.*, collected at, or near Columbus, Ohio, by Mr. Sullivant; and also a single specimen from Illinois, communicated by Dr. Engelmann of St. Louis. They correspond perfectly with the European plant, and the species may possibly be common in the Western States, where it may have been hitherto confounded with the nearly allied, though very distinct, C. stipata, *Muhl.*

Rhynchospora Knieskernii: culmo trigono gracili; spicis numerosis in glomerulis 4–6 distantibus aggregatis; nuce lævi obovata substipitata setas 6 retrorsum hispidas æquante tuberculo triangulari subduplo longiore.

Hab. In pinetis Nov-Cæsar., detexit cl. P. D. Knieskern, M.D.

Culm 12–18 inches high, branching from the base, slender, nearly smooth: leaves short and narrow. Spikes small, setaceously bracteate, forming small distant clusters throughout the entire length of the culm, each subtended by a long foliaceous bract. Nut obovate, lenticular, attenuate at the base. Tubercle compressed, broad at the base, about half the length of the nut.

In its characters this species is closely allied to R. capillacea, *Torr.*, from which, however, it is readily distinguished by the shorter and more numerous aggregated spikes, and the much smaller nut and short bristles. In general appearance it more nearly approaches to R. gracilenta, *Gray*, but the nut is quite different, and the bristles are not antrorsely hispid as in that species. I learn from Dr. Knieskern, that it grows exclusively on banks of iron ore in the Pine barrens of New Jersey. He distributed it, as new, under the name of R. Grayana, which name being preoccupied by Kunth for the R. Elliottii, *Gr. Mon. Rhynch.*, I dedicate it to the discoverer.

Art. V.—*Observations on the Whirlpool, and on the Rapids, below the Falls of Niagara; designed by illustrations to account for the origin of both;* by R. Bakewell, New Haven.

On my return to England soon after visiting the Falls of Niagara in the year 1829, I published in Loudon's Magazine a short memoir illustrated by drawings, exhibiting the physical structure of the country along the river Niagara, with special reference to the retrograde movement of the falls; in the course of my remarks I endeavored to prove from the conformation of the strata, and the erosive action of water, that the falls were once at Queenston. During the six days that I remained there, I made several sketches of the falls and the surrounding scenery, little expecting at the time that I should ever see the cataract again. I returned to America to reside in the summer of 1830, and in the autumn of 1846, I spent eight days at Niagara, taking with me the sketches which I had made seventeen years before. After a lapse of so many years, I was sensibly impressed with the change, which had taken place, particularly in the Canada fall. The waters had receded from the American side of the Horse-shoe fall towards the centre; parts of the precipice were bare which in 1827 were entirely hid by the descending flood. The water which then flowed over these projecting bare rocks, in descending, spread out into magnificent festoons. The beautiful feature which I formerly saw has disappeared. To this it may be said, that the waters of Lake Erie were unusually low in 1846, and this may account for the retreat. But I would reply, that no diminution was indicated by the banks of the river. I was told in 1829, by one who had resided there forty years, that a difference of level was perceptible only when a strong southwest wind sweeps over the wide expanse of Lake Erie, driving its waters into the mouth of the river. Not having made a very careful outline of the edge of the American fall, I am not prepared to say, whether any material change had taken place, with the exception of its being apparently more broken in the centre, where the cutting process appears to go on with great activity. It is stated by residents there, that a considerable alteration had taken place, from the falling of masses of limestone rock from the middle of the cataract. That a constant change is in progress no one can doubt who carefully examines for himself as he wanders over this wonderful scene. I was particularly impressed with its magnificence while making a drawing of what is called the cave, situated half a mile below the ferry on the American side. This cave or ledge of bare rock, has just the appearance that the rocks over which the American falls are now precipitated, would present, if the *waters were suddenly withdrawn.* The same broken outline appears in both instances, giving evidence that in each case the most violent action had been in the centre. When the cataract was here, the space between the American fall and the commencement of the 'cave', was in all probability, an island, presenting a similar appearance to what the falls now have. There is still a small stream flowing down the precipice where once a mighty torrent fell.

What surprised me much on my second visit, was the comparative stillness in which the mighty work of discharging the surplus waters of so many inland seas down a precipice of one hundred and eighty feet was carried on. In father Hennepin's curiously interesting description of this "vast and prodigious cadence of water," he represents himself or his friends as being so overcome by the noise, that the hands were applied to the ears by way of dampers. The marvel to me is, that they make so little noise. It cannot be denied, however, that the state of the atmosphere and direction of wind, have much to do in regulating the sound produced by the fall of this immense body of water.

After these preliminary remarks, I will now confine myself more particularly to the object for which this communication was undertaken, which was to offer some observations on the whirlpool, as well as on the rapids below the falls, and to assign a probable cause for their existence. If in doing this I should be able to add any thing to the interest which will ever be felt by those who visit the falls, and its vicinity, my labor will not be altogether in vain.

Fig. 1.

A Birds-eye View, or Map of the Ravine from the Falls of Niagara to the Whirlpool.

K. Canada.—U. United States.—The dotted lines represent the outline of the ancient valley, partly filled with drift, H.—F. Ravine.—C. Whirlpool.—B. Summer-house.—D, E. Quartzose rock seen below the surface of the water.

Having made several visits to the whirlpool, taking sketches from points which I thought most desirable, I found that each visit increased my admiration and wonder. A general idea of its situation may be had by reference to the drawing, fig. 1, giving a birds-eye view of the country from the falls to the whirlpool, a distance of three miles. Perhaps I shall make myself better understood by giving a description of the ravine from A to B. The width of the river at the ferry is about eleven hundred and forty feet. The height of the rocks, one hundred and eighty feet. On the verge of the precipice, a little below the American falls, there is a path which leads directly to the Summer-house, B, situated immediately above the whirlpool; this path continues close to the edge of the precipice. About half a mile down, we come to the 'cave' before alluded to—a bare rock on which nothing grows—a place of deep interest to the traveller as he stands upon this ancient bed of a former lateral torrent.

The river below the falls moves majestically along without a ripple, having the appearance of dark bottle-green marble, varying at times into blue, with yellowish and greenish veins, the latter due to the foam which seems as if imbedded as it streams down in long wavy lines. This solid representation of water, gave an additional novelty to the scene. About one mile from the falls the sides of the ravine gradually converge, diminishing of course the width of the river. Half a mile still lower,* following along by the edge of the precipice, the stream takes a gentle turn to the left. The water on each side is seen to ripple; then commences a chain of waves preceded by deep furrows, which converge to a point in the middle of the river, indicating not only the rapidity of the current, but also the upheaving of the waters, rising, as has been ascertained by measurement, eleven feet above the level at the sides; after this, it is broken into foam and spray, and dashing on with impetuous fury, pursues its wild career for about a mile, then rushes with the swiftness and violence of an avalanche into a wide circular area of one hundred and twenty acres in extent. Then, suddenly, as by an unseen power, it is calmed down, and in silence sweeps round in eddying circles; these circles glide into curves which swell round this vast amphitheatre in gentle undulations, as if gathering strength for its last conflict through the narrow portal which leads to its oblivion in the waters of Ontario.

While standing on the precipice at the Summer-house, (B, fig. 1,) which overlooks the whirlpool, my attention was particularly directed to the place where the waters enter the whirlpool, where I could distinctly see the rocks projecting for a considerable distance from the Canada side towards the centre of the current, not many feet below the surface of the water, contracting very considerably the space through which the waters apparently escape. The curved line, DE, indicates this projection. There was something impressively grand in the whole scene as contemplated from this point. The drainage of four great lakes covering an area of about 135,000 square miles, escapes at the northern extremity of Lake Erie through a channel, (as stated by Mr. Allen, from measurements by Mr. E. R. Blackwell,) seventeen hundred feet in width, thirty-two feet in depth, running at the rate of six miles an hour, equal to 22,440,000 cubit feet, weighing 701,250 tons, flowing every minute;†—here the whole is confined to a breadth not exceeding two hundred and twenty-five feet! the distance from rock to rock, as I was informed by the proprietor

* I observed a steamboat intended to ply between a landing place, which had been constructed at great expense down the precipice to the water's edge, at the base of the falls, &c.; but on trial, the engine had not power sufficient to contend with the current. It is to be hoped the project will be forever abandoned. In case of accident to the machinery, there is nothing to prevent the destruction of the boat in the rapids.

† Am. Jour. of Sci., Vol. xlvi, p. 71.

of the grounds. The question naturally arises, how is it possible for this immense volume of water to escape through so narrow a defile, and then suddenly to become comparatively sluggish in the whirlpool. On referring to Mr. Lyell's admirable work on America which I had with me, and examining the section of the strata from Niagara to the whirlpool, which Mr. L. had taken from Mr. Hall's geological Report on the Geology of New York, it occurred to me that a satisfactory explanation might be given. The projecting rock under the water is unquestionably the hard quartzose sandstone, and underneath this lies a very thick bed of soft red shale. A short distance before the waters enter the whirlpool, this floor of hard sandstone rock is broken through, and the resistless torrent has made itself a passage underneath this rock, on each side of the ravine, and it is by this excavation that the waters escape. This perhaps will be made more apparent, when explaining in the sequel the supposed origin of the whirlpool.

The section, fig. 2, is principally from Lyell, in which I have introduced the river, whirlpool, and the ancient lateral valley, (H,) filled with drift. In the following remarks, great stress is laid on the relative hardness of the rocks which compose the Niagara group: consisting as it does, of hard limestone, calcareous shale, soft shaly sandstone, and of quartzose sandstone. Had all the strata consisted of solid limestone, as I remarked in the communication before re-

Fig. 2.

A Section of the Strata on the Canada side of the Niagara River, from the Falls to Queenston.

S.

N.

F, G. Compact limestone resting on soft beds of shales.—3. Red shaly sandstone—very friable drift.—2. Quartzose sandstone extremely hard.—1. Thick bed of shale, very soft.—H. Valley filled up with drift, marked H in fig. 1.—W. Whirlpool, which forms the terminus to the deep lateral valley as represented by W in fig. 4, and by the dotted lines, I, F, G, in fig. 1.

ferred to, 'there is great reason to believe that the erosive action of the water would have been very slow, and many generations might have passed without any sensible change; but the vast mass of waters breaking with inconceivable force on the softer shale which forms the base of the hard rock, the foundation is thus undermined, the harder rocks fall down for want of support,' thus causing the various changes between turbulence and tranquillity which take place in the river in its course from the falls to the outlet at Queenston.

Taking it for granted that the cataract was once at the precipice at Queenston, it will be seen by reference to the section, fig. 2, that, owing to the inclination of the strata, the falls would be considerably higher than they are at present; thus exposing to view several beds of shale, limestones, and sandstones not found at the falls. The lowest (No. 1) is a very thick stratum of friable shaly red sandstone, through which the river ploughs its way. The river at Queenston, as we are informed by Mr. Allen, before referred to, is one hundred and sixty feet in depth. This depth is sufficient to entomb the huge fragments of the harder rocks, as they would gradually fall down by the erosive, undermining process continually going on by the descending flood, without causiug any agitation of the surface. It will be seen from the dip of the strata, that as the falls retrograde, the hard quartzose rock would be at the base of the falls, and in time cease to be broken through by the cataract; as the retrocession advanced, the waters would have to flow *over* this hard rock. The superincumbent limestone falling on this hard pavement would cause a great impediment to the escape of the water, which would give rise to the rapids.

From the whirlpool to what is called the Devil's hole, and for a considerable distance below, the river rushes with great impetuosity, when it gradually subsides, and then moves on in silent grandeur towards the lake. On crossing the river at Lewiston, and ascending the hill near Brock's monument, I was agreeably surprised on beholding the singular and furrowed appearance of the ground. It was smooth on the surface, but shaped into knolls and ravines, having the appearance of a mountainous country in miniature—hills and valleys—but without water; and this all excavated out of the hard limestone rock. This appearance gave me satisfactory evidence that the waters of the lakes once rushed over the ground on which I was walking.

The whirlpool as seen on the Canada side of the river, presents many more points of interest than on the American, independently of the curiosity excited by Mr. Lyell's discovery of a deep lateral valley filled with drift, which he traced from the whirlpool to St. David's; Mr. Hall having first suggested the idea that it might be connected with the opening at that place.

Fig. 3.

Sketch of the Whirlpool taken on the Canada side near the ravine which forms part of the lateral valley marked F G, on the map fig. 1.

On the Canada side, more than three-fourths of this magnificent amphitheatre of rock may be explored along the margin of the pool which it incloses. One reason why so few comparatively visit the whirlpool on this side, is the want of enterprise in the individual who owns the land, in not making the descent more practicable. On visiting the place last summer, it was not only very difficult but dangerous to descend, particularly so after rain. Having reached the base of the precipice and scrambled over rocks and through dense masses of roots, decayed branches and foliage of trees, for about the space of two hundred yards, the entanglement suddenly disappears, and a clear open space is left along the margin of the pool, on which it is a great pleasure to rest and admire the sublime scene. The shore is uninterrupted for near two hundred yards; after which it is obstructed as before, by huge fragments of rocks, &c. The foreground of the sketch, fig. 3, from A to B, represents this open space, which also indicates the extent of the base of the cliff of drift lying between the rocks F and G, in figs. 1 and 2. The cliff is less precipitous than the rocks which enclose it; its debris consists of sand with boulders of conglomerate or igneous rocks, and affords easy access to the water's edge.

At the northern extremity of the whirlpool, there is by far the most comprehensive view of the high perpendicular wall of rocks which encloses this deep, dark, circling pool. Here we are brought to the immediate confines of the whirling vortex. On its surface are seen the ruins of a forest, floating round, marking out to the eye the outline of that fatal circle. These yellow logs and trunks, grinding against each other, dip and rise, following on in ceaseless round until they waste away in this their winding sheet. Occasionally, some are thrown out and are borne along in a circuitous route to the rapids which commence at the outlet of the whirlpool; a few find a resting place on the beach, where they present many very grotesque forms, some resembling the boomareng of the New Hollander, others cimiters, rolling-pins, and the like.

The sketch, fig. 3, was taken at the northern extremity near the gorge, marked F, fig. 1. In going up this narrow gorge, through which a small stream flows, I was very much interested in noticing that the high perpendicular rocks which form part of the Niagara group on my left, presented the same wall-like appearance as in the ravine through which the river flows, from the falls to Queenston. Fragments of limestone rock which once crowned the summit of the precipice, lay in confusion at its base. On my right rose the steep cliff of drift, H, with its motley group of boulders extending from F to G. As I was exploring this wild picturesque gorge, formed at the western extremity of the lateral valley by the descending rains washing away the sand into the whirlpool, I was led to think that in all probability, there was a time when the cataract thundered through this channel, now nearly filled with drift, and its waters emptied into the lake or sea, through the opening at St. David's. That this assertion may not appear altogether visionary, I would state that it is an ascertained fact, that this ancient valley extends from the whirlpool to St. David's, about six miles from Queenston, as was first suggested by Mr. Hall to Mr. Lyell, when the latter having called Mr. Hall's attention to this bed of drift at the whirlpool. "Ascending," says Mr. Lyell, "the steep bank formed of these materials, we soon reach the general level of the table land and pass over it for two miles before we begin to enter the depression, which deepening gradually, carries us down to St. David's. This valley is entirely excavated in the boulder formation, and we may infer that the latter maintains its full depth between St. David's and the whirlpool, from sections obtained in sinking a well in the intervening township of Stamford, where a great thickness of drift was passed through."*

It is perhaps worthy of remark that the direction of this valley from the falls to St. David's, does not materially differ from a straight line. The width of this valley, at the whirlpool, (FG, fig. 1,) which is deserving of particular attention, Mr. Lyell gives at about one hundred and seventy yards. Now this width, whether more or less than one hundred and seventy yards, agrees so nearly with the width of the ravine at the entrance into the whirlpool, IB, that it is difficult to resist the conclusion that they had both one origin, but at periods of time immeasurably remote from each other. The continuous appearance now presented is accidental. The origin of this valley and its termination at the whirlpool may, I think, be explained on the supposition that ages anterior to the commencement of the ravine at Queenston, this valley or channel was hewn out by the floods which drained the inland lakes or sea. The width of the valley at St. David's, which is about two miles, militates nothing against the assumption that the waters once rushed over the precipice at St. David's. It is reasonable to infer that its volume was immeasurably greater than at present, and that in process of time the valley would contract, as the waters were concentrated and were brought to act with greater energy on a given point on the various strata of hard and soft rocks; this increased erosive action of the waters would go on until the cataract would finally assume a wall-like appearance as is now seen at the falls. This process appears to have gone on from the time when the river first fell over the precipice at Queenston, and thus the falls have continued to advance on their retrograde journey south. This I think is very evident from what

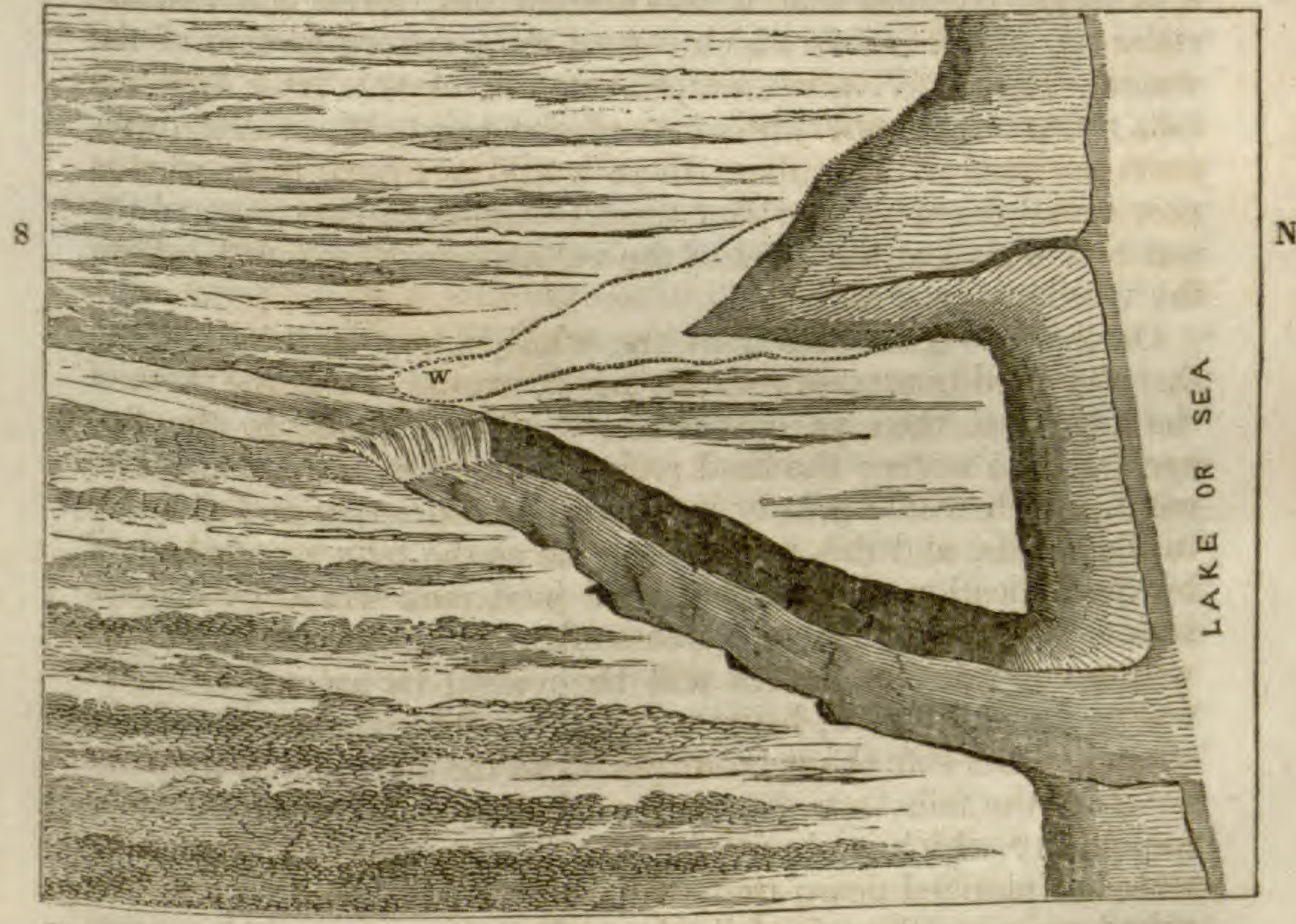
---

* Lyell's America, Vol. ii.

is now seen on the sides of the declivity near Brock's monument. The smooth, scooped out appearance in the solid limestone rock, as before alluded to, indicates that long before the waters were concentrated at the ravine at Queenston, they were for ages sweeping over the precipice on each side of the present opening. When the falls had retrograded as far as is represented by the dotted lines in fig. 4, their further progress was arrested by physical changes constantly but slowly going on, according to Mr. Lyell, which have so materially changed the surface and condition

Fig. 4.

The supposed situation of the Falls when near what is now called the Whirlpool.



The dotted lines mark the deep lateral valley filled with drift, for a considerable distance towards the Lake.

of the globe. This was chiefly the submergence of the whole table-land, which, Mr. Lyell, in his work before referred to, says, caused the valley to be filled up and also covered the table-land itself with drift, which in some places is three hundred feet deep. After a long interval of time the country was again elevated, or the sea retired, exposing the precipice over which the waters would rush. But their direction, from the great inequalities of the surface arising from the accumulations of drift, might be changed, and instead of continuing to plough out for itself a passage in its former channel, might finally be concentrated about the precipice at Queenston, and there commence anew its great work of retrocession. It will be seen by reference to fig. 4, that the ravine at Queenston and onward, to the whirlpool, is not parallel to the lateral valley, (represented by dotted lines,) but makes an angle, the apex of which is the head of the valley. When the falls advance to the dotted lines, W, which mark the boundary of this valley of drift, and had broken and cut its way through the hard limestones, &c., into this soft and very thick bed, a violent and rapid excavation would go on by the mighty force exerted from the falling cataract on the soft material, most of which would be carried away in the form of mud. As this drift descended far into the soft shale below the quarztose rock, it is highly probable that it was cleared out, forming a vast *circular* pit, and it is this which caused the gyratory motion of the water. Fig. 2, W, gives a representation of this pit. Had the falls retrograded a few yards east of the point, W, which represents the head of the valley, there would not have been what is now called the whirlpool; for then it would not have entered the soft bed of drift at the head of the valley, out of which I believe the whirlpool was formed.

On the falls retreating from the whirlpool, it will be noticed, that the hard quartzose rock, 2, fig. 2, would form the base of the falls, and then an obstruction would be made to the free egress of the water; the hard rocks would then fall *on* this pavement, which would greatly increase the obstruction and give rise to the rapids, and this would continue as the falls receded, until by the indication of the strata, this hard rock would by degrees sink so low as to allow a depth sufficient for the waters to flow without commotion. This will be evident by an inspection of fig. 2, the stratum, 3, being soft shale. The inclination of the strata and the soft character of the rocks through which the river flows at the falls, are the causes of that apparently miraculous tranquillity which is observed to take place immediately after the river has plunged down the precipice. This sudden repose surprised me more than the falls themselves.

ART. VI.—*On certain Improvements in the Construction and Supply of the Hydro-oxygen Blowpipe, by which Rhodium, Iridium, or the Osmiuret of Iridium, also Platinum in the large way, have been fused;* by ROBERT HARE, M.D., Professor of Chemistry in the University of Pennsylvania. (Communicated by the Author.)

HAVING observed while I was a pupil of my predecessor, Dr. Woodhouse, in the year 1801, that a jet of hydrogen when inflamed in atmospheric air, of which only one-fifth is oxygen, produced a heat of pre-eminent intensity, I was led to infer that in combining with pure oxygen, the gas in question ought to produce a temperature at least five times as great. This led to the contrivance of two modes of producing a jet consisting of a mixture of hydrogen with oxygen. Agreeably to one mode, the gaseous currents meeting like the branches of a river, were made analogously to form a common stream. This object was accomplished by means of perforations drilled in a conical frustum of pure silver, so as to converge until met by another shorter perforation, commencing at the opposite surface, and so extended as to join them at the point of their meeting. The other mode was that of causing one tube to be within another, so as to be concentric; the outer tube being a little the longer of the two, the latter being employed for hydrogen, the former for oxygen.

In the year 1814, this last mentioned mode was improved, so as to have the means of securing, by adjusting screws, the concentricity of the tubes, and varying the distance of the orifice of efflux of the inner tube from that of the other.

The constructions employed in 1801, were described and published in a pamphlet, and afterwards republished in Tilloch's Philosophical Magazine, Vol. xiv, and in Annales de Chimie, Vol. xlv. At the same time an account was given of the fusion of pure lime and magnesia, and of the fusion of platinum. Subsequently in a paper published in the Transactions of the American Philosophical Society, it was mentioned that I had volatilized platinum.

About the year 1811, Professor Silliman, in a memoir read before the Connecticut Academy of Sciences, gave an account of a series of experiments, in which the experiments which I had performed were repeated, and many additional fusions made. I had adverted to the intensity of the light produced during the exposure of lime to the flame. Alluding to the heat and light, my words were, "the eyes could not sustain the one, nor the most refractory substances resist the other." The intensity of the light was still more insisted upon by Silliman.

My experiments were also repeated by Mr. Rubens Peale, during many successive years, at the Philadelphia Museum, for the amusement of visitors.

About the year 1813–14, it was ascertained, at the laboratory of Dr. Parrish, that a bladder being supplied with a mixture of hydrogen and oxygen, in due proportion, and punctured by a pin, while subjected to compression, on igniting the resulting jet, the gas within the bladder did not explode. Of course a burning jet of flame thus created, was found competent to produce, while it lasted, the same effect as when otherwise generated by the same gaseous mixture.

Soon after this result was obtained, Sir Humphrey Davy discovered, that if a lamp flame be completely surrounded by a gauze of fine wire, it may be introduced into an inflammable gaseous mixture without causing it to explode. This was ascribed to the refrigerating influence of the metal, keeping the gaseous mixture below the temperature requisite for inflammation. Hence it was inferred, that if a mixture of hydrogen and oxygen, while condensed within a suitable receiver, were allowed to escape through a capillary metallic tube, so as to form a jet, this might be made to burn without communicating ignition to the portion remaining in the receiver.

By means of an apparatus contrived agreeably to this idea, Dr. Clark of Cambridge, England, repeated the experiments, made many years before by Silliman and myself, without any other reference to ours, than such as was of a nature to do injustice. An exposition of the invalidity of Dr. Clark's pretensions to originality was made in Silliman's Journal for 1820, vol. ii, and in Tilloch's Philosophical Magazine, for 1821, vol. lvii.

The light produced by the hydro-oxygen flame with lime having been observed by Lieutenant Drummond, of the British navy, was ingeniously proposed by him, as the means of illumination in light-houses, and in consequence, has been subsequently used as a substitute for the solar rays, in an instrument known as the hydro-oxygen microscope, which is a modification of that which has been called the solar microscope. The name of Drummond light has consequently been given to a mode of illuation, which I originally produced as above stated.

The instrument which was used by Professor Silliman and by Rubens Peale, was that above described as having two perforations meeting in one. In this form it was, I believe, employed by Dr. Hope, of Edinburgh, and Dr. Thompson of Glasgow, who both treated it as my contrivance, anteriorly to the publication of Dr. Clark's memoir.

The other form, consisting of two concentric pipes, was modified by a Mr. Maungham, with the view of producing a lime light for the microscope above alluded to. When I saw Mr.

Maungham at the Adelaide gallery in 1836, he treated this instrument as mine, in another form. I was surprised afterwards to learn that he had obtained a premium for this modification from the British Society for the Encouragement of Arts, without any allusion to the original inventor.

After my return from Europe in 1836, I was very much in want of a piece of platinum of a certain weight, while many more scraps than were adequate to form such a piece were in my possession. This induced new efforts to extend the power of my blowpipe; and after many experiments, I succeeded so as to fuse twenty-eight ounces of platinum into one mass.

Although small lumps of platinum had been fused by many operators, with the hydro-oxygen blowpipe, as well as myself, it had not, up to the year 1837, been found sufficiently competent to enable artists to resort to this process. I am informed by Mr. Saxton, that some efforts which were made while he was in London were so little successful, that the project was abandoned. There was an impression that the metal was rendered less malleable when fused upon charcoal, as in the experiments alluded to. This is contradicted by my experiments, agreeably to which fused platinum is as malleable as the best specimens obtained by the Wollaston process, and is less liable to flake. The celebrated Dr. Ure, on seeing the platinum in the form of wire, of leaf, and plate, said that there was no one in Europe who could fuse platinum in such masses. He also alledged that it had been found so difficult to weld platinum, that no resort was had to that process. In this I concur, having had the welding tried by a skillful smith, both with a forge heat, and with a heat given by the hydro-oxygen blowpipe. An incorporation of two ingots was effected on their being hammered together, when heated nearly to fusion; but on hammering the resulting mass cold, a separation took place along the joint by which the ingots were united.

The difficulty seems to arise from the rapidity with which the platinum becomes refrigerated. It seems to have a less capacity for heat than iron, and, not burning in the air as iron does, has not the benefit of the heat acquired by iron from its own combustion with atmospheric oxygen.

Lately, by means of the instrument and process which it is my object here to describe, I have been enabled to obtain malleable platinum directly from the ore, by the continued application of the flame. From some specimens of platinum I have procured as much as ninety per cent. of malleable metal. The malleability is not inferior to that of the best specimens obtained by reducing it to the state of sponge, through the agency of aqua-regia and sal-ammoniac. There is, however, a greater liability to tarnish, arising, probably, from the presence of a minute portion of palladium.

Of the fusion of iridium and rhodium, I have already given an account in the Bulletin of the American Philosophical Society, which was subsequently embodied in an article in this Journal for October last, 1846.*

It remains now to give an account of the apparatus employed in the fusion of platina on a large scale.

Fig. 1 represents the association of fifteen jet pipes of platinum with one large pipe, B, D, at their upper ends, so that their bores communicate, by means of an appropriate brass casting, with that of the large pipe, the joints secured by hard solder. Their lower extremities are made to protrude about half an inch from a box, A, of cast brass, their junctures, with the appropriate perforations severally made for them, being secured by silver solder. They come out obliquely in a line along one corner of the box, an interval of about a quarter of an inch alternating with each orifice. By means of flanges, the brass box is secured to a conical frustum of copper, fig. 2, so as to form the bottom thereof, while the pipe, extending above the copper case, is screwed to a hollow cylinder of brass, A, fig. 3, provided with two nozzles and gallows screws, *g*, *g*, for the attachment of appropriate hollow knobs, to which pipes are soldered, proceeding from the reservoirs of oxygen and hydrogen. Cocks are interposed by which to regulate the emission of the gases in due proportion.

In connecting the pipes conveying the gases with the brass cylinder, A, fig. 3, care should be taken to attach that conveying oxygen to the upper nozzle, while the other, conveying hydrogen, should be attached to the lower nozzle ; since, by these means their great difference in density tends to promote admixture, which, evidently, it must be advantageous to effect.

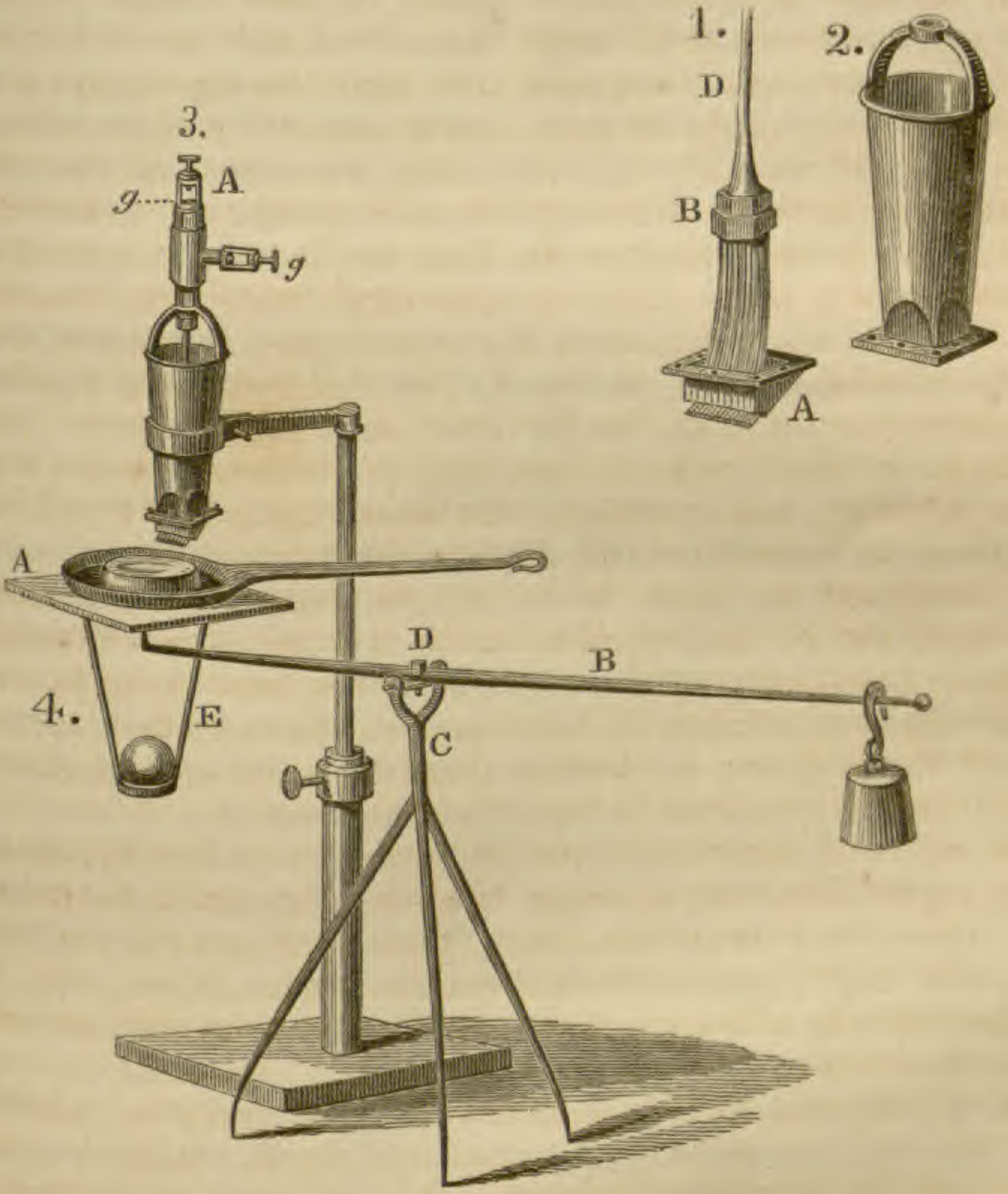
The object of surrounding the jet pipes with water, by means of the copper box,† is to secure them against being heated to such a degree as to cause the flame to retrocede and burn within them, so as finally to explode within the cylinder, A, *g*, *g*, fig. 3. It is preferable to add ice or snow to the water, in order to prevent undue heat.

Fig. 4 represents a movable platform, A, of cast iron, wholly supported upon the point of the iron lever, D, B, which is curved towards the extremity under the platform, so as to point upwards, and to enter a small central conical cavity made for its

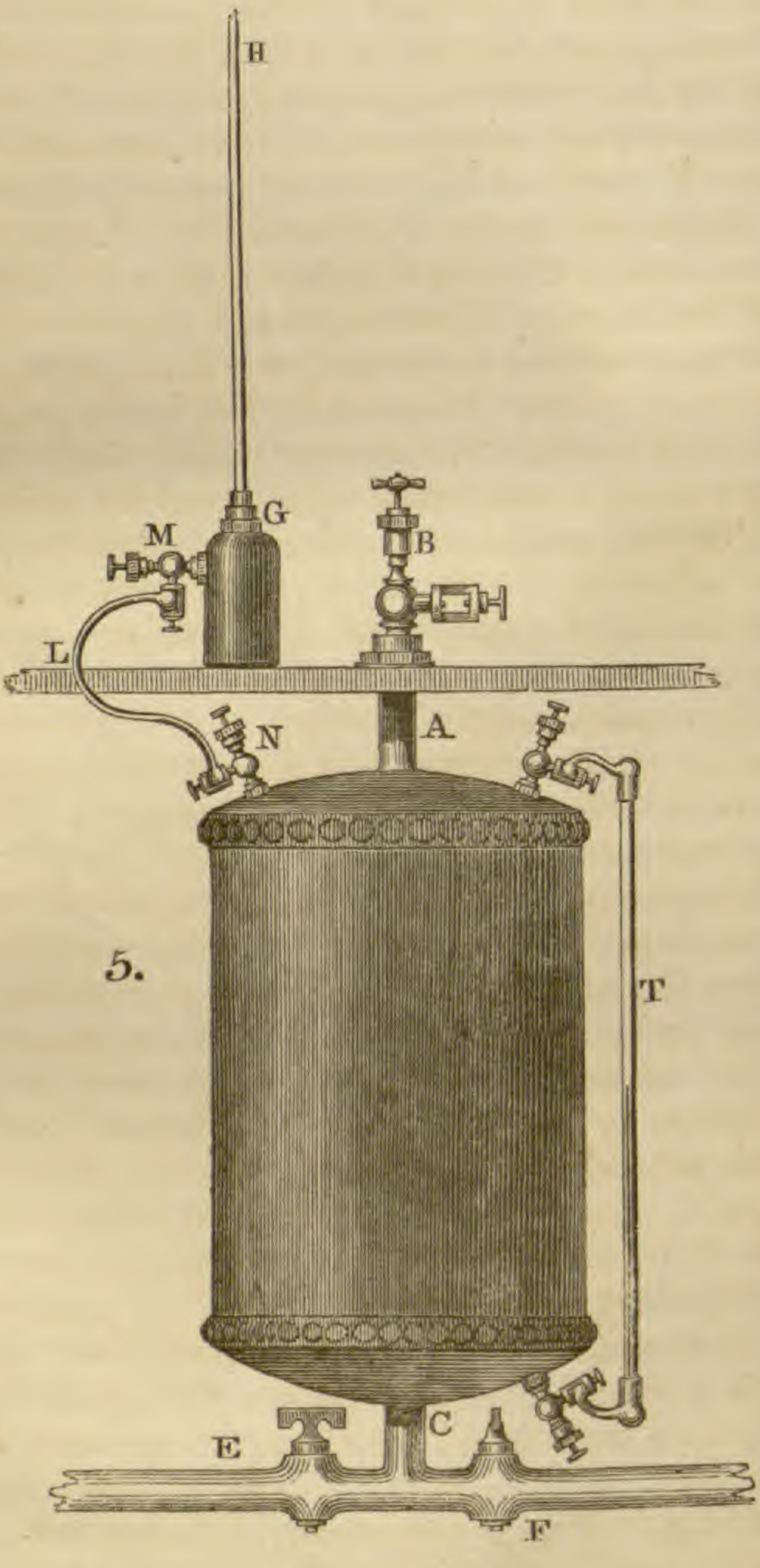
* Since published in the Revue Scientifique at Paris.

† Since the engraving was made, I have preferred to use water-tight boxes, with gallows screws and nozzles, situated one near the bottom on one side, the other on the opposite side near the top. By means of the lower nozzle, a pipe is attached, communicating with a head of cold water, the other being so situated as to carry the water into a waste pipe, or large tub ; a circulation may be kept up during the whole time that the operation is going on.

As a support, a brick kaolin is used, having an oblong ellipsoidal depression on the upper face for the reception of the metal to be fused.



1.
D
B
A
2.
3.
A
g
g
4.
A
D
B
C
E



5.

reception. The lever is supported by a universal joint upon the fulcrum, C, so that by means of a sliding weight at one end, the platform and its appurtenances are counterpoised at the other. The platform is kept in a horizontal position by the cannon ball, supported in a sort of iron stirrup terminating in a ring, in which the ball is placed. Upon the platform is situated an iron pan with a handle, holding the brick, on a cavity in which as already mentioned, the metal is supported. The apparatus being duly prepared, and connected with the supply pipes, the hydrogen is first allowed to escape, and then the oxygen, until the ignition has attained apparently a maximum. The accomplishment of this object may, of course, require the adjustment of either cock several times, especially where there is any decline in the pressure either of the one or the other gas in its appropriate reservoir.

By means of the handles of the lever and of the pan, the operator is enabled to bring the metal into the position most favorable for the influence of the heat, while his hands and face are sufficiently remote to render the process supportable. In fusing any quantity, not being more than four ounces, the platform may be dispensed with, the handle of the pan being held in one hand of the operator, while by the other, the cocks may be adjusted.

When the blowpipe of fifteen jets, or any larger, may be employed, and the platform is necessarily resorted to, the cocks must be adjusted by an assistant.

Fig. 5 represents a cask made of boiler iron, three-sixteenths of an inch thick, so as to resist an enormous pressure. The joints are secured by riveting, as in constructing high pressure boilers.

This cask communicates with the hydrant pipes, so called, by which our city is supplied with water, of which the pressure varies from a half to more than two atmospheres, say from seven to thirty pounds per square inch, according to the number and bore of the cocks from which the water may be flowing at the time, for the consumption of the community. Hence, experiments, while using this head, are best made towards bed-time, or between that time and sunrise. The vessel is filled with water by opening a cock, F, on one side of the pipe, C, and allowing the air to escape through the valve-cock, B. Being thus supplied, the cock, F, closed, and a communication with a bell glass, into which oxygen is proceeding from a generating apparatus, being made by means of a flexible leaden tube, on opening the valve cock, B, and the cock, E, the water will run out, and be replaced by gas from the bell. This process being continued till the iron cask is sufficiently supplied with gas, the cock, E, must be shut. Whenever the gas is wanted for the supply of the blowpipe, it is only necessary to establish a communication between the valve-cock, B, and the upper gallows screw, fig. 3, of the cylinder, A, and to open the cock, F, so as to admit the water to press upon the gas, the efflux being regulated by B, or preferable by a cock of the ordinary construction, one of which kind should be interposed at a convenient position between the valve-cock, B, and cylinder, A.

T, represents a glass tube, which, by due communication with the interior, shews the height of the water, and consequently the quantity of gas in the vessel.

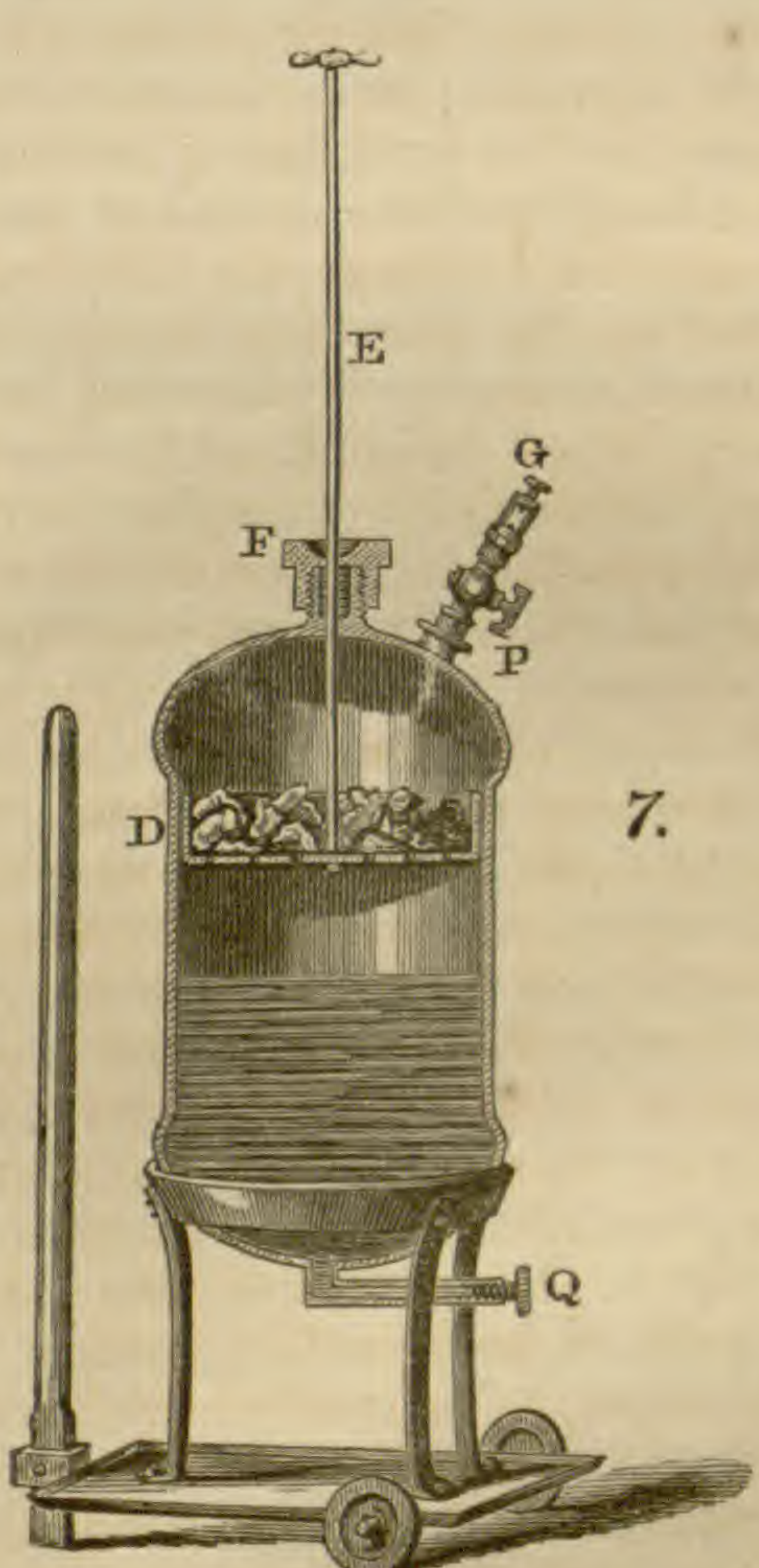
G, H, represents a gauging apparatus, consisting of a cast iron flask, of about a half a pint in content, and a glass tube of about a quarter of an inch in bore, which should be at least five feet in height. The tube is secured air-tight into the neck of the flask, so as to reach nearly to the bottom within. The flask is nearly full of mercury. Under these circumstances, when a communication is made, by a leaden pipe between the cavity of the flask and that of the reservoir, an equilibrium of presure resulting, the extent of the pressure is indicated by the rise of the mercury in the tube.

In order to generate hydrogen for the supply of a reservoir like that represented by the preceding figure, I have employed the vessel represented by fig. 7. This vessel, by means of a suitable aperture, susceptible of being closed by a screw plug, is half filled with diluted sulphuric acid. Being furnished with a tray of sheet coper, D, punctured like a coal sieve, and supported by a copper sliding rod, E, strips of zinc are introduced in quantity equal to the capacity of the tray. The sliding rod passes through a stuffing-box, F, at top of the reservoir, so that the operator may, by lowering or raising the tray, regulate or suspend the reaction between the zinc and its solvent, accordingly as the supply of hydrogen is to be produced, suspended, increased, or diminished.

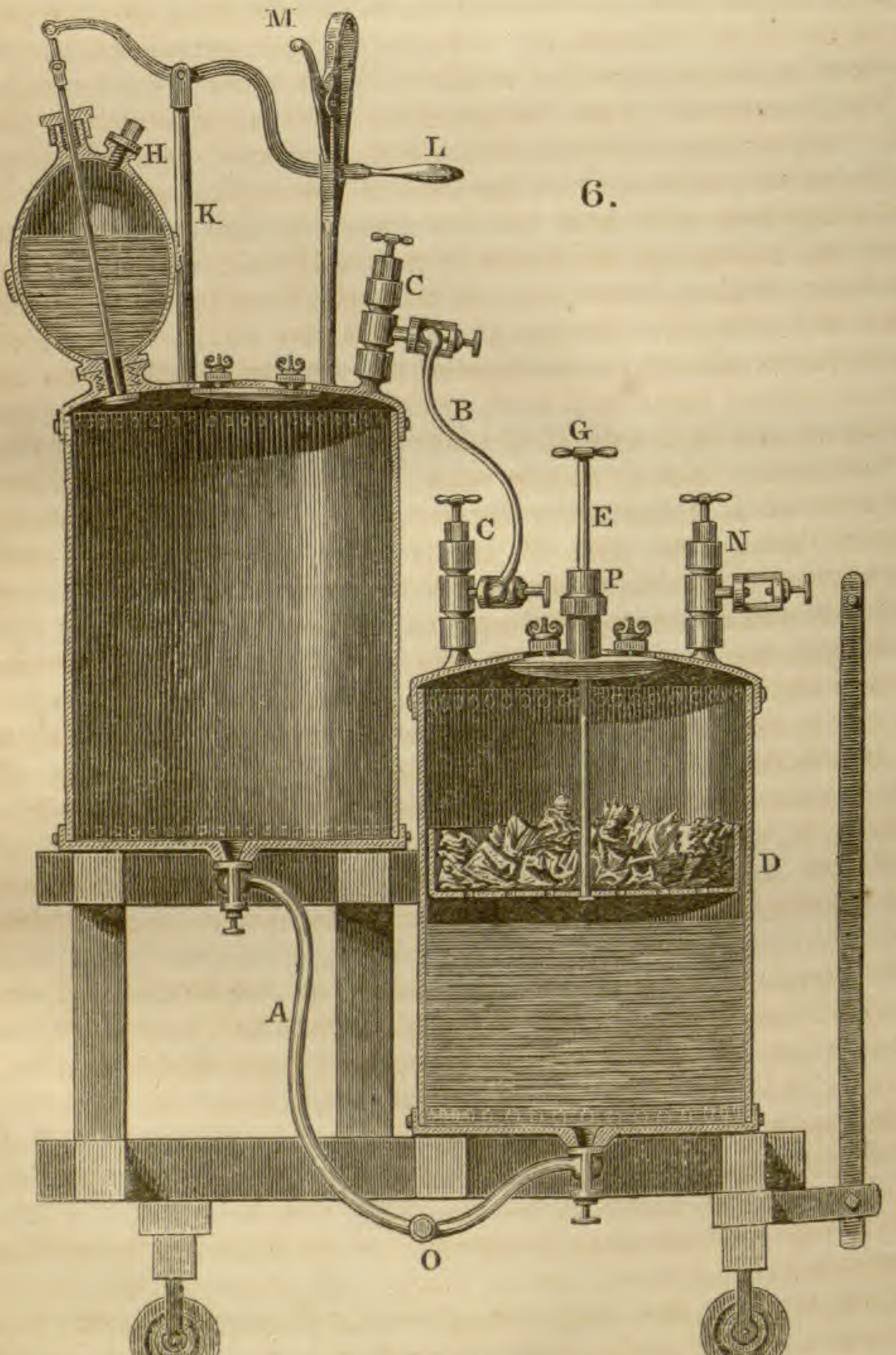
The communication with the reservoir is open and regulated by means of a cock, P, furnished with a gallows screw, G, for the attachment of a leaden pipe, as above described, in the process for supplying the reservoir with oxygen.

Another apparatus for producing a supply of hydrogen, is represented in fig. 6. It consists of two similar vessels of boiler iron, each capable of holding forty gallons. They are lined internally with copper, being situated upon a wooden frame, so that the bottom of one is two-thirds as high as the top of the other. The upper portions of these vessels communicate by a leaden pipe, B, of about half an inch bore, furnished with a cock, while the lower portions communicate by another leaden pipe of a bore of one and a half inches.

The upper vessel is surmounted by a globular copper vessel, of about twelve inches in diameter, which, from its construction, renders it possible to introduce an additional supply of concentrated acid, while the apparatus is in operation, without reducing the pressure within the reservoir, by permitting the excess above the pressure of the atmosphere to escape. This object is accomplished as follows:—



7.



6.

The valve at the end of the rod, attached to the lever, L, being kept shut by the catch, M, the screw plug, H, removed, the acid is introduced through the aperture thus opened. In the next place, the plug being replaced, and the valve depressed by means of the lever and rod, so as no longer to close the opening, which it had occupied, the acid descends from the chamber into the cavity of the vessel beneath it. The valve is of course restored to its previous position as soon as the acid has effected its descent.

The lowermost vessel is furnished with a perforated copper tray, supported by a copper sliding rod, in a way quite analogous to that already described in the case of the copper reservoir. It is also supplied with zinc and its solvent in like manner, being made half full of the diluted sulphuric acid. Of course, on contact being produced between the zinc and its solvent, the generation of hydrogen will take place. So long as the communication between the upper portions of the two vessels is open, the gas will extend itself into both, occupying the whole of the upper vessel, and that half of the lower one which is unoccupied by the liquid. But if, in this way, the pressure reaches to two atmospheres, as indicated by the gauge,* on shutting the communication through the pipe, B, the pressure in the inferior vessel will augment, that in the superior vessel remaining as before, but the liquid will consequently begin to pass out of the inferior vessel through the pipe A, and thus may lessen the contact between the acid and zinc, and finally suspend it altogether. Meanwhile the gas in the upper vessel being condensed to nearly half its previous bulk, the pressure will be nearly four atmospheres. It will, in fact, always be nearly double that which existed before the pipe, B, was closed.

In order that nearly the whole of the acid shall be expelled from the inferior vessel, the tray must be depressed till it touches the bottom of that vessel.

The pressure being four atmospheres at commencement, as soon as, by means of a pipe attached to the valve-cock, N, an escape of gas is allowed, the acid is forced again upon the zinc, and thus prevents a decline of pressure to any extent sufficient to interfere with the process.

The gases may be used from a receiver in which they exist, in due proportion, safely by the following means:—

Two safety tubes are to be made, not by Hemming's process exactly, but as follows:

A copper tube, silver soldered, of which the metal is about the eighth of an inch in thickness, is stuffed with the finest copper wire, great care being taken to have the filaments straight and

---

* I have used for a gauge an instrument like G, fig. 5, the tube being about two feet in length, and sealed at the upper end.

parallel. The tube is then to be subjected to the wire-drawing apparatus, so as to compress the tube on its contents until the draught becomes so hard, as that it cannot be pushed farther without annealing. The stuffed tube thus made is to be cut into segments, in lengths about equal to the diameter, by a fine saw. The surfaces of the sections are to be filed gently with a smooth file. By these means, they appear to the naked eye like the superficies of a solid metallic cylinder. Brass caps being fitted on these sections, they are to be interposed by soldering, at the distance of a foot or more, into the pipe for supplying the jet. Under these circumstances, the posterior section becoming hot, may allow the flame to retrocede; but the anterior section being beyond the reach of any possible combustion, and remaining cold, will not allow of the retrocession; and as soon as the flame passes the first section, the operator, being warned, will, of course, close the cock, and subject the posterior section to refrigeration before proceeding again.

But this plan of operating may be rendered still more secure by interposing a mercury bottle, or other suitable iron vessel, half full of oil of turpentine, between the reservoir and safety tubes, as in the arrangement of a Woulfe's bottle. A leaden pipe proceeding from the reservoir is, by a gallows screw, attached to an iron tube which descends into the bottle, so as that its orifice may be near the bottom. The leaden pipe communicating through the safety tubes with the jet-pipe, is attached to the neck of the bottle. Thus the gaseous mixture has to bubble through the oil of turpentine in order to proceed through the safety tubes to the jet-pipe. If, while this process is going on, the flame should, by retrocession, reach the cavity of the bottle, exploding in contact with the turpentine, a compound is formed, which is, *per se*, inexplosive from the excess of carbonaceous matter. Meanwhile the shock, acting on the surface of the oil, drives it into the bore of the iron tube, and thus, both by its chemical and mechanical influence, renders it utterly impossible that the flame should reach the cavity of the reservoir.

Apparatus for the Fusion of Iridium or Rhodium or masses of Platinum less than five ounces in weight.

For the fusion of either Iridium or Rhodium or masses of Platinum not exceeding the weight of half an ounce, an instrument with three jets has been employed, the bore of each jet pipe being such as not to admit a wire larger than the $\frac{1}{32}$ of an inch in diameter. The flame produced by these means was quite sufficient to envelope the mass to which it was applied.

In fusing any lumps or congeries of platinum, not exceeding five ounces, an instrument has been used capable of giving seven jets of gas, issuing of course, from as many pipes. Of these pipes, six protrude through the brass casting forming the bottom of the copper case constituting the refrigerator, so as to be equidistant from each other upon a circumference of three-fourths of an inch in diameter, the seventh protruding from the centre. The bores of these jets are such as not to admit a wire larger than $\frac{1}{32}$ of an inch in thickness. Those of the larger instruments represented by the accompanying engravings were such as to admit wires of $\frac{1}{24}$th of an inch in thickness.

The jet-pipes may be made by the following process:—A thin strip of sheet metal, somewhat wider than the length of the circumference required in the proposed pipe, after being roughly turned about a wire so as to form an imperfect tube, is drawn through several suitable holes in a steel plate, as in the wire-drawer's process. Under this treatment the strip becomes converted into a hollow wire; the edges of the strip being brought into contact reciprocally, so as to leave only an almost imperceptible crevice. Having drawn one strip of platina in this way, another strip sufficiently wide nearly to enclose it, is to be drawn over that first drawn, care being taken to have the crevices left at the meeting of the edges on contrary sides. The compound hollow wire or tube thus fabricated, is finally to be drawn upon a steel wire of the diameter of the requisite bore.

The following method of making jet-pipes, though more difficult, is preferable; as there is less liability of the water of the refrigerator leaking into the bore.

Select a very sound and malleable cylinder of platina, of about three-eighths of an inch in thickness, perforate it by drilling in a lathe, so that the perforation may be concentric with the axis. A drill between $\frac{1}{16}$th and $\frac{1}{8}$th of an inch in diameter may be employed. In the next place the cylinder may be elongated by the wire-drawing process, until the proper reduction of metallic thickness is effected, the diameter of the bore being prevented from undergoing an undue diminution, by the timely introduction of a steel wire.

Of course, the metal must be annealed as often as it hardens, by drawing. For this purpose, a much higher temperature is necessary in the case of platinum, than in that of either copper, silver, or gold.

The annealing is best performed by the hydro-oxygen flame. If charcoal be used, the greatest care must be taken to have the fireplace clean.

Agreeably to a trial made last spring, palladium may be used as a solder for platinum; and as it is nearly as difficult to fuse as this metal, it is of course, for that purpose, preferable to gold where great heat is to be resisted. No doubt, by employing palladium to solder the exterior juncture of the double drawn tubes above mentioned, they might answer as well nearly as when constructed of solid platinum.

Art. VII.—*Description of Two New Species of Fossil Footmarks found in Massachusetts and Connecticut, or, of the Animals that made them;* by Rev. Edward Hitchcock, President of Amherst College, and Professor of Natural Theology and Geology.

I have long wished to describe several new and peculiar fossil footmarks which have been brought to light in the sandstone of the Connecticut Valley in Massachusetts and Connecticut. But a constant pressure of more important duties has delayed the work, not months merely, but years. I have determined, however, to begin it; hoping that time and health may allow me to prosecute the descriptions in future numbers of the American Journal of Science. For the present I content myself with describing two species; one of them, if I rightly understand it, of most extraordinary dimensions and character.

Before the Association of American Geologists and Naturalists, at their meeting in New Haven, in 1845, I communicated a paper, in which, instead of naming the tracks, as I had formerly done, I attempted to name the animals that made them. That paper I have never found time to get ready for the press; though a list of names was given in the Proceedings of that Society. I am more and more satisfied that this principle, suggested to me by my friend, Mr. James D. Dana, is the true one by which these singular relics should be described.

I have been surprised, however, to learn that some object to giving scientific names, either to these footmarks, or to the animals that impressed them; because they think the characters by which they must be described too indefinite for distinguishing species, or even genera. My reasons for a contrary opinion are briefly as follows.

1. The existence of these tracks demonstrates the existence of certain animals that made them during the triassic period. 2. The facts well known concerning organic remains, render it almost certain, that these animals have never been described, either in the living or fossil fauna of any country. 3. All who have seen a good collection of these tracks, will be satisfied that they were made by several species of animals. Now this conviction must result from some diversity of character, which we witness in these footmarks. And if that diversity could produce such a conviction, it can be expressed in words; and thus the different species, at least many of them, be distinguished from one another. If they cannot thus be distinguished, then they must be regarded as only varieties of the same species. But no comparative anatomist will admit this to be possible. 4. Comparative anatomy teaches us that some of the surest and most constant characters by which animals are distinguished, are derived

from their feet. This is eminently true of birds. "Indeed," says Duméril, "it is by the form and the length of the feet, and the disposition of the toes, that birds are divided into six orders," &c.* 5. Living animals could to a great extent be divided correctly into families, genera, and species, by their tracks. 6. If no fossil animal is to be named until we obtain a complete description of it, then a large part of those already named, should be stricken from the list of organic remains, since only fragments of their skeletons have been found; and we have the authority of Cuvier for saying, that sometimes even the whole skeleton is insufficient to distinguish species from species. "The difference," he remarks, "between two species is sometimes entirely inappreciable from the skeleton. Even the genera cannot always be distinguished by osteological characters."† My conviction is, that not a few fossil animals have been described from characters much more uncertain than those derived from well preserved tracks. 7. We have the highest authority for naming animals from their tracks alone. This was done by Professor Kaup, in the case of the *Chirotherium;* and by Professor Owen, in the case of the *Festudo Duncani;* the only evidence of whose existence is the tracks on the sandstone of Scotland.‡ 8. Convenience in writing or conversing about different kinds of these relics, demands that scientific names should be attached, either to the tracks or the animals that made them. In making attempts to describe them without names, I have sometimes been reminded of the *house that Jack built*, in an old nursery story: Ex gr., "this is the dog that worried the cat, that killed the rat, that ate the malt, that lay in the house that Jack built."

Upon the whole, I cannot see why it is not as desirable, and as consonant to the laws of zoology and comparative anatomy, to derive the name of an extinct animal from its tracks, as from a fragment of a skeleton. Admit that in most cases there may be more danger of mistake in the former than in the latter instance: yet in the first case there is almost every possible degree of uncertainty as to the exact place which the animal ought to occupy. But if well assured of its former existence, why should it not have a name assigned it, among the preadamite inhabitants of the earth, according to the rules of nomenclature derived from zoology and comparative anatomy? So far as these sciences will justify distinctions, and no farther, do I contend for the erection of genera and species. In the present instance, I have so constructed the generic and specific names that they will hold good, though future researches should prove the animals to have been very different in nature from what we now suppose. Fur-

* Elemens des Sciences Naturelles, Tome ii, p. 258, fourth edition.
† Ossemens Fossiles, Tome troisième, p. 524, third edition.
‡ Rep. of Brit. Assoc. for Advancement of Science, for 1841, p. 160.

ther reflection and new discoveries have led me to alter somewhat the names which I presented to the Geological Association. But as I offered at that time no descriptions, I suppose such changes are lawful, according to the rules of zoological nomenclature.

My present object, however, is not to present a complete view of this subject, but only to describe two new species recently discovered in South Hadley. They were brought to light by Pliny Moody, Esq., the same individual, who, about forty-six years ago, discovered near the same spot, the first specimen of footmarks ever noticed as an object of interest in the valley of the Connecticut. That specimen, described and figured in my final Report on the Geology of Massachusetts, plate 48, fig. 55, and now in my cabinet, was turned up by Mr. Moody, then a boy, while ploughing upon his father's farm, and recognized as a row of tracks made by a bird. While he was absent at college, it passed into the hands of Dr. Dwight, of South Hadley. Yet now, after the lapse of nearly half a century, Mr. Moody has found, within ten rods of his house, perhaps the largest and most extraordinary track yet brought to light in this valley. It is but an act of justice, therefore, it seems to me, to affix his name to this most remarkable species, which would have been destroyed by the quarryman had he not rescued it. The slab containing it, is, indeed, considerably mutilated, and only one very distinct track remains. But three others of the same animal are obvious, and enable me to give its characters with considerable confidence. This interesting slab is about ten feet long, six or eight inches thick, and weighs more than half a ton. It is broken open lengthwise, as shown in the drawing, fig. 1: and some smaller fragments are broken off, some of which are lost. Mr. Moody having allowed me to deposit this slab in the Cabinet of Amherst College, I have brought the fragments together, and am gratified to find so much remaining. Besides the large tracks, several rows of smaller species are exhibited almost without any loss. Of the large tracks, four remain. The second (A, fig. 1,) is the most perfect, being deficient in nothing but the extremities of the two middle toes, and a confusion at the end of the shortest lateral toe.* So peculiar is the shape of this track, and so different its phalangeal impressions from those of the feet of any living animal with which I am acquainted, that I should hardly have dared to describe it from a single specimen, had I not found its essential features exhibited in the other tracks. Some of these are badly broken, and others are indistinct, owing apparently to the peculiar state of the mud when they were made. Yet enough remains to identify them with the most perfect one just described. It is clear, also, that they were

* Pres. Hitchcock sent for this Journal an outline sketch of this remarkable track, of full size, (twenty inches in length,) which from the magnitude of the plate required for it, is not inserted.

Fig. 1. Reduced 18 diameters.

made by the right and left feet of the animal: and hence I was forced, contrary to my first impressions, to regard the animal as a biped. In attempting to trace its analogies to living animals, however, I have been less successful than in respect to any other animal of the thirty or forty species that impressed the forming new red sandstone of New England. Indeed, the enquiry has recurred to me more forcibly than ever, whether some of these animals may not have combined in their structure, characters now found in several distinct races; as seems to have been the case with some of the Saurians. But this suggestion can be judged of better after describing the footmarks under consideration.

On the same slab with the large tracks, are those of two other species of thick toed bipeds; one of which is the *Brontozoum Sillimanium*, (Ornithoidichnites Sillimani of my Report,) and the other a new species which I have denominated *B. parallelum*, on account of the slight divergence of the lateral toes. I shall first describe the genus Brontozoum, and then this new species, in the manner in which I propose in future to describe all the species known to me.

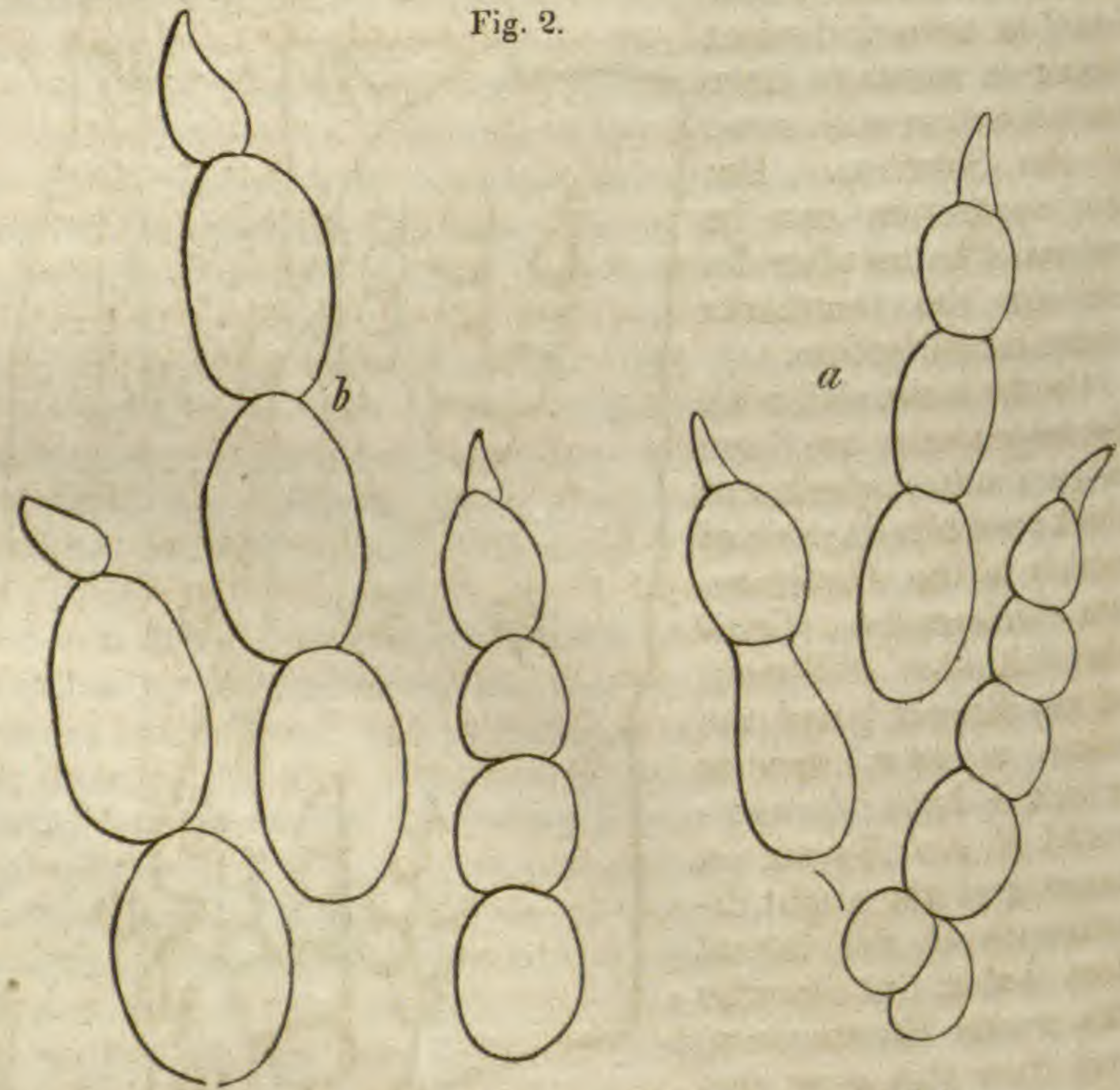
Genus Brontozoum, (*βροντης*, a giant, and *Ζωον*, an animal.)

Foot tridactylous, pachydactylous, the toes making strong tubercle-like phalangeal impressions; having claws, which in the lateral toes proceed from the outer side, and in the middle toe from the inner side; inner toe shortest: all of them directed forward. Tubercular swellings or phalanges of the inner toe, two; of the middle toe, three; of the outer toe, four. The distal extremity of the tarso-metatarsal bone double-headed; yet rarely reaching the ground: the cushion beneath it, making an impression, which slopes upward posteriorly. Animals bipedal, gregarious.

Five species known: one of them of great size,—with a foot eighteen inches long.

Affinities.—The number and position of the toes, and of the phalanges of the several toes, as well as the manner in which the steps succeeded one another, ally the animals to birds. The deficiency of the hind toe, and the great length of most of the steps, ally them to Grallæ. The great thickness of the toes, and the great size of the feet in some instances, suggest a relation to the Struthionidæ.

Fig. 2.



Brontozoum parallelum. (Fig. 2, *a* and *b*.)

Divarication of the lateral toes, 15° to 20°; do. of the inner and middle toe, 5° to 6°; do. of the outer and middle toe, 8° to

15°. Length of the middle toe, 2 to 3 inches; do. of the inner toe, 1·5 to 2 inches; do. of the outer toe, 1·8 to 2·3 inches; do. of the claw of the middle toe, 0·4 inch; do. of the foot, 3 to 3·5 inches; do. of the step, 13 to 29 inches. Width of the toes, 0·33 to 0·5 inch; do. of the posterior part of the foot, 1 to 1·4 inch. Longest diameter of the double-headed lower extremity of the tarso-metatarsal bone, 0·5; shortest do., 0·27 inch. Length of the middle toe beyond the outer ones, 1·2 to 1·4 inch. Distance between the tips of the lateral toes, 1·5 to 1·6 inch; do. between the inner and middle toe, 1·37 to 1·64 inch; do. between the outer and middle toe, 1·2 to 1·65 inch. Length of the first phalanx of the inner toe, 0·65 to 0·8 inch; do. of the second and third, (supposed to make but one impression,) 0·6 to 0·8 inch; do. of the first of the middle toe, 0·64 to 0·8 inch; do. of the second phalanx, 0·53 to 0·8 inch; do. of third and fourth, 0·4 to 0·8 inch; do. of the first of the outer toe, 0·4 to 0·54 inch; do. of the second, 0·3 to 0·4 inch; do. of the third, 0·26 to 0·35 inch; do. of the two last, 0·33 to 0·45 inch. Tracks in a right line, and the axis of the foot coincident with that line.

Distinctive Characters.—The most striking characters by which the tracks of this animal are marked off from all others, are the near approach to parallelism of the lateral toes, and the great length of the step compared with the size of the foot. This is particularly the fact in respect to the smaller of the outline tracks given on Fig. 2, *a;* for the animal by which this was made, had a stride of two feet: nor is this confined to a single specimen; so that the idea that the animal was running, is not probable. The great disparity between the step in the large specimen (fig. 2, *b*) and the small one (fig. 2, *a*), has led me to suspect that in the above description I may have embraced two species: but their form coincides too exactly to allow of a separation: and yet the large track shows a stride of only 13 inches, while that of the smaller one is 24 inches. The former is from Turner's Falls in Gill, and the latter from South Hadley. I am more disposed to this opinion, from the fact, that I find another row of tracks on the same slab from South Hadley, that contains fig. 2, *a*, running in the opposite direction, and about as large as fig. 2, *b*, yet exhibiting a stride of 29 inches. See the two rows on Fig. 1, *a, a, a, a*, and *b, b, b, b*.

The ratio between the length of the foot and the step in this species, (taking the two examples on fig. 1 as our guide,) is much greater than that of any other animal whose footmarks I have found. That ratio is 8 for the smaller track, and 8·3 for the larger: that is, the step is eight times larger than the foot. Applying the rule which I have suggested for ascertaining from these numbers the length of this bird's leg,* we find it to be 39

* See Final Report by the writer on the Geology of Massachusetts, vol. ii, p. 522.

inches for the smaller animal, and 47 inches for the larger one; that is, from the hip joint to the ground. This is rather more than the length of the leg of the Red Flamingo of this country, which I think also has a larger foot than the fossil bird.

I now proceed to describe the large and extraordinary animal whose tracks occur on the same slab with the B. parallelum, (fig. 1,) but whose affinities to any existing animal are far less obvious. For this remarkable animal I have selected the generic name of *Otozoum*, from that of Otus, one of the fabled præadamic giants. The meaning of Otozoum is, *an animal Otus, or giant.*

The description of the foot of this animal, as we learn it from its footmarks, will depend to a considerable extent upon the zoological class to which we refer it. The protuberances exhibited on the footmark may be all the result of phalangeal impressions; or a part of them may be produced by carpal or metacarpal, or if by the hind foot, by tarsal or metatarsal bones: or if the animal were a bird, by the distal extremity of its tarso-metatarsal bone. Can we then discover to what class of animals these tracks are to be referred?

In the first place, the proof seems quite strong that they must have been made by a biped. This evidence is shown on fig. 1; where it will be seen that the feet regularly alternate as those of a biped would do. But if made by a quadruped, there ought to be two rows, or at least two tracks, near to each other, separated by a longer interval from two others in close proximity: for in one or the other of these modes do most quadrupeds (except those that leap, and those that bring up the hind foot exactly into the place impressed by the fore foot) advance. Besides, the distance of the tracks to the right and left of the animal's general course, is no greater than a biped so large would exhibit: whereas if it were a quadruped, that distance must have been much larger, and the axes of the feet would probably be more divaricate.

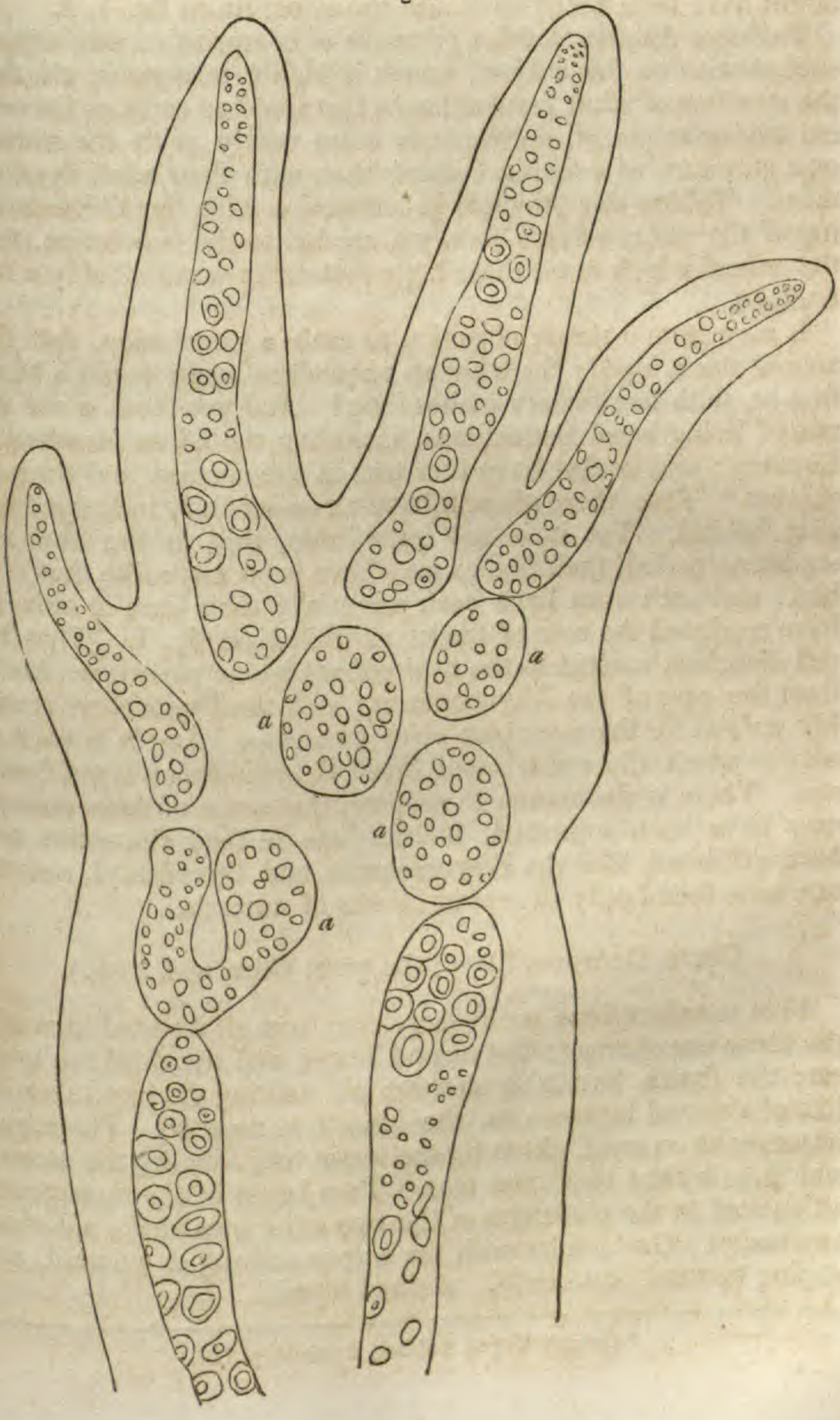
When I saw that these tracks were four-toed, it occurred to me that they might have been made by the hind foot of the crocodile. But their biped character forbids the supposition: and besides, the phalangeal impressions do not agree at all with the phalanges of that animal, which are two in the inner toe of the hind foot, three in the second, and four in the third and fourth.* This latter reason, as well as the number of toes, affords strong evidence against the supposition that this animal was a bird. Some slight resemblance may be noticed between the accompanying drawing, fig. 2, and the feet of the Armadillos, as given in the *Ossemens Fossiles, tome cinquième, Pl. XI, figs.* 10 *to* 14; yet I doubt whether the resemblance is real.

On showing a drawing of this track to Professor Agassiz, he made a suggestion as to the nature of the animal that im-

* Cuvier, Ossemens Fossiles, Tome cinquième, p. 104.

pressed it, which I regard as very important. He at once exhibited to me a drawing of the foot of a recent Batrachian, the *Alytis obstetricans*, in a paper by Dr. Carl. Vogt, while the animal was in an embryo state. This drawing, which I have copied on fig. 3, shows the condition of the forefoot while yet ossification

Fig. 3.



was in an incipient state, or had not begun. The resemblance is certainly rather striking between this sketch and that on fig. 1: and it leads to the suspicion that some of the tubercular impressions of the track may have been made by the metacarpal bones. Such I suppose to be the character of *a*, *a*, *a*, *a*, fig. 3; and when these were fully ossified, it is easy to conceive that they might have been anchylosed into the structure in fig. 1, A.

Professor Agassiz stated a principle of comparative anatomy, in conversation on this subject, which is highly important, viz. that the structure of adult fossil animals, that lived as early as the new red sandstone period, corresponds more nearly with the embryonic structure of existing animals than with their adult development. Taking this principle in connection with the above drawing of the embryo-frog's foot, we are led to the conclusion, that the animal which made these huge footmarks was probably a Batrachian.

It may seem a strong objection to such a conclusion, that the animal was a biped: for what an anomalous being would a biped frog be, with feet twenty inches long! And yet there is one genus of living biped Batrachians, including the *Siren lacertina* of Linnæus; and its feet have four toes in one species, and three in another.* True, these animals have an enormously long tail dragging behind. Yet it is not improbable, that in the new red sandstone period, their bodies may have been more like that of a bird: and such must have been essentially their form in order to have produced the row of tracks exhibited on fig. 1. That biped Saurians existed in the new red sandstone period, we know from the case of the Rhyncosaurus: and the Pterodactyl probably walked for the most part upon two legs. And it is quite as easy to admit the existence of biped Batrachians as biped Saurians. There is also reason to suppose, that some of these animals may have been somewhat intermediate in their characters, and have exhibited, like the Rhyncosaurus and Pterodactyl, a structure now found only in several classes of animals.

Genus Otozoum, (*Ωτος*, the giant Otus, and *Ζωον*.)

Foot tetradactylous, pachydactylous; toes all directed forward: the inner one shortest; the second longer, and the third the longest; the fourth but little shorter: all making distinct tubercle-like phalangeal impressions, the inner toes most so. Phalangeal impressions on mud, three by the inner toe, four by the second, and three by the two outer toes. Two bones of the metacarpus, articulated to the phalanges of the two outer toes, make a distinct impression. Cushion beneath the carpus arching downward, and sloping upward posteriorly. Animal bipedal.

* Cuvier, Règne Animal, Tome ii, p. 120.

Remarks.—It may be that what I have reckoned as the first phalangeal impression on the two inner toes was made by metacarpal bones: and it is also possible, on the other hand, that both the impressions which I have described as having a metacarpal origin on the two outer toes, may have been phalangeal.

Otozoum Moodii. (Fig. 1, A.)

Divarication of the outer toes, 35°; do. of the inner and second toe, 15°; do. of the outer and third toe, 12°; do. of the two middle toes, 5°. Length of the inner toe, 8·5 inches; do. of the second toe, 10·25 inches; do. of the third toe, 8 inches; do. of the outer toe, 8·5 inches; do. of the foot, 20 inches; do. of the step, about three feet. Distance between the extremities of the outer toes, 13 inches. Width of the foot behind the phalanges and metacarpus, 5 inches; do. of the toes, from 2 to 3·25 inches. Length of the phalanges of the inner toe:—proximal phalanx, 3 inches; of the second, 2 inches; of the third, 3·4 inches (?) do. of the second toe:—proximal, 2·4 inches; second, 2·5 inches; of the third, 2·9 inches; do. of the fourth, 2·6 inches (?); do. of the proximal metacarpal bone of the third and fourth toes, 3·5 inches; of the second, 4 inches: of the first phalanx of the third toe, 2 inches; of the second, 2 inches; of the distal, 3·8 inches (?); do. of the outer toe:—proximal, 1·6 inch; of the second, 1·6 inch; of the distal, 5·4 inches (?) Divarication of the axes of the feet, 30°. Distance to the right and left of the middle of the heel, from the average line of direction along which the animal moved, 2·5 inches. Integuments of the bottom of the foot, rugose and irregularly papillose.

Distinctive Characters.—Four thick toes directed forward and making strong phalangeal impressions, distinguish this animal from all others that have left their footprints in the sandstone of New England. The number of phalanges, also, in the toes, separates it from every other. As only one of the tracks of the animal is entire enough for description, I should have suspected some deception in both these characteristics; but sufficient remains of the other tracks, to identify them by their repetition; particularly in respect to the phalangeal impressions of the two outer toes.

Situation and character of the Deposits containing these tracks.—The tracks above described are all in relief, and the rock is a very coarse gray sandstone, the grains being often as large as buckshot. Yet every thing is exhibited most distinctly. Nearly the whole slab is covered with rain drops most beautifully exhibited, and shown upon the drawing, fig. 1. The tracks appear to have been made upon a fine micaceous sand, which has little more coherence now than when the animals trod upon it. But the coarse material that was subsequently brought over this fine stratum, seems to have adapted itself to every irregularity, and now presents us with perfect casts of the original tracks, while the subjacent rock, which seems to have been a good moulding sand, does not hold together enough to show a single entire track.

It seems that the rows of tracks at this locality were parallel to the edges of the water. They run nearly east and west, and in the direction of the strike of the strata; and in one or two places upon the slab figured above, we can see where the water acted by gentle undulations upon the fine micaceous sand, and upon the coarse grit, partially wearing them both away, or intermixing them; and some of the large tracks look as if the sand had been so wet that the impressions were partly filled up by the sand sliding into them. Only the second track exhibits the outlines of the parts entire. On that, the protuberances rise from one to two inches above the general surface. The extremities of this track have been broken off accidentally, except the inner one which is obscured by lying too near the edge of the water. It is obvious however how far it extended. As I have before mentioned, the second large track on fig. 1, forms the type by which I have restored the others, or rather, completed them; for some of the toes remain in all cases, and so far as they go, they confirm the characters exhibited by the second. It is only a part of the phalangeal impressions that shows the rugosities or papillæ of the skin: yet I can hardly doubt but we have them exhibited on some of the protuberances.

All the left-hand side of the slab, represented on fig. 1, for about half its length, embracing the first two of the large tracks, has been split off an inch or two lower than the other part of the slab. This makes no difference in the large tracks, except to make them stand out in higher relief; but it brings to light several of the smaller tracks, which, although of the same species, must have been impressed at a later period—probably one or two years later—than those scattered among the rain drops.

I have not been able to find any certain example of claws upon the large tracks. Most of the toes are somewhat mutilated at their extremities; and in general, the sides converge rapidly on the last phalanx, so that if claws existed on the foot—and I think they did—they must have been short and blunt.

Circumstances under which the tracks of these animals were made.—Have we any facts in this case indicating the circumstances under which these tracks were made and preserved? It is difficult, without a sketch of the topography of the region, to convey an adequate idea of their situation. The spot is on the south side of Mount Holyoke, which here runs nearly east and west. It curves southerly, however, as it crosses the river, and on the west we have Mount Tom, as the continuation of Holyoke is called. On the east we have a primary range at a short distance, against which the east end of Holyoke abuts, with only a narrow space between. It is obvious then, that this locality must have been the north shore of an estuary, opening southerly, and extending to what is now Long Island Sound. That it was salt-water is evident from the occurrence of fucoids in the same basin, a few miles south. Now we know that the current through this estuary was either north or south, for the ripple marks have an east and west direction, and in size they correspond with those made by the waters of the Connecticut on the sand in the same region. The direction of that stream also is south; and some have thought that the floods of that stream may have brought in the sand which filled the tracks. But the locality must have been defended from a northerly current by Mount Holyoke, whose elevation doubtless formed the shore on which the animals trod. Indeed, it would be exposed to no current that I can conceive of, sufficiently powerful to move such coarse materials, except the waves and tides from the south. And yet, a deposit at least six inches thick of coarse sand, was brought in over the tracks. It seems difficult to conceive how any river floods should have raised the waters of an estuary enough for this purpose; and more difficult to show how these coarse materials could have been thus brought over this spot. I have hence been rather inclined to suppose that they were silted in by the waves and the tides:—not the daily tides, but the spring tides. Suppose the animals walked along the shore during neap tide, and that no rain fell till the return of spring tide. By that time the mud might have become so indurated, that even such coarse materials might have been brought in by moderate waves, without erasing the impressions. It might be also that the river, which doubtless flowed into this estuary, answering to the present Connecticut, was at the same time swollen; and perhaps also we must resort to the supposition of a subsidence of the locality—an occurrence not uncommon during igneous eruptions: and we know from other circumstances, that the tracks were made about the same period in which Holyoke was erupted. We have evidence also that this period, including some precursory outbursts of the igneous matter, was quite long.

Should time and health permit, I hope to send another communication ere long, describing other new species of tracks in the Connecticut valley. I have no others, however, that are so remarkable as the large one herein described. This, indeed, seems to eclipse that of the *Brontozoum* (Ornithoidichnites) *giganteum*, figured in the Journal of Science for 1836, being even of greater dimensions. I had thought that we had reached nearly the end of this ancient volume; but it may be, that many new chapters will yet be brought to light, when its stony leaves shall be still farther opened.

ART. VIII.—*Glycocoll (Gelatine Sugar) and some of its Products of Decomposition;* by Prof. E. N. HORSFORD.

(Continued from Vol. iii, p. 381.)

COMPOUNDS of glycocoll and sulphuric acid are even more remarkable than those with hydrochloric acid. As little success attended the effort to ascertain the precise conditions under which some of them are formed, as rewarded the labors with the compounds already described. Of these, two, the double sulphate of glycocoll and oxyd of ammonium, and the anhydrous sulphate of glycocoll, have especial interest, as they throw much light over the constitution and nature of this body.

Anhydrous Sulphate of Glycocoll.

Gl, SO_3.

By dissolving glycocoll in hot spirits of wine, cooling, adding sulphuric acid drop by drop, and setting aside in a quiet place, after a day or two there are formed beautiful elongated thin flat prisms with right angled terminal planes. From another portion the salt crystallized in the most delicate attenuated tables of the greatest brilliancy. It is soluble in water and hot diluted alcohol, and quite insoluble in absolute alcohol and ether. It tastes sour and reddens litmus paper, does not change upon exposure to the air, and loses no weight by 100° C. (212° F.)

Combustion with chromate of lead gave the following results:

I. 0·5147 grm. gave 0·4257 carbonic acid and 0·2509 water.
II. 0·3134 " " 0·2574 " " " 0·1616 "
III. 0·1541 " " 0·1260 " "
IV. 0·3397 " " 0·7039 platin-salammoniac.
V. 0·4248 " " with chlorid of barium 0·4673 grm. sulphate of baryta.

In per cent. expressed agreeing with,

	I.	II.	III.	IV.	V.
Carbon,	22·55	22·40	22·30	. .	. .
Hydrogen,	5·41	5·72	. .	. .	. .
Nitrogen,	. .	. .	. .	13·05	. .
Sulphuric acid,	. .	. .	. .	. .	37·97

Which give the formula

$$C_4\ H_4\ NO_3,\ SO_3,$$

as the comparison of estimated and analytical results shows.

		Theory.	Experiment.
Carbon, - - - - -	4 equiv. = 24	22·66	22·42
Hydrogen, - - - - -	4 " = 4	3·77	5·56
Nitrogen, - - - - -	1 " = 14	13·20	13·05
Oxygen, - - - - -	3 " = 24	22·64	21·00
Sulphuric acid, - - -	1 " = 40	37·73	37·97
	106	100·00	100·00

Repeated combustions did not enable us to lessen the per-centage of hydrogen. The variation from the theory is, doubtless, to be attributed to the absorption in the chlorid of calcium tube, of a small quantity of sulphurous acid, which escaped from the combustion tube. This explanation unfortunately occurred after repeated analyses had consumed the stock of salt.

This constitution is remarkable in the field of organic chemistry. On its borders we have a similar instance in anhydrous sulphate of ammonia, NH_3+SO_3.

Sulphate of Hydrate of Glycocoll.

$$Gl, SO_3, HO.$$

This salt was obtained from a solution similarly prepared to that which yielded the anhydrous salt, except that the solution was boiled with sulphuric acid, instead of the latter being added to the cold solution. It crystallizes in short prisms, reminding one of sulphate of copper, and the crystals, though small, are of exceeding beauty and perfection of form. They do not change upon exposure to the air.

A single determination only was made, and *that* of the nitrogen. The other determinations were not made, from want of substance, all subsequent efforts to form the salt having failed.

By Varrentrapp and Will's method:—

0·3367 grm. gave 0·2943 grm. platin-salammoniac.

In per cent. expressed, Nitrogen 12·37.

This corresponds with the formula

$$C_4\ H_4\ NO_3,\ SO_3,\ HO,$$

which requires 12·17 per cent. of nitrogen.

Basic Sulphate of Glycocoll.

(a.) $3Gl\ HO,\ 2SO_3,\ 2HO$.

If to a solution of glycocoll in diluted spirits of wine, sulphuric acid in excess be added, and set aside, in twenty-four hours long rectangular prismatic crystals form upon the bottom of the containing vessel. A very considerable excess of sulphuric acid did not change the constitution of the crystals.

They taste and react acid, and like the salts already described suffer nothing from exposure to the air.

Combustion with chromate of lead gave the following results:

I. 0·4199 grm. gave 0·3528 carbonic acid and 0·2149 water.
II. 0·3944 " " 0·3219 " " " 0·1974 "
III. 0·2399 " " by Varrentrapp and Will's method, 0·5067 grm. platin-salammoniac.
IV. 0·6866 grm. gave 0·4928 sulphate of baryta.
V. 0·5808 " " 0·4170 " "
VI. 0·4532 " " 0·3225 " "
VII. 0·4960 " " 0·3500 " "

In per cent. expressed the above determinations correspond with

	I.	II.	III.	IV.	V.	VI.	VII.
Carbon,	22·91	22·25	. .	. .	. .	. .	. .
Hydrogen,	5·68	5·56	. .	. .	. .	. .	. .
Nitrogen,	. .	. .	13·31	. .	. .	. .	. .
Sulphuric acid,	. .	. .	. .	24·62	24·62	24 20	24·40

These numbers give the formula,

$$3(C_4\,H_4\,NO_3, HO)+2(SO_3, HO).$$

The juxtaposition of the estimated per cents. and analytical results follows:—

		Theory.	Experiment.
Carbon, - - - - -	12 equiv. = 72	22·29	22·58
Hydrogen, - - - -	17 " = 17	5·26	5·62
Nitrogen, - - - -	3 " = 42	13·00	13·31
Oxygen, - - - -	14 " = 112	34·69	34·03
Sulphuric acid, - - -	2 " = 80	24·76	24 46
	323	100·00	100 00

The following formula is submitted as expressing the rational constitution of this salt:—

$$(Gl\ HO, SO_3\ HO+Gl\ HO)+(Gl\ HO, SO_3\ HO).$$

The following sulphuric acid compounds were none of them completely analyzed. They were prepared in small portions while seeking to obtain a neutral sulphate of hydrate of glycocoll; and it was not until the capacity of this body to combine with others of such different nature, and in such varied proportions became fully apparent, that the existence of so complex and unusual compounds was believed.

The crystallized salts were for the most part groups of elongated prisms.

Basic Sulphate of Glycocoll.

(b.) $3Gl, 2SO_3, HO$.

The constitution of this salt differs from that of the preceding in the amount of water. As both of them were dried in the air over sulphuric acid, and suffered no change, this difference is attributable doubtless to the degree of concentration, or difference of temperature. It will be observed that it corresponds precisely with a basic hydrochlorate (d), whose constitution is given on page 380 of the last volume.

With chlorid of barium, 0·2182 grm. of crystals, gave 0·1940 grm. sulphate of baryta.

In per cent. sulphuric acid 27·74.

This corresponds with the formula

$$3(C_4\,H_4\,NO_3)+2SO_3+HO,$$

which requires 27·87 parts in 100. As the probable rational constitution of this salt the following is submitted:

$$(Gl, SO_3+Gl, HO)+Gl, SO_3.$$

Basic Sulphate of Glycocoll.

(c.) $3(Gl, HO)2SO_3, HO$.

A mixture of the salt (b) with the previously described one (a), doubtless gave the crystals for the following determination:

0·3076 grm. gave 0·2300 grm. sulphate of baryta, which gives in per cent. expressed, sulphuric acid 25·65; corresponding with the above formula. The following is more rational.

$(Gl, SO_3, HO+Gl, HO)+(Gl, HO+SO_3 HO)$.

This requires 25·47 parts of sulphuric acid in 100.

(d.) $2(Gl, HO)+SO_3$.

Another salt gave by combustion with chromate of lead,—

From 0·3039 grm., 0·2872 grm. carbonic acid, and 0·1680 grm. water; which expressed in per cent., give carbon 25·77, hydrogen 6·01. These numbers correspond with the formula

$2(C_4 H_4 NO_3, HO)+SO_3$,

which requires carbon 25·26, and hydrogen 5·26.

Glycocoll and Sulphate of Oxyd of Ethyl.

Gl, HO, AeO, SO_3.

The particular circumstances of the formation of this salt, beyond those already given, viz. a solution in hot spirits of wine, or in water to which absolute alcohol was added, are not ascertained.

With chlorid of barium, 0·6470 grm. gave 0·3036 grm. sulphate of baryta; which in per cent. give of sulphuric acid 17·27. This quantity of acid corresponds with the formula

$C_4 H_4 NO_3, HO+C_4 H_5 O, SO_3$,

which requires 17·62 per cent. of sulphuric acid.

Nitrate of Glycocoll.

$Gl, HO+NO_5, HO$.

The capability which this compound possesses of uniting with bases enveloped the earlier conceptions of the nature of glycocoll in obscurity:—an obscurity from which the changes the nitrate of copper salt experienced upon subjection to heat, and the simple combinations with the oxyds of silver, copper and lead, did not in any degree relieve it. It was then suggested that the glycocoll played the part of the water of crystallization in the salts that were formed. From the analysis below, it will be seen that the salts were double salts, in which glycocoll with or without water, as a *base*, united with hydrated nitric acid, or as a salt with nitrates of metallic oxyds.

Braconnot obtained this compound by direct combination of nitric acid with glycocoll prepared from isinglass. Dessaigne procured it directly from hippuric acid, employing nitric instead of hydrochloric acid for its decomposition.

We prepared it by dissolving glycocoll in strong nitric acid, and setting the solution over sulphuric acid to crystallize. Occasionally large tabular crystals, apparently belonging to the monoclinate system, are formed. Not unfrequently, however, the salt crystallizes in needles, especially if the fluid has been warmed.

They do not deliquesce upon exposure to the air. They taste and react acid. They were dried over sulphuric acid. Combustion with chromate of lead gave the following results:—

I. 0·4509 grm. substance gave 0·2954 grm. carbonic acid, and 0·1963 grm. water.

II. 0·4968 grm. substance gave 0·3122 grm. carbonic acid and 0·2054 grm. water.

Two analyses, according to Varrentrapp and Will's method, gave respectively 10·04 per cent. and 10·64 per cent. of nitrogen. From this it is evident that this method cannot here be employed:—a fact with regard to nitrates, to which attention has already been drawn by the chemists just mentioned.

Failing in this, a determination was made by the quantitative method of Prof. v. Liebig.

The proportions of carbonic acid to nitrogen in four tubes, were: 17:9, 14:7, 10:5, 24:11; or, together 65:32=2:1.

In per cent. expressed the above determinations give

	I.	II.	III.
Carbon, - - -	17·86	17·15	. .
Hydrogen, - - -	4·83	4·59	. .
Nitrogen, - - -	. .	. .	20·50

These correspond with the formula

$$C_4\ H_4\ NO_3,\ HO+NO_5\ HO,$$

as will be seen by the annexed estimates and results of analysis.

		Theory.	Experiment.
Carbon, - - - - -	4 equiv. = 24	17·38	17·49
Hydrogen, - - - -	6 " = 6	4·32	4·71
Nitrogen, - - - -	2 " = 28	20·29	20·50
Oxygen, - - - -	10 " = 80	58·01	57·30
	138	100·00	100·00

Boussingault by drying the salt at 110° C. (230° F.) obtained as already noticed the anhydrous compound $C_4\ H_4\ NO_3,\ NO_5$.

Oxalate of Glycocoll.

$$Gl,\ \bar{O},\ HO.$$

An aqueous solution of glycocoll with oxalic acid, evaporated upon a watch glass, crystallizes in rays reminding one of a cross section of wavellite. If alcohol be added to a solution of glycocoll in oxalic acid, the latter in excess, the solution becomes milky, with the separation of oxalate of glycocoll. If added in small quantities and successively, it crystallizes with the beauty that characterizes all or nearly all the compounds of this body. Dessaigne obtained the salt directly from hippuric acid by employing oxalic instead of a stronger acid, to effect the decomposition. It does not alter upon exposure to the air.

Combustion with chromate of lead gave the following:—0·3600 grm. gave 0·4227 grm. carbonic acid, which in per cent. expressed, gives carbon 32·02, corresponding with the formula

$$C_4\ H_4\ NO_3,\ C_2\ O_3,\ HO,$$

which requires 32·43 per cent. of carbon.

Acetate of Glycocoll.

$$Gl,\ HO,\ \bar{A},\ 2HO.$$

This salt is readily prepared by dissolving glycocoll in acetic acid, and adding absolute alcohol drop by drop, till the solution becomes turbid, and then afterward at intervals, as the crystallization proceeds. The salt analyzed was prepared by adding absolute alcohol in excess to a concentrated solution of glycocoll in acetic acid, (the latter in excess,) by which the salt was thrown down. It was then redissolved by heat, and set aside to cool and crystallize, by which slender prismatic crystals of great beauty were obtained.

On combustion with chromate of lead, 0·2981 grm. gave 0·3644 grm. carbonic acid and 0·2031 grm. water, which in per cent. expressed correspond with carbon 33·33, hydrogen 7·57. The formula

$$C_4\ H_4\ NO_3,\ HO+C_4\ H_3\ O_3+2HO,$$

requires of carbon 33·33 per cent. and of hydrogen 6·94 per cent.

Tartrate of Glycocoll.

By dissolving glycocoll in tartaric acid and adding absolute alcohol in excess to the solution, an oily appearing liquid separates and settles to the bottom. Repeated and protracted agitation with alcohol and ether effect no change. This liquid dried upon a watch glass gave a gummy mass which was not further investigated.

Palmatinate of Glycocoll.

By dissolving palmitinic acid and glycocoll in hot spirits of wine, and setting aside to cool, the excess of acid rises to the surface in the form of an oil, while the salt crystallizes in white, thin, silky, radiating scales or blades of the greatest brilliancy. The oily layer, above, which with the whole mass becomes solid, may be readily removed, and the remainder pressed in silk and dried in the air over sulphuric acid. Combustion with chromate of lead gave the following results:

	I.	II.	III.
Carbon, -	51·30	51·23	50·84
Hydrogen, -	9·45	. .	9·44

With these, no formula embracing palmitinic acid and glycocoll has been found. The formula

$$C_4\ H_4\ NO_3,\ C_{32}\ H_{31}\ O_3+12HO,$$

requires 51·31 per cent. of carbon and 11·16 per cent. hydrogen, which would correspond with the carbon, but not with the hydrogen determinations.

Glycocoll and Bi-chlorid of Platinum.

Gl, $PtCl_2$, 2HO.

When to a concentrated solution of glycocoll in water, a concentrated solution of bi-chlorid of platinum is added, and then absolute alcohol drop by drop, the solution becomes turbid, and in a very short time, regular cherry-red crystals attach themselves to the sides of the vessel. Or if the concentrated aqueous solution be evaporated over sulphuric acid, after a time, groups of prismatic crystals are formed.

They become instantly covered with a bright colored crust upon exposure to the air, manifestly with the loss of water.

0·3679 grm. substance gave 0·0872 grm. platinum.

In per cent. expressed = 33·03, which corresponds with the formula $C_4\ H_4\ NO_3,\ PtCl_2+2HO$,
which requires 33·26 per cent. of platinum.

Glycocoll and Chlorid of Barium.

Gl, BaCl, 2HO.

To obtain this salt, equivalents of crystallized chlorid of barium (= BaCl + 2HO) and glycocoll were dissolved in the least quantity of hot water, and suffered to crystallize quietly in the cold. In a few moments the salt crystallized in groups of short prisms of extreme beauty. None were sufficiently perfect to admit of measurement. They appeared to belong to the rhombic system, of the combination $\infty P.\ \breve{P}\infty\ .\ \infty\bar{P}\infty$.

The addition of alcohol to the solution changed the form to that of slender flat needles.

The salt is soluble in water, more so in hot than in cold, tastes bitter, gives neither acid nor alkaline reaction, does not deliquesce or change upon exposure to the air.

Dried over sulphuric acid, 0·6715 grm. substance gave 0·3833 grm. sulphate of baryta, = 55·34 per cent. of chlorid of barium, giving the formula $C_4\ H_4\ NO_3$, BaCl, 2HO, which requires 55·31 per cent. of chlorid of barium.

Glycocoll and Chlorid of Potassium.

Gl, KCl.

This compound was prepared by dissolving glycocoll and chlorid of potassium in water, and evaporating over sulphuric acid.

When the solution had become very concentrated, fine needle-formed crystals filled the whole mass. They deliquesce readily in the air.

A single combustion with chromate of lead, gave from 0·4992 grm., 0·3055 grm. carbonic acid = 16·58 per cent. of carbon.

The formula $C_4 H_4 NO_3$, KCl, requires 16·92 per cent. of carbon.

Glycocoll and Chlorid of Sodium.

A concentrated solution of glycocoll and chlorid of sodium in water, gave upon addition of absolute alcohol and standing a length of time, crystals containing both of the above mentioned ingredients. A quantitative examination was not made.

Glycocoll and Bi-chlorid of Tin.

By dissolving glycocoll in the least quantity of water, and adding bi-chlorid of tin, after a time, crystals containing both ingredients of the solution are formed. They were not more particularly examined.

Glycocoll and Hydrochlorate of Berberin.

Gl, Ber, HCl.

This salt is obtained by adding a hot solution of hydrochlorate of berberin in spirits of wine, to a concentrated solution, in excess, of glycocoll in the same menstruum. Upon cooling, the whole mass becomes solid, and consists of myriads of the most delicate needles, of a brilliant orange color and bitter taste. The salt may be washed with water, as glycocoll is therein readily soluble, while the salt of berberin is not.

The salt dried at 100° C. [212° Fah.] and burned with chromate of lead, gave the following results:

0·1563 grm. substance gave 0·3485 grm. carbonic acid and 0·0826 grm. water, which expressed in per cent. give carbon 60·80, hydrogen 5·87. These correspond with the formula

$$C_4 H_4 NO_3 + C_{42} H_{18} NO_9, HCl,$$

which, containing berberin with the constitution given by Fleitmann,* requires 60·21 per cent. of carbon and 5·03 per cent. of hydrogen.

Glycocoll and Potash.

By dissolving glycocoll in diluted caustic potash and evaporating to syrup consistence over a water bath, crystals in the form of long delicate needles, containing the two ingredients, are formed. They may be rapidly washed with spirits of wine. They deliquesce rapidly in the air, even over sulphuric acid. Dissolved in water, the salt gives a very strong alkaline reaction. It was not further examined.

* Liebig's Annalen, Bd. lix, s. 166.

Glycocoll and Hydrate of Baryta.

It has already been mentioned, that glycocoll rubbed with pulverized hydrate of baryta, in a mortar, becomes almost instantaneously semifluid. Upon diluting the solution, and setting aside, after a time crystals containing both baryta and glycocoll were deposited. The salt was not analyzed. Its composition, in all probability, corresponds with that of the oxyd of copper, silver and lead, noticed below, and there exist, doubtless, similar salts of strontia, lime and magnesia.

Glycocoll and Oxyd of Copper.

Gl, CuO, HO.

This salt may be prepared by adding to a solution of glycocoll sulphate of copper and caustic potash—and addition of absolute alcohol,—or by dissolving hydrated oxyd of copper, with the aid of heat, in a solution of glycocoll, and adding absolute alcohol: —or lastly by boiling the anhydrous oxyd of copper, in excess, with glycocoll. If the latter be concentrated it must be filtered hot. In this case, the filtrate in a few moments is resolved into a solid mass of the most exquisite cerulean blue color. More carefully examined, it is found to consist of exceedingly delicate needles. The addition of absolute alcohol to the concentrated solution precipitates the whole salt; to the diluted, less perfectly.

At 100° C. [212° F.] 0·5443 grm., at the conclusion of several days, had lost 0·0438 grm. =8·04 per cent. =one atom of water.

With this loss the color passed through a light green to a shade in which a lavender or violet tint is discernible.

The analysis was made with the substance dried in the air over sulphuric acid.

Combustion with chromate of lead gave the following results:—

I. 0·2030 grm. of substance gave 0·1538 grm. carbonic acid and 0·0912 grm. water.

II. 0·2373 grm. by the method of Varrentrapp and Will, gave 0·4762 grm. platin-salammoniac.

III. 0·1745 grm. gave 0·0592 grm. oxyd of copper.

IV. 0·2871 grm. gave 0·0972 grm. oxyd of copper.

Which expressed in per cent. give

	I.	II.	III.	IV.
Carbon,	20·66	. .	. .	. .
Hydrogen,	4·99	. .	. .	. .
Nitrogen,	. .	12·65	. .	. .
Oxyd of copper,		. .	33·85	33·92

These give the formula $C_4H_4NO_3$, CuO, HO, as will be seen by comparing the theoretical and analytical results.

		Theory.	Experiment.
Carbon,	4 equiv. = 24	20·92	20·66
Hydrogen,	5 " = 5	4·35	4·99
Nitrogen,	1 " = 14	12·20	12·65
Oxygen,	4 " = 32	27·92	27·81
Oxyd of copper,	1 " = 39·7	34·61	33·89
	114·7	100·00	100·00

With the loss of an atom of water, we have the salt

$$C_4\,H_4\,NO_3, CuO,$$

which it will be seen is precisely the composition derived from Boussingault's analysis of the salt dried at 120° C. = [248° F.] See page 373.

Glycocoll and Protoxyd of Lead.

Gl, PbO, HO.

This salt was prepared by dissolving with the aid of heat, protoxyd of lead (obtained from the peroxyd by long continued heat) in a concentrated aqueous solution of glycocoll, and the addition of alcohol till it began to be turbid. In a few hours it separated in prismatic crystals that slowly increased in size for several days, particularly with successive additions of absolute alcohol. The crystals remind one of cyanid of mercury.

A single combustion with chromate of lead gave from 1·3967 grm. substance, 0·6182 grm. carbonic acid, equal to 12·07 per cent. of carbon, corresponding with the formula derived from Boussingault's analysis with the addition of an atom of water,

$$C_4\,H_4\,NO_3, PbO, HO,$$

which requires 12·83 per cent. of carbon.

Boussingault's analysis was made from the salt, dried at 120° C., [248° F.,] leaving $C_4\,H_4\,NO_3$, PbO.

Glycocoll and Oxyd of Silver.

Gl, AgO, HO.

If oxyd of silver be added to a solution of glycocoll, it readily dissolves with the application of heat. With the addition of alcohol the above compound crystallizes in wartform crystals, which become dark upon exposure to light.

This salt was not analyzed, as Boussingault's analysis of it, dried at 110° C. [230° F.] as already noticed, gave the formula

$$C_4\,H_4\,NO_3, AgO.$$

There is scarcely a doubt that corresponding compounds of cobalt, nickel, manganese and iron protoxyds with glycocoll, might with nearly equal facility be prepared.

These compounds are perhaps analogous to those of ammonia with copper and nickel oxyds, when the latter are dissolved in the volatile alkali.

Glycocoll and Nitrate of Silver.

Gl, AgO, NO_5.

If the filtrate from a chlorine determination of the hydrochlorate of glycocoll be evaporated to concentration, and set aside over sulphuric acid, in a little time tolerably regular crystals of the above salt may be obtained.

It may be procured by dissolving glycocoll in nitrate of silver: or by dissolving oxyd of silver in the solution of the nitrate of glycocoll.

Upon melting, it explodes with violence. When exposed to moist air it deliquesces; though it remains unchanged over sulphuric acid.

The salt dried over sulphuric acid, on combustion with chromate of lead:—

I. 0·9300 grm. of substance gave 0·3550 grm. carbonic acid and 0·1880 grm. water.

II. 0·7840 grm. of the same gave 0·2950 grm. carbonic acid and 0·1560 grm. water.

III. 0·6469 grm. of the same gave 0·0258 grm. chlorid of silver.

In per cent. expressed,

	I.	II.	III.
Carbon,	10·11	10·26	. .
Hydrogen,	2·24	2·21	. .
Silver,	. .	. .	49·83

giving the formula $C_4H_4NO_3$, AgO, NO_5,
as the annexed estimates and results of analysis will show:

		Theory.	Experiment.
Carbon, - - - -	4 equiv. = 24	10·16	10·18
Hydrogen, - - -	4 " = 4	1·69	2·22
Nitrogen, - - -	2 " = 28	11·86	. .
Oxygen, - - -	8 " = 64	26·76	. .
Ox. silver, - - -	1 " = 116	49·53	49·83
	236	100·00	

Glycocoll and Nitrate of Copper.

Gl, HO, CuO, NO_5, CuO, HO.

This salt was analyzed by Boussingault, and may be considered as a compound of hydrate of glycocoll with nitrate of copper, united to hydrate of oxyd of copper.

(Gl, HO + CuO NO_5) + CuO, HO.

Glycocoll and Nitrate of Potash.

Gl, KO, NO_5.

This salt forms readily from a solution of glycocoll in nitrate of potash, upon the addition of absolute alcohol. No quantitative analysis of it was made. The above formula is derived from the analyses on page 373.

Glycocoll and Bi-sulphate of Potash.

$$Gl, SO_3 + Gl, KO, SO_3.$$

By dissolving bi-sulphate of potash in water and adding a solution of glycocoll, throwing the whole down with alcohol, redissolving by heat and setting aside to cool and crystallize, the above salt is obtained in semi-opaque prismatic crystals.

A single determination from the salt dried over sulphuric acid gave from 0·6873 grm. of substance 0·6200 grm. sulph. baryta. In per cent. giving sulphuric acid =30·94. The formula

$$C_4\ H_4\ NO_3, SO_3 + C_4\ H_4\ NO_3, KO, SO_3,$$

requires of sulphuric acid 30·83 per cent.

Glycocoll and Bi-chromate of Potash.

If glycocoll be dissolved in an aqueous solution of bi-chromate of potash, and absolute alcohol be added till the liquid becomes turbid, and the whole set aside, in a little time crystals will be formed.

These, even under the liquid, in a few days become decomposed, with the deposition of carbon. They were not further examined.

Glycocoll and Urate of Ammonia.

$$Gl, \bar{U}, AmO, \bar{U}.$$

When to a hot filtered solution of urate of ammonia, glycocoll is added, in a little time as the liquid cools, long semi-opaque needles shoot out from the sides of the vessel. The addition of alcohol after the first crystallization, causes the separation of a second portion.

Upon dissolving in hot water equivalents of glycocoll and urate of ammonia, and cooling, a flocculent mass was thrown down, which the addition of alcohol increased, and which, when examined with the microscope, proved to consist of exceedingly minute prisms.

The salt dried over sulphuric acid and burned with chromate of lead, gave from 0·2926 grm. substance, 0·3463 grm. carbonic acid and 0·1144 grm. water, which equal carbon 32·46, hydrogen 4·40. The formula

$$C_4\ H_4\ NO_3, C_5\ N_2\ H_2\ O_3 + NH_4\ O, C_5\ N_2\ H_2\ O_3,$$

requires carbon 32·30, hydrogen 4·61.

Similar flocculent precipitates were obtained from solutions of glycocoll in both urates of potash and soda.

Glycocoll and Uric Acid.

The importance of finding a compound of uric acid that would readily dissolve in water, suggested the effort to combine it with glycocoll.

Two atoms of glycocoll united to two of uric acid would equal three atoms of cyanate of glycocoll:

$$C_8H_3N_2O_6+C_{10}N_4H_4O_6=3(C_4H_4NO_3, C_2NO),$$

a compound that may be presumed readily to dissolve in water. All effort to this end, however, proved unsuccessful. Uric acid remained unchanged in the most concentrated solution of glycocoll, even with the long continued application of heat.

Glycocoll and Benzoic Acid.

As these two bodies exist in combination in hippuric acid, it was to be presumed that a reunion might be effected. To this end, solutions of the two in spirits of wine were made and poured together. After a time the glycocoll on the one hand and the benzoic acid on the other crystallized out.

The same result attended the effort to combine cinnamic acid, cane sugar and neutral phosphate of lime with glycocoll.

(To be continued.)

Art. IX.—*On the Potato Disease.*

Recherches sur la Nature et les Causes de la Maladie des Pommes de Terre, en 1845; par P. Harting, Professeur à l'Université d'Utrecht. Amsterdam, 1846.

De Ziekten der Aardappelen in het Algemeen, door Prof. von Martius. Of de Aardappel Epidemie der Laatste Jaren. Berigten en Meddeelingen door het Genootschap voor Landbouw en Kruidkunde te Utrecht.

The above are the titles of two of the most extended scientific investigations of this subject that have yet appeared. The work of Prof. Harting is particularly valuable, as containing a methodical and extensive series of microscopic observations which seem to have been made with much care and accuracy. It is illustrated by colored plates, showing the tissues, the cells, &c., of the potato in its healthy state, and proceeding through the commencement and various stages of disease.

Prof. Harting is clearly of the opinion that the disease is not to be ascribed to a parasitic fungus; but that the fungus is an effect only, as in the commencement it is never visible and sometimes is wholly absent during the whole progress of the malady. He has distinguished and figured no less than six varieties of these singular plants. The greater part of them belong to the genus Fusisporium of Link. One of them Fusisporium Solani is also described and figured by von Martius. Its characters are:

Floccis fertilibus erectis ramosissimis parce septatis, ramis patentibus, sporidiis terminalibus arcuatis, 4-5 septatis, facile decidentibus.

Another species Spicaria Solani, is thus described.

Floccis albis, decumbentibus dense intertextis, ramulis fertilibus vulgo quatuor erectis, sporidiis minimis ovalibus concoloribus.

Some of these species are only found in the internal cavities caused by disease, others in cavities under the skin through which they eventually pierce and then expand to a very considerable comparative bulk. In one instance and one alone Prof. Harting has perceived the formation of a particular fungus within the sac of a perfect cell; ordinarily their commencement is on the edges of internal cavities among the remnants of destroyed cells. In this instance the potatoes were of a particular variety from the vicinity of Coblence. The fungus belonged to the genus Oidium, (Link,) or Oospora, (Wallworth,) and was named by Prof. H. Oidium violaceum. Its characters are:

Floccis ramosis violaceis, fertilibus in sporidia subglobosa secedentibus. It is therefore quite different from any of the others. Von Martius does not appear to have met with this, but he describes several other distinct varieties. Payen mentions one of the same nature, but of an orange color.

These fungi seem not to be capable of spreading by infection. A large number of experiments were made upon this point; some of their sporules were placed in contact with freshly cut potatoes and allowed to remain in contact under favorable circumstances for many days; in no case was a fungus of the same species reproduced. This would appear to be conclusive, but von Martius and Payen, both obtained results of a different character. In any case we may conclude that it is not a very easy matter to spread infection in this way.

When the brown or black liquid matter, which appearing in the *sacs* of the cells, is the *first* visible proof of disease, is placed in contact with a freshly cut surface, the disease is readily communicated, but not if the skin of the tuber be perfectly sound and unwounded. A very curious additional fact is, that in this way the disease may be communicated to apples, pears, &c.

Both Harting and Martius agree that the disease is not to be ascribed to insects. During the early stages of the disease nothing is to be seen of them or their larvæ. They usually appear at about the same time as the fungi. Ordinarily two species are observed, Glyciphagus fecularum and Tyrogliphus feculæ. Later in the disease, a species of Rhabditis sometimes appears of the same class as those which are found in vinegar, &c. These are only some of the more common varieties which occur.

Prof. Harting has made a partial chemical investigation of the difference between the sound and the diseased portions of the tubers. The reaction of the sound portions was acid, that of the diseased alkaline, with an evolution of ammonia. As might be supposed from this, the quantity of nitrogenous compounds was reduced in the unsound portions, disappearing at last almost entirely. The brown and black parts contain a greatly increased proportion of insoluble matter; the increase is chiefly owing to the deposition of brownish granular matter, in the cells. This matter is insoluble in water, in ether, in boiling alcohol, in acids or alkalies, and exhibits most of the properties of ulmin, resulting from the composition of the substance contained in the cellular liquids. We will here quote Prof. Harting's words.

"Cette matiére est le resultat des transmutations qu'ont subies l'albumine et la dextrine dissoutes dans le suc cellulaire, et de la fécule, que, aprés s'être transformée en dextrine, y contribue aussi.

"Il est três-vraisemblable que c'est l'albumine, qui soit transformée la première, puis la dextrine, enfin la fécule, qui résiste le plus long-temps, et dont l'alteration est encore peu visible même à un état trés-avancé de la maladie.

"Tontes ces transformations chimiques, appartiennent à cette grande série de phénomènes, comprise sous le nom général de fermentation, et qu'on pourrait désigner ici plus particulièrement par le nom *d'humification*, or *d'ulmification*."

He thinks that we may observe the same things every year in apples, pears, &c. The same granular brown matter is shown by the microscope in the cells, and by chemical analysis is proved to be idêntical with the brown matter of the potatoes.

Prof. Harting, led on by these facts, sought to find in the temperature of the air and earth, the cause of this disease. He has collected a large number of observations upon this point. The winter of 1844–1845 was long and rigorous, and the cold especially severe during March. The equilibrium between the air and the surface of the earth, when a change took place, was thus disturbed, the earth becoming warm much more slowly than the air. The early planted potatoes then found the ground in an unfavorable state. The year 1845 is compared with the preceding years as far back as 1838. The month of March was excessively cold as noticed above, the month of April was a little warmer than the mean of the preceding Aprils; May was very rainy, and the temperature below the *minimum* of preceding years. June, on the contrary, was very hot, above the former maximum, July was also very warm with much rain, so that the potatoes grew with much rapidity. The variations of the barometer were not greater than ordinary, but the case was far otherwise as to the humidity of the air and the pressure of vapor. During the months of July and August, the relative humidity was above the maximum of the same months in preceding years; in those years also the pressure of vapor was less at two in the afternoon than at eight in the morning, but in 1845 this rule was reversed. The malady in Holland ended in the month of July, and after the middle of that month the above differences were not more perceptible. The great heat of the air and excessive moisture caused a rapid developement of the plant, and of course an increased transpiration was necessary, but was always checked by the increased pressure of vapor in the middle of the day; this of course deranged the circulation and caused the liquids in the circulation to begin to ferment. This view is supported by the fact that in Holland the parts first attacked were the leaves and stalks, the parts more directly in contact with the air. In Scotland and some parts of Prussia the disease made its appearance in September, for the most part; the temperature of the earth was then higher than that of the air, and accordingly the disease generally attacked the tubers first. But when we acknowledge all of these extraordinary facts, we still are forced to look for some special predisposition to disease among the potatoes themselves. In what this special predisposition consists, it is not easy to say.

It has not been the same in all species of potatoes, some have almost escaped while others of another kind in the same neighborhood have been almost utterly destroyed; it must reside in the plant itself, either in the structure of its tissues, or in the chemical state of its juices. It has been noticed that the potatoes of late years have had a much greater tendency than usual to germinate. This indicates an unusual molecular movement in the juices, which under the influence of moisture and the atmosphere, in place of changing the starch into dextrine and dextrine into cellulose, ferments and causes the disease.

Potatoes planted during the early morning have in some instances been almost entirely free from the malady, while those of the same variety planted in the afternoon, after lying in the sun sometime, were almost all destroyed. In this case, it seems possible that the heat of the sun gave a movement to the juices and prepared the way for the subsequent attack.

Von Martius describes two distinct kinds of disease, De Drooge kankerachtige Ziekte der Aardappelen, the dry canker disease of the potatoe, Gangræna tuberum Solani; and "De schurftachtige Ziekte der Aardappelen," the scabby disease of the potatoe, Porrigo tuberum Solani.

Prof. Harting's results and suggestions certainly furnish ample ground for very probable theories as to the cause of this disease, and indicate the course to be taken in future investigation. If, as seems possible, atmospheric influences induce such chemical changes in our growing crops, though we have found a cause, we have not found a remedy; to guard field crops from atmospheric changes is not an easy matter.

Such changes may occur only at long intervals of years, but the fact of their occurring at all, will be a warning to the nations not to place their sole dependence on a single crop. Unhappy Ireland and the north of Scotland are mournful examples of this mistake.

J. P. N.

Utrecht, April 25, 1847.

ART. X.—*Report on Meteorites;* by CHARLES UPHAM SHEPARD, M.D., Professor of Chemistry in the Medical College of South Carolina, and in Amherst College, Mass.

(Continued from Vol. ii, ii Ser., p. 392.)

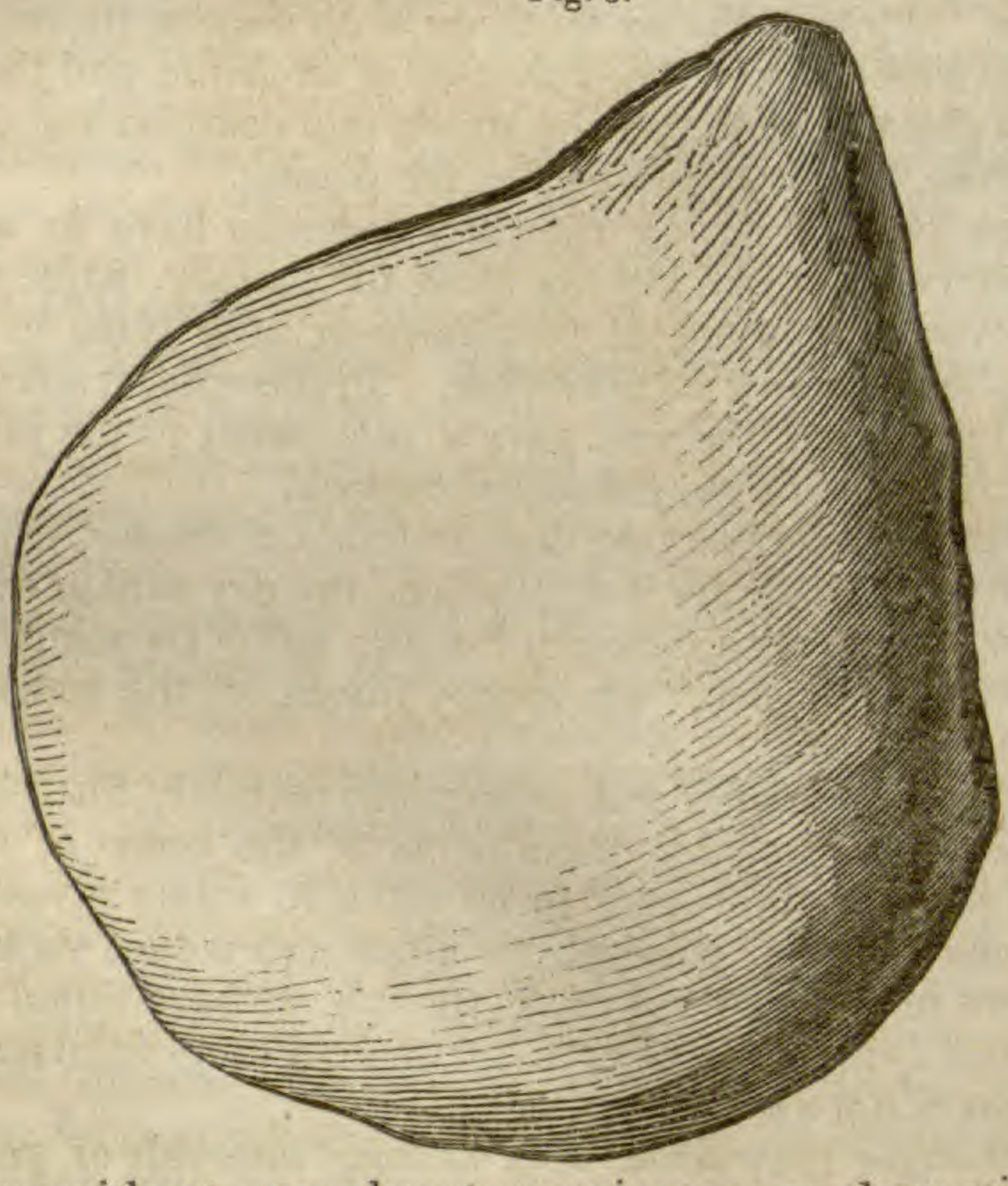
CLASS II. METALLIC.

ORDER FIRST. *Malleable, homogeneous.*

Section 1*st.* PURE.

1. *Walker county, Alabama.*—This mass was described by Dr. TROOST in Vol. xlix, p. 344, (1845.) Through the assistance of Dr. I. F. SOWELL, of Athens, Ala., I am able to supply a few additional details, concerning the occurrence of this unusually interesting specimen. Dr. Sowell observes, that "the existence of this iron was made known to me in 1839 or '40; and I was in treaty for it during two or three years, before being able to obtain possession of it. The original mass was irregularly oval, resembling the figure here sketched.

Fig. 6.



"It was without any abrupt prominences or depressions, and was covered by a smooth, black crust. It was found with the larger end buried in the ground, leaving a portion of the smaller extremity projecting above the soil,—suggesting the idea, that it was driven into the ground by the force of its fall. Upon this smaller end, the finder (Mr. Speaks) placed his foot to rest, while abroad on a hunting excursion. Its unusual appearance attracted his attention, and led him to remove it to his house as something valuable. The mass was found remote from any settlement, in an uncultivated and rather unfrequented region. Its weight was one hundred and sixty-five pounds."

This iron does not afford by etching, the Widmannstättian figures; although it exhibits glistening freckles, or angular spots of the size of fine-grained gunpowder, which are occasionally intermingled with shining lines and fibres. Sp. gr.=7·265.

It consists of iron 99·89, with traces of calcium, magnesium and aluminium, in the order, as to quantity, in which they are enumerated,—the calcium being most abundant.

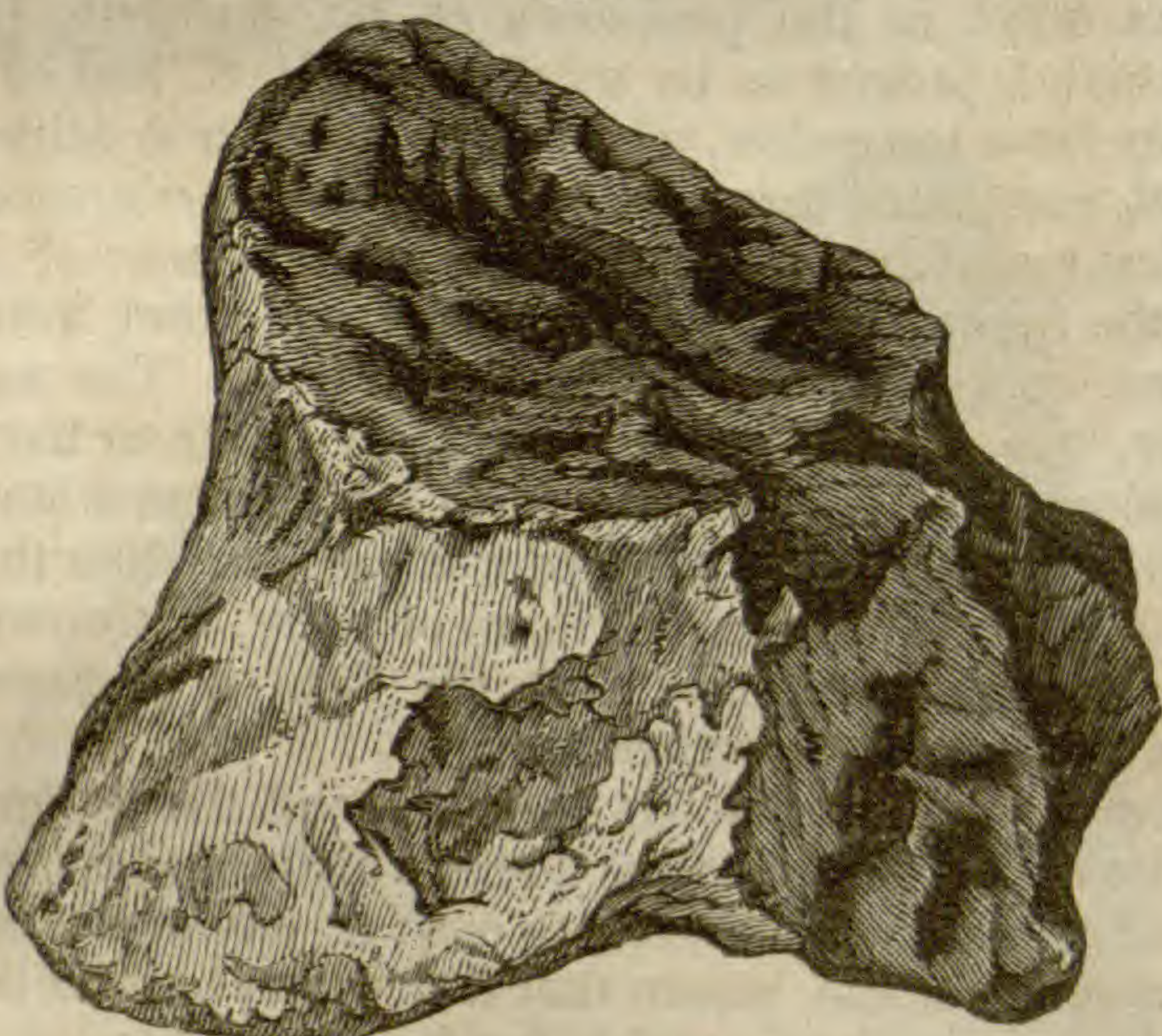
2. *Scriba*, (*Oswego*,) *N. Y.*—My description of this mass was published in Vol. xl, p. 366, (1841.) To that account may now be added the statement of Mr. John G. Pendergast, communicated to me in a letter dated July 15, 1846. "I saw a mass of iron at Oswego in 1834, in the possession of Mr. Rathbun, (a blacksmith,) which I judged to be meteoric. Mr. R. had obtained it on that day from his collier, who had been down to deliver a load of charcoal, and stated that he found it in the woods, some where in the vicinity of his coal-pit. The circumstance of its being found in the forest, together with its size and form, induced me at the time to believe it to be meteoric iron. The mass in all probability, was originally globular in form, but from having been highly ignited, and striking the earth (perhaps on a stone) with great force, a flattening in its shape was produced, like that which would be occasioned in a round lump of putty, if thrown against a board. I was fully satisfied that the form it possessed, could have been imparted in no other way."

The foregoing contains but little beyond the testimony of a second witness, to the conditions under which the mass was found. It appeared important however, to omit no circumstance relative to its discovery, for the reason that it does not possess that peculiar chemical composition, which has heretofore been regarded as confirmatory of the extra-terrestrial origin of similar productions, and on which account, I hesitated in my first notice to include it among undoubted meteoric irons. Its resemblance however, to the Walker county, Ala., iron, not only in composition, but in the generally smooth surface and black color of its crust, and still more, in the freckled figures developed upon its polished sections by nitric acid, establishes an analogy of the most marked kind between the two bodies. And as it seems unreasonable to ascribe the large drop-shaped mass of Alabama, either to a terrestrial or an artificial source, I feel authorized in claiming a meteoric origin for them both.

Section 2d. ALLOYED. *Sub-section*, CLOSELY CRYSTALLINE.

3. *Babb's Mill*, 10 *miles north of Greenville, Green county, Tennessee.*—This mass was described by Dr. TROOST in Vol. xlix, p. 342, (1845.) Judge PECK has afforded me (under date of Dec. 14, 1845) some additional particulars, relating to the locality, from whence he had obtained a specimen, in its natural condition. His remarks are as follows: "Of the two masses found in Green county, the first, as well as I can recollect, weighed twelve or thirteen pounds; the other which I have, weighs upwards of six pounds. The former was injured by having been heated and cut. It exhibited however, a crystalline structure, when small portions were torn or broken asunder, though the grains were very small. It was homogeneous; and formed as malleable and tough an iron, as I have ever seen. The second mass (of about six pounds) I was fortunate enough to obtain, just as it was found."

Fig. 7.



This specimen was in the most obliging manner transferred to me, in exchange, by Judge Peck; and with the exception of a few hundred grains taken from an angle, has been preserved precisely in its original shape. It exhibits in the most perfect manner that peculiar moulding (consisting of somewhat irregular basin-shaped depressions of various sizes, connected with blunt rounded angles and edges) which marks so many of these productions.* A wood-cut does but inadequately render these appa-

* Having observed that this kind of surface occurs in masses of artificial iron, both cast and malleable, if it have been a long time exposed to the action of weather, (as in iron palings and posts, as well as in old cannon,) I cannot avoid attributing the pitted, indented outside of the meteoric irons, in part, to terrestrial influ-

rent. The black coating of oxyd of iron, so often investing meteoric iron, is here nearly replaced by broad patches of a thin, yellowish, ochrey brown incrustation.

Sp. gr. =7·548. It is close grained and perfectly compact, taking a very high polish, and exhibiting at the same time, a color rather whiter than that of steel. It shows no crystalline figures on being corroded with nitric acid; although on very close inspection, minute, whitish spots, (isolated and collected into patches,) may be seen here and there, scattered without order over the surface. When broken, it presents a fine granular texture, attended by a high silvery lustre.

Dr. Troost found the mass he obtained to contain, iron 87·58, nickel 12·42, remarking however that the ratio of the nickel given was probably too high, and that the compound might contain other ingredients. My own specimen affords me, iron 85·30, nickel 14·70, with traces of calcium, magnesium and aluminium.

4. *Claiborne, Alabama.*—Vol. xxxiv, p. 332, (1838.) Vol. xlviii, p. 145, (1845.)

5. *Livingston county, Kentucky.*—Vol. ii, ii Ser., p. 357, (1846.)

6. *Dickson county, Tennessee.*—Vol. xlix, p. 337, (1845.)

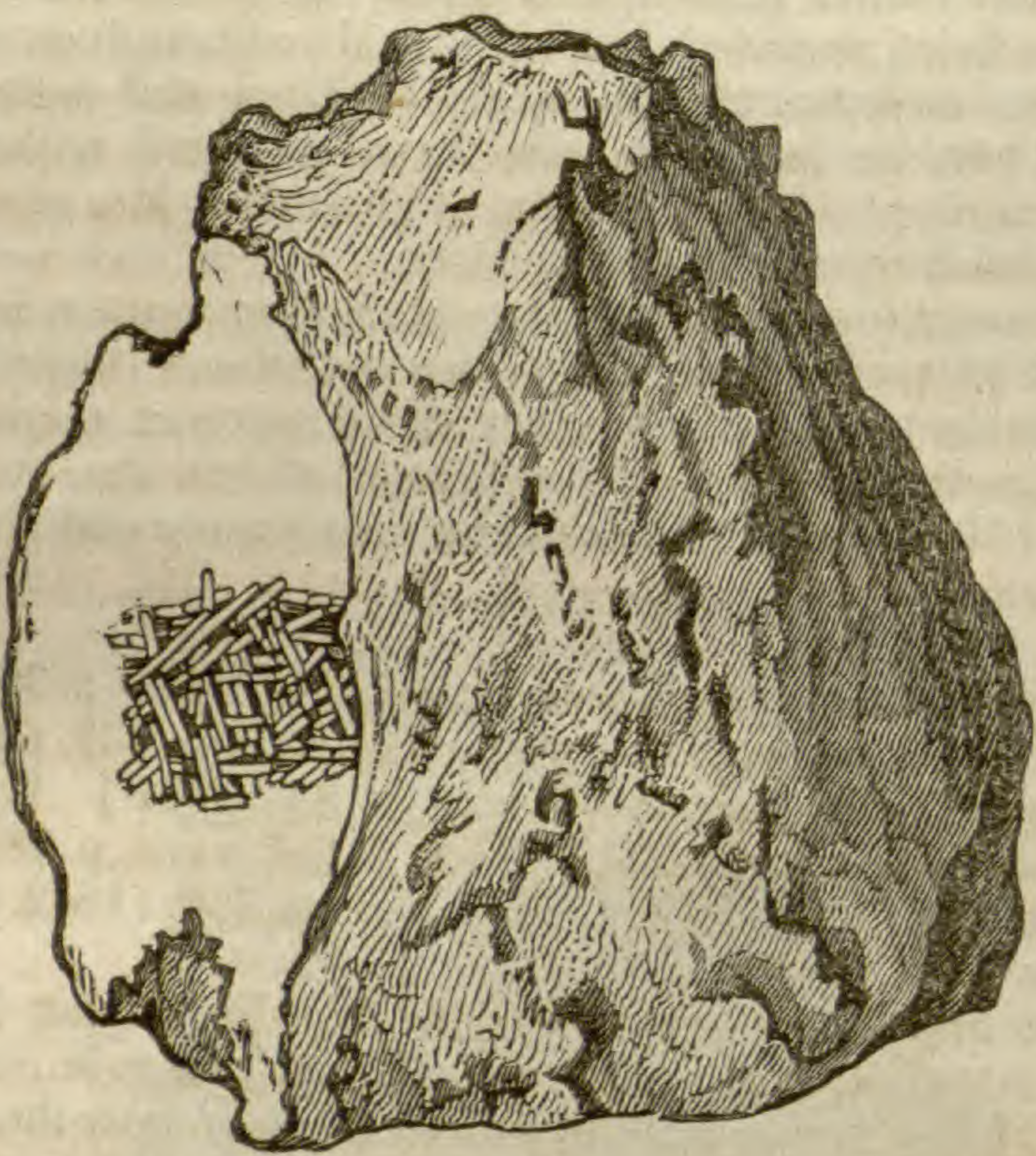
7. *Texas, (Red River.)*—Vol. iii, p. 44, (1821.) Vol. viii, p. 218, (1824.) Vol. xvi, p. 217, (1830.) Vol. xxvii, p. 382, (1835.) Vol. xxxiii, p. 257, (1838.) Vol. xliii, p. 358, (1842.) Vol. ii, ii Ser., p. 372, (1846.)

8. *Burlington, Otsego county, N. Y.*—This mass (originally 150 lbs. in weight) was described by Prof. Silliman, Jr., in Vol. xlvi, p. 401, (1844.) It was ploughed up by a farmer, near the north line of the town, sometime prior to 1819. Portions were cut from it, from time to time, by the discoverer's blacksmith, for agricultural uses; until its weight was diminished to about a dozen pounds, when it fortunately fell into the hands of Prof. Hadley, of Geneva, N. Y., to whom I am indebted for a conical lump, (weighing nine pounds,) which must have formed a somewhat pointed extremity of the original mass. From the base of this, a slice was taken, leaving a lump of five pounds of the annexed form. Its sides show for the most part, the natural crust of the iron; but where this is not the case, the surface has been cut and polished, or is coarsely crystalline with large tetrahedral and sub-hackley faces, occasioned by the breaking off of what were apparently projecting prongs. Its polished faces show a very high lustre, with a color of nearly the same whiteness as German silver. Held at a proper angle, they discover very distinctly the same crystalline characters, which are still more distinctly brought out by the ac-

ences, which have acted upon masses not perfectly homogeneous either in composition or in density. For this reason perhaps, the Lockport iron, which is very much charged with amygdaloidal kernels of magnetic iron pyrites, presents an uncommonly pitted and jagged surface.

tion of acids. The etched surface is illustrated in the accompanying figure. The pattern is strikingly peculiar, as well as beautiful. The bright shining veins, which resist the action of the acid, are rarely nearer together than the $\frac{1}{15}$th or $\frac{1}{20}$th of an inch;

Fig. 8.



and these in place of being continuous, are interrupted at frequent intervals. In their course also, they frequently exhibit little triangular enlargements, the sides of the triangles curving inwards. The surface included between the shining lines, and which forms at least $\frac{9}{10}$ths of the whole, is every where finely freckled as if depending upon a granular texture, and even bears some analogy to what is familiarly known as crystallized tin, or *Moiree metallique.*

Its hardness is very unusual, no iron with which I am acquainted offering on the whole, so much resistance to the operation of slitting. Mr. Rockwell gives as its composition, iron 92·291, and nickel 8·146. My own result in a single analysis, is as follows:

Iron, ...	95·200
Nickel, ...	2·125
Insoluble, ...	·500
Sulphur and loss, . . .	2·175
	100·000

Sub-section, COARSELY CRYSTALLINE.

9. *De Kalb county, Tennessee.*—Vol. xlix, p. 341, (1845.)

10. *Asheville, (Baird's plantation, near French Broad River, six miles north of Asheville,) Buncombe county, North Carolina.* —Vol. xxxvi, p. 81, (1839,) and Die Meteoriten, von P. PARTSCH, Wien, 1843, s. 116.

As this county has of late afforded two other localities of meteoric iron, I have taken pains to ascertain as nearly as possible the exact position of each. The Hon. T. J. Clingman informs me, that this locality is six miles north of Asheville, on the estate of Col. Baird, who is of opinion that other fragments may there be found, as he has within two years observed small pieces of rusty iron in the same field from which Dr. Hardy's mass was obtained.

Farther experiments on the composition of this iron, enable me to add to what was before made known, that it contains cobalt, magnesium and phosphorus; and that the nickel is sometimes present in a ratio as high as 5 p. c., while the silicon is considerably below 0·5 p. c., as formerly quoted.

11. *Guildford county, North Carolina.*—Vol. xl, p. 369, (1841,) and Die Meteoriten, von P. PARTSCH, s. 114.

12. *Carthage, Tennessee.*—Vol. ii, ii Ser., p. 356, (1846.)

13. *Jackson county, Tennessee.*—Vol. ii, ii Ser., p. 357, (1846.)

ORDER SECOND. *Malleable, heterogeneous.*

Section 1*st.* AMYGDALOIDAL.*

14. *Hommoney Creek, near base of Pisgah Mountain, (ten miles west of Asheville,) Buncombe county, North Carolina.*

The present iron was brought to light through the perseverance of the Hon. T. J. CLINGMAN, of Asheville, to whose liberality I am indebted also for the possession of so interesting an object. He informed me in March, 1846, that while in the adjoining county of Haywood, he had accidentally been told by a Mr. Clarke, that his son had a mass of ore, five or six pounds in weight, that was very black and heavy, and which they could not break with a sledge-hammer, though they were able to indent its surface. Mr. C. was disappointed, on visiting the son, to find the piece had been mislaid and probably lost. His description however, agreed closely with that given by the father. He learned also from the young man, that the mass had the appearance of

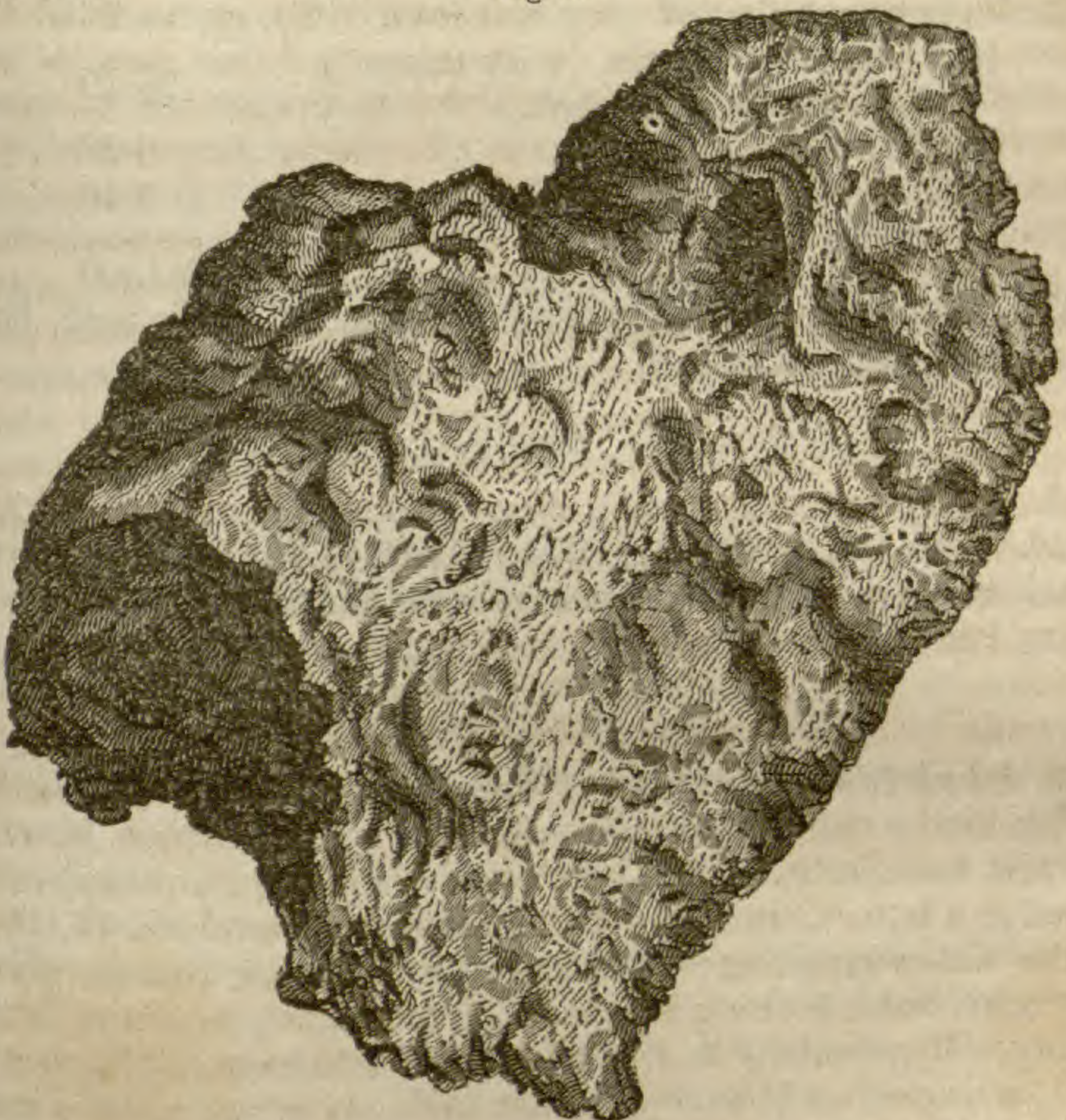
* The present mass having been discovered since the classification of the previous paper was made, it becomes necessary to create a new section for the reception of this remarkable variety. In some respects, it resembles the amygdalo-peridotic species from Siberia and Atacama. It differs however, from them both, in the more diminutive cavities, and still more in this, that these cavities are almost completely empty. The term amygdaloidal therefore, is here applied, in analogy with its use in geology, for describing the vesicular traps.

having been melted, one side being flattened, while from other parts of it, there were projections ("spurs") as long as a man's finger, which he could batter down with a stroke of the hammer. He said he obtained it a year before in Buncombe county, in a field, where he was of opinion that more of the same might be found. Mr. C. afterwards visited the neighborhood in which the specimen occurred; and was there assured by a young man, that he had seen the piece that the Clarkes had described, and that he knew of another much larger piece, similar to it, at an old house on the Clarke farm, where the smaller had been found.

On procuring the mass, (which weighed nearly twenty-seven pounds,) Mr. C. communicated to me the following particulars respecting it, which may perhaps be given in this place as generally descriptive of its aspect. "It is rather flat on one side, as though it had been laid when semi-fluid on a somewhat plane surface, while its other sides are irregular, with cavities and various inequalities. It has no appearance of ever having been hammered, and externally looks like a cinder from a blacksmith's fire." (At first, from not having seen any vesicular meteoric iron, Mr. C. was led to question its genuineness.) "But it is too large, and much too heavy to be compared with cinder. It has some malleability, though it may be broken if struck on its thinner projections and edges. Its knotted appearance, toughness and malleability, together with the peculiar form of the broad side, or bottom, and that of the large end, indicating that a greater than human force must have been applied to the mass, and evincing that it was cleft by an explosion from some large body, lead me on the whole, to rest in the inference, that it is of foreign origin." Mr. C. likewise remarked, that its external appearance would be well conceived of, if we supposed an ordinary mass of meteoric iron to be thrown into a forge-fire, and when thoroughly fused at its surface, suddenly to be withdrawn and cooled.

Its shape may be judged of by the figure on the opposite page. As frequently happens with these productions, a general conception may best be obtained by likening them to some familiar objects: this specimen strikingly reminds one of the head of a reptile. As figured, it reposes on its flat and broad side, and the dark shadow at the left, is in the place of the nearly vertical section, supposed to represent the junction of the animal's head with its body. It measures eleven inches in length, by seven in breadth; and is four in thickness at the thicker end, while at the upper extremity of our figure, it is not above two and a half, and on the right and lower edge, it thins down to little above one inch. Its surface is rather tuberose and jagged, than pitted with regular depressions. Color various shades of brown to black, and somewhat variegated (especially in the bottoms of the cavities) with an ash colored earthy matter. This last was undoubtedly derived from the circumstance, that the mass was for a considerable time employed as a support for fuel in the fireplace of a farmer's kitchen. Upon the under side, there adheres over a few inches,

Fig. 9.



a crust of an earthy, black amygdaloid, scarcely distinguishable, unless freshly broken, from the iron itself; and in one spot, nearly buried within the substance of the iron, a few grains of a dull, yellowish, gray olivine were noticed, similar to those found in the Bitburg iron. Near the surface, and especially upon the thinner edge and at the small extremity of the mass, its structure is eminently vesicular, the cavities being from one-fourth to one-twentieth of an inch in diameter, sometimes distinct, at others running together, and generally lined with a black powder. But as the distance increases to an inch from the surface, the cavities grow smaller and more remote from one another. No deeper section than one inch has yet been made in the mass; it is therefore possible, that the central portions may be nearly compact. The fresh fracture has a color and lustre, intermediate between steel and magnetic iron-pyrites. Etched surfaces, excepting where the structure is highly vesicular, exhibit the most delicate Widmannstättian figures, consisting of very minute and thickly interspersed triangular figures, distinct enough to be easily seen with the naked eye, but under a microscope exceedingly beautiful. They resemble somewhat in this respect, the Bitburg iron, to which it also approximates in the tuberose conformation of the exterior surface.

Hardness about that of grey cast iron. Sp. gr. = 7·32.

It is composed of iron, (with traces of chromium and cobalt,)	98·19
Nickel, ...	0·23
Carbonaceous, insoluble matter and loss,	1·58
	100·00

The yellowish, olivine-like grains consist of silicic acid, lime, magnesia, and oxyd of iron.

Section 3d. AMYGDALO-PYRITIC.

15. *Lockport*, (*Cambria*,) *New York*.—Vol. xlviii, p. 388, (1845.) Vol. ii, ii Ser., p. 374, (1846.) In addition to the nickel, copper, phosphorus and silicon, found in this iron by others, I have detected cobalt.

Section 4th. PYRITO-PLUMBAGINOUS.

16. *Black Mountain, head of Swannanoah River, eastern line of Buncombe county,* (*fifteen miles east of Asheville,*) *N. C.*—My first knowledge of this iron was derived from a remark, contained in a letter from Hon. T. J. CLINGMAN, dated Feb. 17, 1846, to the following effect: "Dr. Hardy informs me that he gave a very remarkable looking specimen of meteoric iron found in this county, (Buncombe,) to the late Col. Nicholson of Charleston, S. C., who died at Abbeville in that state, six or seven years ago." Being in Charleston, I applied to the executors of Col. N. for information respecting that portion of his effects, which would be likely to include this specimen; but my inquiries were without success. Previous to this date however, I had been informed by Prof. Tuomey, who was then the state geologist, that he had seen a specimen of malleable iron in the cabinet of Dr. BARRATT of Abbeville, which led me to address a letter to this gentleman, relative to the subject, from whom I received the following note, dated June 1, 1846, accompanied by the specimen itself. "I can furnish you with little that is definite concerning its history. The year Col. Nicholson, of Charleston, died, he had obtained it in Pendleton or Greenville District. It was given to him by some person, who had picked it up as a meteorite. Col. N. gave it to me, as I was the only person in this part of the country who preserved such objects. I believe it to be meteoric in its origin, and as such it has had a place in my cabinet. To yourself and to science, it is most cheerfully tendered."

On communicating a description of the mass to Dr. Hardy, he replied, "I have no doubt that the specimen referred to is the same which I gave Col. Nicholson. It was found at the head of Swanannoah river, near the base of Black mountain, towards the eastern side of Buncombe county."

The fragment weighs only twenty-one ounces; and, judging from the size and shape of that side which still exhibits the natural outside of the meteor, it is evidently a portion of a mass that must have been much larger. Its texture is throughout, highly crystalline, having all the laminæ (which are unusually thick) arranged conformably to the octahedral faces of a single individual. These layers, which commonly have a thickness of one-tenth of an inch, adhere to one another with much tenacity, so as not to be separable by any ordinary force. They manifest a slight tendency however, as the result of weathering, to separate into granular portions of the thickness of the layers themselves; the particles being somewhat oval in form—a result which seems to flow from the existence of very minute veins of magnetic iron-pyrites: for when a surface of the iron is polished, it exhibits the appearance of being mapped off into rounded patches by thin veins of the pyrites; and on the application of nitric acid this structure is still farther developed by the corrosion of the veins. Within these areas, the structure of the iron, when etched, scarcely seems crystalline; at most, exhibiting a few faintly marked crossing lines. A somewhat similar structure is visible in the Cocke county iron.

The mass contains several rounded and irregular nodules of plumbaginous matter, (from half to one inch in diameter,) with which again (and often situated in the midst of the kernels) are found large pieces of foliated, magnetic iron-pyrites. In this respect also, the present iron is closely related to the Cocke county iron.

Its sp. gr. = 7·261.

It consists of nickel, (with traces of cobalt,)	2·52
Iron,	96·04
Insoluble matter, sulphur and loss,	1·44
	100·00

17. *Cocke county, Cosby's Creek, Tennessee.*—For our earliest notice of this truly wonderful locality of meteoric iron, we are indebted to Dr. Troost, (see Vol. xxxviii, p. 250, 1840,) and for an additional account of its composition by myself, see Vol. xliii, p. 354, (1842.) The history of this locality is still farther illustrated by the following particulars, derived from two letters from Judge Jacob Peck of Jefferson county, Tennessee, the one dated July, 1845, and the other December, of the same year.—Extract from the former, which was addressed to

Dr. J. H. Kain of this city: "The large mass of meteoric iron found some years ago in Cocke county, (on a creek called Cosby's,) fell into the hands of some persons who tried to break it with sledge-hammers, but not succeeding, they placed it upon what is here called a 'log-heap,' where after roasting for some time, it developed certain natural joints, of which advantage was taken with cold chisels and spikes, for its separation into fragments. These were put into a mountain waggon, and transported thirty or forty miles to a sort of forge, and there hammered into 'gun-scalps,' and other articles of more common use. Some remnants of the mass fell into the hands of Dr. Troost. The original mass was one of rare character, and ought to have been preserved entire. Much of it was composed of large and perfect octahedral crystals. Its weight was about a ton. Another mass weighing one hundred and twelve pounds, was found near the locality of the larger one. This also was malleable, very white, and easily cut with a sharp instrument. It was picked up by a mountaineer, who supposing it to be silver, asked fifteen hundred dollars for it. After retaining it for some years, he finally sold it to a friend of mine for a small sum, who transferred it to Dr. Troost."

Extract from the letter of December, 1845, to myself: "The weight of the mass has been variously estimated; but I am certain it was never weighed, prior to its being broken up. It was probably about two thousand pounds. In figure, it was an oblong, square block. I saw several very regular octahedral crystals that had been detached from the exterior angles of the mass. I had formerly supposed that the whole of it had been taken to Lary's forge, in Sevier county, and the greater part of it there wrought into 'gun-scalps;' but very recently, I have been informed, that part of it was taken to the forge of Peter Brown, in Green county, and there forged. I understand that a man by the name of McCoy, had a neat bar forged from it for making a gun-barrel, which, to use the expression of Brown's son, 'was as bright as silver.' In the conversation, young Brown informed me that he thought a piece of the iron in its natural state still remained. On searching, it was found by a little girl of the family. It weighs rather more than a pound, and had been preserved by the family as a nut-cracker.*

"The great mass was found on a hill, or rather on an offset of an eminence, at about one hundred feet above the bed of Cosby's creek. I was at the place after the mass was taken away. The formation was a hard clay-slate, and very little impression was left at the spot, except some stains of red oxyd of iron. McCoy,

* This specimen I owe to the kindness of Judge Peck.

who claimed to be the owner of the land, took me there, under the impression that I should be able to aid him in discovering a mine of pure iron near the spot, especially, as the mass of one hundred and twelve pounds was found in the same immediate vicinity. The search of course was to no purpose. The mass of one hundred and twelve pounds appeared to me to be identical in character with the fragments I have seen of that supposed to weigh a ton."

The sp. gr. of this iron, as given by Partsch, (Die Meteoriten, p. 151,) is 7·26. I have found that of the included magnetic iron-pyrites, to be 4·454.

Order Third. *Brittle.*

Section 1*st.* Pure.

18. *Randolph county, North Carolina.*—This mass (originally two pounds in weight) was described by me in Vol. xvii, p. 140, (1830,) as native iron. It had been previously mentioned in Vol. v, p. 262, (1822,) by Prof. D. Olmsted, in a descriptive catalogue of rocks and minerals collected by him, during his geological survey of North Carolina. It is spoken of by Prof. O., as occurring in the vicinity of a bed of argillaceous iron ore. It is distinctly foliated, the laminæ being thin and much interlaced. Color and lustre resembling those of mispickel. When etched, it presents very fine, almost invisible, feathery lines, much resembling hoar frost on a window pane. Hardness equal to that of the best tempered steel. Sp. gr. = 7·618. The only metal I have been able to detect in this steel, is cobalt, and this only in traces. A reddish brown powder, not soluble in nitro-hydrochloric acid, did not communicate any color to a bead of borax, which led to the suspicion that it was silicon.

19. *Bedford county, Pennsylvania.*—This variety was described in Vol. xiv, p. 183, (1828,) as native iron, slightly arsenietted. It closely resembles the Randolph county specimen, in structure, color, hardness and lustre. Its sp. gr. = 6·915. In the few grains at my command for its examination, I have been unsuccessful in verifying the existence of arsenic, or of detecting the presence of any other metal, besides iron. Still, its greater analogy to the Randolph iron than to any other terrestrial production, either natural or artificial, induces me to retain it in the category of meteorites.

Section 2*d.* Alloyed.

20. *Otsego county, New York.*—The precise locality of this very curious iron cannot at present be given. It came into my possession under the following circumstances. Two or three persons from Otsego county submitted a number of specimens to

Dr. James R. Chilton, practical chemist of New York, for determination, stating that they had collected them in that region. Among the collection was the iron in question, which they described as having been picked up by them in the soil. They were of opinion, that it was some valuable metal; and were only satisfied that it was iron, by being shown by Dr. C., that it adhered strongly to the magnet. Dr. C. was at once led to suspect that it was a meteoric production, from the peculiarity of its shape; and induced the proprietors to exchange it for several specimens of silver ores, which they were desirous of procuring, to enable them to prosecute their mining researches with more intelligence. By paying Dr. C. the value of the specimens he had given for it, he very kindly transferred it into my hands.

Its weight was 276 grs., and its figure almost spherical or drop-like, as represented in the margin. It was covered with a black

Fig. 10.

coating, save on one side, where it had been partially polished. The application of a drop of dilute nitric acid to this side, brought into view the most beautiful, raised lines, closely compacted together, and crossing each other in every direction. Its hardness was too great to allow of its being sawn; it was therefore broken upon an anvil (within a closed ring of iron) by means of heavy blows with a sledge. Its structure within, is foliated, or foliated-columnar, the individuals radiating from the centre to the circumference. Its color when first broken, was a light steel-grey, with a faint yellowish or reddish tinge, somewhat analogous to magnetic iron-pyrites. Interspersed through the mass, a close inspection discovers very minute, perfectly round globules of magnetic iron-pyrites, the number of which is much increased by the aid of the microscope. These globules are easily detached, and leave behind cavities with smooth, silvery colored walls. A polished surface of its interior, on being etched, exhibits a very exquisitely beautiful crystallization, consisting of innumerable, closely compacted, silvery lines, crossing each other in various directions, but rarely forming regular triangles, as in the malleable irons, (but more resembling the brittle irons of North Carolina and Pennsylvania,) more or less spotted with black globules of pyrites.

Being anxious to preserve as much as possible of this smallest of all the known meteoric iron-masses, I have contented myself with such inferences as a solution of less than twenty grains, enabled me to make respecting its composition. It dissolves with difficulty in nitro-hydrochloric acid, at the same time evolving sulphuretted hydrogen, leaving behind minutely divided carbon (plumbago) and a heavy whitish powder. This latter, fused with carbonate of soda on charcoal, gave what appeared to be metallic tin. The clear solution saturated with ammonia, afforded peroxyd of iron that corresponded to 94·57 per cent. of metallic iron; and the solution possessed an intensely azure blue color, which I ascertained to proceed chiefly from the presence of copper, though nickel and cobalt were also both detected in the liquid. This little meteorite, therefore, contains the following elements:—iron, copper, nickel, cobalt, sulphur, carbon, tin? and possibly chromium.

Notwithstanding this specimen comes from the same county with the Burlington iron, still its peculiar physical and chemical properties, leave no doubt of it having formed a totally independent body; and for aught that yet appears, two hundred and seventy-six grains in weight constitutes the totality of the fall!

Appendix to Class I.

a. Grayson county, Virginia.—A meteoric iron is referred to by Prof. J. W. Rogers, as existing in this county, and in which he found 6·15 per cent. of nickel. Vol xliii, p. 169, (1842.)

b. Roanoke county, Virginia.—A meteoric iron is mentioned by Prof. W. B. Rogers as existing in Roanoke county, in which he detected the presence of chlorine. Vol. xliii, p. 169, (1842.)

c. *Franconia, New Hampshire.*—The following note from Robert Gilmore, Esq. of Baltimore, leads me to believe that a mass of meteoric iron was obtained by this gentleman, ten or twelve years ago in New Hampshire. "It was supposed by Dr. J. F. Dana (late Prof. of Chemistry in Dartmouth College) to be native iron. I purchased it at a village about twelve miles this side of the notch of the White mountains, of a person who told me, that it was found under the roots of a large tree, which was overturned upon the banks of a small stream in his neighborhood. He informed me that the blacksmith who had tried it, found it to be pure iron, and that he had refused to dispose of it to Dr. Dana, who was desirous of purchasing it. I tempted him, however, by a proposal of a higher offer than he had before had made for it, and obtained the mass. The tree, under whose roots it was found, must have been fifty or one hundred years old. I had presented the mass (whose weight was about fifteen pounds) to the Baltimore Academy of Science, in whose keeping it was lost sight of, during the destruction of their building by fire."

(To be continued.)

Art. XI.—*A General Review of the Geological Effects of the Earth's Cooling from a state of Igneous Fusion;* by James D. Dana.

In former papers in this Journal,* the writer has endeavored to illustrate the origin of many of the earth's features, by reference to the necessary consequences of cooling from a state of igneous fusion. In conclusion, a summary of the results arrived at is here offered, in order to aid the reader in a cautious and comprehensive revision of the subject; for its bearing upon the history of our globe is so important and of so universal a character, that it cannot receive too close attention. If there has been a state of igneous fluidity, the cause appealed to has acted; and to reason rightly on many points in geological dynamics, the effects of this prime cause should be first ascertained. Whatever the fact under consideration, be it an elevation, a subsidence, a fracture, earthquakes, igneous ejections, or any of the like operations or their consequences, we cannot be sure of assigning the true explanation, until it is shown whether this grand agency—which commenced with the very beginning of solidification, to end only with cooling itself,—has operated or not in producing or modifying the result. It is much to be desired that mathematical science may give definiteness to our views on this fundamental point in geological theory.†

The hypothesis of the former fluidity of the earth, we have not deemed it necessary to discuss. The proofs of an approximate uniformity of trend in the earth's features, and consequently of a prevailing structure in the very nature of the crust of our globe, place the question almost, if not quite, beyond doubt. The investigations of W. Hopkins, Esq., showing on astronomical data, that the whole is not now solid, afford still stronger confirmation of the hypothesis, and fully authorize the adoption of it as a basis of reasoning.

---

* Vol. ii, ii Ser., p. 335, and iii, 94, 176. 381, 1846, 1847.

† In this branch of investigation, principles of the highest importance to science have already been deduced, with great ability, by W. Hopkins, Esq., F.R.S. We alluded to his researches on the systems of fissures consequent on elevations, in the last volume of this Journal, pp. 395, 396; and we mention here what escaped us till too late for insertion in that place, that his "Researches in Physical Geology," are continued in a series of articles in the Transactions of the Royal Society, for the year 1839, p. 381, for 1840, p. 193, and for 1842, p. 43, treating especially of the bearing of the amount of precession and nutation on the question of the fluidity of the interior of the earth and the thickness of the crust. Mr. Hopkins argues that the earth could not have cooled at the surface as long as there was perfect freedom of motion in the igneous fluid, and concludes that "the minimum thickness of the crust of the globe, which can be deemed consistent with the observed amount of precession, cannot be less than one-fourth of the earth's radius;" also, that the mean inclination of the earth's axis to the place of the ecliptic, can never have changed since solidification commenced.

It should be remarked, that in the following summary the causes alluded to are not presented as the only source of the effects enumerated, though a legitimate and sufficient source. The causes have acted conjointly with the wide-spread agency of water, yet they may have been less dependent on the latter for many results, than has often been urged. We mention no authorities for any of the conclusions stated, as they are already given, as far as known to the author, in the previous articles alluded to.*

General Review of the Consequences of the Earth's Cooling.

I. Solidification of the surface after the fluid material had lost its perfect fluidity.

a. The change inconceivably slow, and hence the rock formed having a coarsely crystalline texture :—the subsequent progress of solidification *beneath* the crust still more gradual, and therefore producing at all periods of the globe a coarsely crystalline texture :—the whole the result of a single immeasurably prolonged operation.†

b. Hence, probably, a general uniformity in the crystalline structure, sufficient to give the crust apparently two directions of easiest fracture, whose mean courses are N.W. b. W. and N.E. b. N.; yet varying much, being probably dependent to a great degree on the early direction of isothermal and isodynamic lines, (this Journal, iii, 392.)

c. In the progress of this cooling, commencing with its first beginning, the surface necessarily presenting large circular or elliptical areas that continued open as centres of fluidity and eruptive action,‡ (ii, 345; iii, 395.) Subsequently, a gradual reduction in size of these centres of igneous action and their frequent extinction.

---

* We add here a reference to the valuable memoirs on slaty cleavage, by W. Sharpe, Esq., in the Quart. Jour. Geol. Soc., No. 7, p. 309, and No. 9, pp. 74–105. See also this Journal, last volume, p. 430, and p. 110, in this number.

See also on the effects of cooling, De la Beche's Report on Cornwall, Devon and W. Somerset, 8vo, London, 1839, p. 33, and elsewhere.

† Long sustained heat of a requisite and scarcely varying temperature, is the essential circumstance demanded for the distinct crystallization of most minerals from fusion. It is well known that lava streams after becoming incrusted over, are often years in cooling. Yet they pass to the cold state too rapidly or irregularly, for a coarse crystallization of all the several ingredients of the rock, and thus illustrate the absolute necessity of the condition stated. We have observed elsewhere, that a granite-like structure is seldom produced about a volcanic vent except in its central mass of lavas where they finally cool, shut out from the air by thick beds of non-conducting rock. (ii, 349.)

We remark farther, that a long-continued uniform temperature, of some specific degree, is a condition of the greatest importance in chemical combination. It is a condition which the Author of nature has established in the animal structure, where the most complex compositions take place. And when the requisite degree of heat in specific cases is ascertained, and the means of sustaining an unvarying temperature are at hand, we may predict that some chemical compositions will be made to take place directly, which now require indirect processes. The reason for this is obvious, if we consider that with difference of temperature is connected difference of size, and difference of attracting power both cohesive and chemical.

‡ Well illustrated on the surface of the moon, as also are many of the points here mentioned, (ii, 335.) See Beer and Mädler's charts.

d. A boiling movement or circulation (up at centre and down around the sides) in the vast circular areas of igneous action, owing to escaping vapors, and dependent mainly on the temperature being greatest below at centre and least at the surface and laterally.* As this circulatory or cyclosis movement occurs in material whose mineral ingredients or products differ in the temperature of solidification or of formation, it determines to some extent the distribution of these mineral constituents, and of the rocks which are formed. In later periods, this cause producing a feldspathic centre to volcanic mountains having basaltic sides, (ii, 343.)

e. As refrigeration went on, the centres of eruption becoming mostly extinct over large areas, and remaining still active over other areas of as great or greater extent:—for cooling, wherever commenced, would extend somewhat radiately from the centre where begun, (yet with some relation to the structural lines,) and so gradually enlarge the solidifying area and encroach upon the more igneous portions.

II. Contraction, as a consequence of solidification, attended by a diminution of the earth's oblateness.

a. Rate of contraction in different parts unequal, according to the progress of refrigeration; and after the formation of a crust, greater beneath the crust than in the crust itself, (iii, 96, 181.)

b. Contraction beneath the crust causing a subsidence of the surface.

c. Subsidence greatest where the crust was thinnest or most yielding, and least in those parts which were thickest from having been first stiffened by cooling;—the large areas that continued to abound in igneous action therefore becoming in process of time more depressed than those areas that were early free (or mostly so) from such action, (ii, 352; iii, 181.)

d. Subsidence of the surface progressive; or, if the arched crust resisted subsidence, a cessation, until the tension was such as to cause fractures, and then a more or less abrupt subsiding, (iii, 96.)

e. Frequent changes and oscillations in the water level, either gradual or abrupt, arising from the unequal progress of subsidence in different parts, and also in early periods from extensive igneous action, (iii, 95, 181.)

III. Fissures and displacements of the crust, owing to the contraction below it drawing it down into a smaller and smaller arc; also, from a change in the earth's oblateness.

a. Fissures influenced in direction by the structure of the earth's crust,—because of the existence of such a structure, and also because

---

* The boiling action in Kilauea, Hawaii, appears in general character, closely like that of boiling water. In the great lake, 1500 feet in diameter, there is an active play of jets over the surface precisely as in a boiling fluid, with no sounds ordinarily but the grum murmur of ebullition. A constant flow is seen in the liquid, (well shown in the jets that move with the current,) from the hottest part, near the northeast side, towards the southwest part of the lake; and this flow is so remarkable that it was formerly accounted for by supposing that a submarine stream of fire here came to the surface, and disappeared again after being for a short distance visible.

the tension causing fractures would be exerted with some reference to the structural lines, the tension and the structure being both a simultaneous consequence of cooling, (iii, 394.)

b. Direction of fissures modified by the relative positions of the large areas of unequal contraction, and whatever the actual course, frequently attended by transverse fractures, (iii, 395, 396.)

c. As the force of tension acts tangentially in a great degree, (like the pressure of stone against stone in an arch, and that of the whole arch against the supporting or confining abutments,) the effects will appear either over the subsiding area, or on its borders; and they will be confined to the latter position whenever the surface is strong enough to resist fracture, (iii, 96, 97, 181, 395.)

d. The borders of large subsiding areas sooner or later experiencing deep fissurings and extensive upliftings through the tension or horizontal force of the subsiding crust; these upliftings frequently in parallel series, of successive formation, or constituting a series of immense parallel folds; *that* side of the fold in general steepest which is most remote from the subsiding area, (iii, 98, 182, 186.)

e. Fissures formed having the character of a series of linear rents either in interrupted lines or parallel ranges, instead of being single unbroken lines of great length, and this owing to the brittle nature and structure of the earth's crust; ranges sometimes curved, either from having a general conformity to the outlines of contracting areas, or because proceeding from an inequality of force along parallel lines of tension over a subsiding area,* (iii, 185, 385.)

IV. Escape of heat and eruptions of melted matter from below through opened fissures.

a. Igneous ejection of dikes an *effect* and not a cause of displacements, (iii, 99, 185.)

b. Some points in the wider fissures continuing open as vents of eruption. The outlines of large contracting areas being liable from the cause just stated to deep fissurings, these therefore likely to abound most in volcanic vents, (iii, 98, 186.)

c. Heat from many fissures giving origin to hot springs.

---

* The writer would remark here, in order not to be misunderstood, that in accounting for curving ranges of elevations, or courses of fissures, by the lateral force of a subsiding crust, (iii, 395,) he has considered the smaller circular areas of igneous action alluded to, as producing scarcely appreciable results, except when combined in large compound areas which subside as a whole. The great curves on the east and northeast of Asia, in the mountains of the continent, as well as in the ranges of islands, are not necessarily due to each being the outline of a circular area of contraction, although we cannot deny that instances of this are possible; but rather to the subsidence that deepened the Pacific depression, and its unequal amount in different transverse lines, connected with the structural character of the crust or its courses of easiest fracture, (iii, 185:)—for these curves are all *convex* alike *towards the ocean*, and similar also are the subordinate curves in the East Indies, (such as that by Negros, West Mindanao and the Sooloo Sea to North Borneo, and that by East Mindanao, Sangir and North Celebes,) as well as the curves in the mountains of Eastern Australia, (iii, 388.)

d. Distribution of the heat attending submarine action, causing metamorphic changes.*

V. Earthquakes, or a vibration of the earth's crust, consequent on a rupture, internal or external, and causing vibrations of the sea besides other effects, (iii, 181.)

VI. Epochs in geological history, (iii, 187.)

VII. Courses of mountains and coast lines, and general form of continents, determined to a great extent by the general direction of the earth's cleavage structure, and the position of the large areas of greatest contraction.

Continents (or areas of comparatively slight contraction) often therefore present ranges of mountains near their borders, and these mountains are highest and abound most in volcanoes around the *largest* ocean, (the Pacific, iii, 398.) Thus the existence of such continental areas determined the existence of the mountains they contain; and also the mountains in their turn, determined to some extent the position and nature of subsequent deposits formed around them, effecting this either directly, or by influencing the courses of ocean currents during partial or entire submergences, or by determining the outlines of ancient seas of different epochs. According to this view, the general forms of continents, and those of the seas, however modified afterward, were to a great extent fixed in the earliest periods by the condition and nature of the earth's crust. They have had their laws of growth, involving consequent features, as much as organic structures. In this remark, we refer not, under the term continent, to the surfaces of land bounded by the water line; for these, by slight subsidences, are greatly varied in form and size:—but to those extended areas, which, were there no water, would stand raised far above the intermediate oceanic depressions.

---

* In this Journal, Vol. xlv, p. 111, (1843,) the writer has supported the principle that metamorphic changes require no other cause but what attends submarine igneous action, and that the word *hypogene* applied to such rocks is inadmissible. The views there presented properly include not only the heat from submarine volcanic action and fissure ejections, but that escape of heat, going on for ages, through the fractures attending the gradual folding and uplifting of strata while beneath the sea. Similar views, of earlier date, are offered by De la Beche, in his very able Report on Cornwall, Devon and W. Somerset, 8vo, 1839. The de-bituminization of the anthracite coal of the Appalachians appears to be attributed by Prof. Rogers essentially to this cause. (Trans. Assoc. Amer. Geol. and Nat., 1840–1842, p. 473.)

Art. XII.—*Review of the Organic Chemistry of* M. Charles Gerhardt.*

This book appeals with peculiar claims to the notice of all interested in the progress of chemical science. Organic chemistry has made great progress during the last few years; but until the publication of the Précis, with the exception of Liebig's excellent Traité de Chimie Organique, no systematic work embracing the results of the last decade had appeared. This is to be ascribed to the great difficulty of classifying the immense array of facts, and harmonizing the various conflicting theories—a task indispensable as a preparation for such a work and at the same time exceedingly delicate.

Liebig in his Traité assumed as the basis of his system, the theory of compound radicals, and commences with the assertion, that "organic chemistry is the chemistry of compound radicals." This was a most ingenious application of the electro-chemical philosophy of Berzelius to the investigation of this class of compounds, and was supported by so many analogies as to render it very probable; at the same time it admitted the application of the received nomenclature to these bodies. These radicals are generally however purely hypothetical, and when we are able to isolate substances having the composition assigned to them, they are found to possess none of the properties which theory would require. Recent experiments have shown that mellon and mellonids have not the composition ascribed to them by Liebig, and that mellon cannot be regarded as a compound radical. Cyanogen and kakodyle must however be excepted, as compounds which comport themselves in many respects like elementary bodies.

The progress of discovery has shown, that this hypothesis is but poorly adapted to form the basis of a system of classification, for the discovery of nearly every new body requires the assumption of an imaginary compound to explain its reactions in accordance with the theory of radicals; and so uncertain are the principles which are to direct us in the application of this theory, that different chemists often assign very different *rational formulas* to the same compound. There have been not less than seven different formulas proposed, to express the arrangement of the elements in alcohol; each author seeking by his own to explain some practical relation. Thus Dumas regards it as the bi-hydrate of olefiant gas; Liebig as the hydrated protoxyd of ethyle,

---

* Précis de Chimie Organique; par M. Charles Gerhardt, Professeur à la Faculté des Sciences de Montpellier. 2 vols. 8vo. Paris, (Fortin, Masson et Cie.) 1845.—We are indebted for this review and abstract of M. Gerhardt's valuable work, to Mr. Thomas S. Hunt, lately from the Laboratory of Yale College, and now Chemist to the geological survey of the Canadas.

C_4H_5; Berzelius as the bin-oxyd of C_4H_6, and Zeise as a hydruret of $C_4H_5O_2$. The inconvenience of this system arises not only from the fact that the radicals are hypothetical, but that their very existence in the compounds is alternately claimed and denied, and the elements are arranged and re-arranged like the letters in an anagram, as the case may require. M. Liebig seems to have felt its deficiencies, for after describing in the first volume of his Traité, a number of bodies as derivatives of compound radicals, in the succeeding portions of the work he returns to the old divisions of acids, alkalies, essential oils, etc.

This mode of viewing organic compounds resulted from the idea of dualism in chemical compositions, which had found advocates in the great majority of chemists since the days of Lavoisier, and has been perpetuated by the received system of nomenclature. And although there have been at different times those who have seen the difficulties of the binary system, it is only within a few years that a different philosophy has gained partisans.* This new system is distinguished as that of the *French school*, and ranks among its adherents the most distinguished chemists of France. It rejects entirely the idea of a binary arrangement in the composition of bodies, and regards their atoms as constituting a system, in which one or more molecules may be exchanged for others without altering the chemical constitution or type of the arrangement.

M. Gerhardt, who has been long known as one of the most distinguished chemists of France, has attempted the task of systematizing the great accumulation of facts which organic chemistry presents, and framing a classification that shall embrace all those substances whose composition is accurately determined, and in the present work he has given us the result of his labors.

Researches in organic chemistry have shown that we can produce artificially many products of the vegetable and animal organisms. Thus sugar yields by different processes, butyric, oxalic and formic acids; the first of these is one of the acids of butter, the second exists in the fluids of many plants, the last is a secretion of ants. Again bee's wax, when fused with caustic potash, forms stearic acid, one of the acids of animal tallow; by the action of nitric acid, it yields a number of new compounds among which is succinic acid, which exists in amber. These products are less complex in their constitution than the original substances; sugar by the action of oxydizing agents yields, besides formic acid, carbonic acid gas and water, and wax when converted into succinic acid, undergoes a similar decomposition.

* Mr. J. D. Whelpley attempted some years since, to show from the electro-chemical decomposition of the metallic salts of the mineral acids, that they must be regarded not as binary compounds of an acid with an oxyd, but as ternary combinations of the metal, oxygen, and the other element. This principle was made by him the basis of a beautiful and ingenious classification of all saline compounds.

We cannot retrace this process and bringing together the formic acid, carbonic acid and water, by a process of dexoydation reproduce the sugar. These products were formed by a combustion in which a part of the carbon and hydrogen is converted into carbonic acid and water, and the power of reducing them belongs to the vegetable organism, where the chemical affinities are controlled and directed in a peculiar way by the vital force. It is thus that in these operations, we commence with a complex body and by a process in which its carbon and hydrogen are gradually oxydized, reduce it to simpler and simpler forms.

There are however some exceptions to this law; a few synthetical processes are known by which we can unite the elements of simpler compounds to form one more complex. Two polymeric bodies are known which are formed by a grouping together of several molecules of aldehyde; and many of the essential oils undergo a similar change by action of sulphuric acid. The decomposition of organic substances by heat offers some remarkable instances of this kind; in the dry distillation of wax $C_{19}H_{38}O$, we obtain paraffine, which is $C_{24}H_{50}$.

In view of these relations, observes our author, "we may consider all organic substances as the result of the combustion of others more rich in carbon and hydrogen, or reciprocally as the products of the reduction or complication of other bodies containing less carbon and hydrogen."

"In considering from this point of view the whole of organic substances, we observe that they offer successive and almost insensible gradations, in such a manner as *to form an immense scale*, the two extremities of which are occupied, the one at the summit, by the cerebral substance, albumen, fibrine and other bodies still more complex; and on the other at the bottom by carbonic acid, water and ammonia, preceded by wood-spirit with formic acid and the other bodies derived from it."

"The chemist in applying the agents of combustion to substances, *descends the scale*, that is to say, he gradually simplifies these substances by burning successively, portions of their carbon and hydrogen. On the contrary, *he remounts the scale* in applying to organic substances the processes of reduction. These considerations conduct us to an exact appreciation of the principles upon which we may classify all organic substances in a simple and complete manner, which does not have recourse to hypothesis, but confines itself strictly to the limits of experience." pp. 21, 22.

In the examination of organic substances, we observe that those which correspond in their chemical characteristics, present a similarity of relation in the proportions of their constituent elements. The alcohols, embracing wood-spirit, spirit of wine, potato-oil and ethal, are examples; their composition is respectively CH_4O_2, C_2H_6O, $C_5H_{12}O$ and $C_{16}H_{34}O$.*

If the single equivalent of oxygen which each of them contains, were united with two equivalents of the hydrogen to form water, the carbon and hydrogen in the residue of each would be in the proportion of 1 to 2. By oxydizing agents the alcohols lose two equivalents of hydrogen and gain one of oxygen, giving rise to the formic, acetic, valerianic and ethalic acids, in each of which the carbon and hydrogen are in the proportion of one to two; and in all the products of the transformation of these bodies, the proportions of these elements still bear a similar relation to each other. Hence if we know the composition of any derivative of spirit of wine, we can at once foresee that of a similar product derived from any other body of the group.

Substances like these having a likeness in characters depending upon a similarity of constitution are denominated *homologues;* and are to be carefully distinguished from those which resemble each other merely in physical characters, and which are called *analogues.* For example, wood-spirit resembles acetone in being inflammable, odorous, very volatile, and soluble in water, while ethal is allied to stearine in being solid at ordinary temperatures, insoluble in water and having other properties common to the fatty bodies; but their resemblances are only analogies, and when we examine wood-spirit and ethal in relation to their constitution and the products of their decomposition, we find that they are closely related to each other and are homologues.

In homologous bodies, the combustible elements, carbon and hydrogen vary exceedingly in their proportions, while the oxygen and azote are always atomically the same. Two bodies therefore which contain the one O_2 and the other O_3, or one N and the other N_2, cannot be homologues, while bodies containing C_2, or C_5 and H_{12} or H_{34}, may very well be so, as in the alcohols already mentioned. M. Gerhardt has adopted some general formulas to express these relations; R, representing the carburets of hydrogen; RO, those bodies which like alcohol, contain one equivalent of oxygen; while other oxygenized compounds are designated as RO_2, RO_3, &c. Those containing nitrogen are represented in a similar manner, thus RN, RN_2O_3.

In order that two or more bodies may be homologues, it is not sufficient that they can be represented by the same general formula; the equivalent ratio between the proportions of carbon and hydrogen must also be identical. Formic acid CH_2O_2, acetic acid $C_2H_4O_2$, valerianic acid $C_5H_{10}O_2$, and ethalic acid $C_{16}H_{32}O_2$ are designated by the general formula RO_2, and in

* In these formulas it will be observed that our author divides the equivalent of hydrogen, representing water by H_2O. The equivalent of most of organic compounds is taken at one-half the number usually adopted, for reasons which will be explained farther on.

each of them R represents a compound in which the carbon and hydrogen are in the proportion of 1 : 2. These bodies are homologues, and the relation of their elements is such that they may evidently be derived from each other by the abstraction of equal equivalents of carbonic acid CO_2 and water H_2O. This is then the most simple ratio, and is selected as the term of comparison. It is not however the most frequent; generally the hydrogen is less than two, and when it exceeds it, the excess is seldom more than two equivalents.

"When homologous bodies are decomposed into other homologues, they lose or fix atomically the same quantities of carbonic acid, water, oxygen, &c." This principle is illustrated by the group of alcohols so often referred to; when converted into hydrocarbons, they give up one equivalent of water, and in the formation of acids they severally lose H_2 and fix O. From this it follows that a geometrical ratio between the elements of homologous substances is not necessary; bodies having the following proportions of C and H may be homologues:

C H	C H
1 : 4 = 1 : (2+2)	4 : 4 = 4 : (8 − 4)
2 : 6 = 2 : (4+2)	6 : 8 = 6 : (12 − 4)
5 : 12 = 5 : (10+2)	8 : 12 = 8 : (16 − 4)
16 : 34 = 16 : (32+2)	16 : 28 = 16 : (32 − 4)

and the same principle applies to any other proportions of these elements. In the first group, each compound by losing in equivalents of hydrogen is reduced to the normal ratio, and in the second, the addition of four is required.

To express these relations, the symbol R is preserved for the ratio of 1 : 2; for those bodies in which the proportion of hydrogen is greater, the number of equivalents is indicated by an exponent preceded by the sign plus (+), and when its proportion is less it is expressed by a similar exponent with the sign minus (−).

Wood-spirit CH_2O, alcohol C_2H_6O, potato-oil $C_5H_{12}O$ and ethal $C_{16}H_{34}O$, are by this notation, homologues of the form $R^{+2}O$, and the acids derived from them by the abstraction of two equivalents of hydrogen and the addition of one of oxygen are expressed by the formula RO_2. The acids, oxalic $C_2H_2O_4$, succinic $C_4H_6O_4$, pimelic $C_7H_{12}O_4$ and suberic $C_8H_{14}O_4$ are homologues of the form $R^{-2}O_4$; oxamid $C_2H_4N_2O_2$ and succinamid $C_4H_8N_2O_2$, are homologous bodies of the form RN_2O_2; benzene C_6H_6 and cumene C_9H_{12} are expressed by R^{-6}, and so on. To determine whether two bodies having the same amount of oxygen, can be homologues, we assume a number of equivalents of hydrogen equal to twice that of the carbon, (this being the proportion of 1 : 2,) and observe whether the excess or deficiency of hydrogen is the same in both; and consequently whether they can be expressed by the same formula.

The salicylic acid $C_7H_6O_3$, and the anisic $C_8H_8O_3$, are monobasic and contain three equivalents of oxygen; in the first, the deficiency of hydrogen is $14-6=8$, and the second $=16-8=8$. These acids may then be represented by the formula $R^{-8}O_3$.

This proportion between the elements of a compound does not, however, necessarily imply a homology; there are some exceptions which depend in some way upon the peculiar grouping of the elements. Thus ordinary ether $C_4H_{10}O$, is represented by the same general formula as alcohol $R^{+2}O$, but the chemical characters of the two are entirely different and do not allow us to consider them homologues. It is then necessary to add as a condition of homology, a similarity of chemical characters, dependent upon a like arrangement of the molecules. Vol. i, pp. 29–35.

This notation expresses in a beautiful and simple manner, the relations of homology which exist between different compounds. It is the peculiarity of this system that it is based upon the natural affinities of bodies and not upon analogies; this is the only arrangement which will always be correct, because it is founded in the constitution of the substances themselves.

The important relations which the combustible elements sustain, appear "to permit us to class homologous bodies according to their carbon," and M. Gerhardt has accordingly constructed upon this basis a classification in which all organic substances are arranged in a tabular form. Those containing the same atomical proportion of carbon constitute a family which is designated by the number of equivalents of that substance. Each family is divided into the carburets of hydrogen and those containing oxygen and nitrogen, so that we have R, RO_2, RN, &c. These divisions are found on the left of the table, while at the top are marked at the head of their respective columns, the proportions of hydrogen. This will be better understood by a view of a part of the 1st and 2d families.

Family.	Gen. formula.	R^{+2}	R	R^{-2}
2.	R	C_2H_6, acetene.	C_2H_4, olefiant gas.	
	RO	C_2H_6O, (*a*) alcohol. (*b*) metl. ether.	C_2H_4O, aldehyde.	
	RO_2	. . . .	$C_2H_4O_2$, acetic acid.	
	RO_4	. . . .	. . .	$C_2H_2O_4$, oxalic acid.
1.	R	CH_4, marsh gas.		
	RO	CH_4O, wood-spirit.	. . .	CO, oxyd of carbon.
	RO_2	. . . .	CH_2O_2, formic acid.	CO_2, carbonic acid gas.

By this arrangement we are able at once to give a new substance a place, and to determine its relation to other series of compounds; those bodies which are homologues are always found in the same vertical column, and hence in looking over the table, we see at once in what families homologues of any particular form exist, and how these may be formed from other bodies of the same family. This may be illustrated by an extensive class of homologous acids of the form RO_2, which are here given with their families and formulas.

1. Formic,	$C\ H_2\ O_2$	11.	
2. Acetic,	$C_2\ H_4\ O_2$	12. Lauric,	$C_{12}\ H_{24}\ O_2$
3. Metacetonic,	$C_3\ H_6\ O_2$	13. Cocinic,	$C_{13}\ H_{26}\ O_2$
4. Butyric,	$C_4\ H_8\ O_2$	14. Myristic,	$C_{14}\ H_{28}\ O_2$
5. Valerianic,	$C_5\ H_{10}\ O_2$	15.	
6. Caproic,	$C_6\ H_{12}\ O_2$	16. Ethalic,	$C_{16}\ H_{32}\ O_2$
7. Enanthylic,	$C_7\ H_{14}\ O_2$	17. Margaric,	$C_{17}\ H_{34}\ O_2$
8. Caprylic,	$C_8\ H_{16}\ O_2$	18. Anamiritic,	$C_{18}\ H_{36}\ O_2$
9. Pelargonic,	$C_9\ H_{18}\ O_2$	19. Stearic,	$C_{19}\ H_{38}\ O_2$
10. Capric,	$C_{10}\ H_{20}\ O_2$		

The acids of the 1st, 2d, 5th, and 16th families are derived directly from alcohols of the formula $R^{+2}O$; and in the 2d we find aldehyde $C_2\ H_4\ O$, a derivative of alcohol, which fixes one equivalent of oxygen to form the acid. Spermaceti in the 16th family has the formula $C_{16}\ H_{32}\ O$, and forms ethalic acid by combining with an equivalent of oxygen; it is consequently a homologue of aldehyde. No homologues of alcohol are known in the other families; but in butyral $C_4\ H_8\ O$, and bees-wax $C_{19}\ H_{38}\ O$, we have bodies corresponding to aldehyde, and enanthole and menthol are probably the aldehydes of the 7th and 10th families. We may anticipate that future researches will discover an aldehyde and alcohol for each of these acids, and fill up the 11th and 15th families by a similar series. Four acids of this group have been added to the list within the last two years,* and butyral was but recently discovered as a product of the destructive distillation of butyrate of lime. It will be remembered that ethal, an alcohol, is formed by the action of potash upon spermaceti its corresponding aldehyde. We can thus obtain aldehydes from alcohols and acids, and alcohols from aldehydes.

---

* They are, the metacetonic, discovered by Gottlieb; the enanthylic or azoleic, which was formerly considered as a bibasic acid; and the pelargonic, observed by Redtenbacher among the products of the oxydation of oleic, and supposed to be identical with the acid of the *pelargonium roseum*. This occupies the place formerly assigned to the copsic acid of Chevreul, which the observations of Lerch have shown to be a mixture of capric with a new acid, the caprylic.

In this series we observe a regular gradation from the volatile and soluble formic and acetic acids to the solid fatty acids at the other extremity of the scale. Those from the 4th to the 10th inclusive are oily and sparingly soluble, and present a regular increase of about 20° Centigrade in their boiling points; higher in the scale they are solid at the ordinary temperature, and the stearic and margaric cannot be distilled without decomposition. Redtenbacher has recently shown that all the liquid acids of this group, with the exception of the formics, are produced in the oxydation of oleic acid by nitric acid.* Stearic acid by the action of the nitric loses two equivalents of carbon and four of hydrogen in the form of water and carbonic acid; and yields the margaric; which by a farther oxydation affords several of the volatile acids of the series. The other solid acids yield the same results, and are perhaps intermediate products in the oxydation of the margaric by nitric acid.

By the action of nitric acid upon wax, we oxydize a portion of its carbon and hydrogen, and obtain a series of bodies lower in the scale; among these are the succinic, pimelic, and suberic acids, which, as we have already seen, are homologues of the form $R^{-2} O_4$. Spermaceti yields the same products as wax, but if we expose its homologue of the 2d family, aldehyde, to this process, it cannot yield succinic acid, which belongs to the 4th family, but we obtain instead its homologue in the 2d family, oxalic acid.

The results of science are continually demonstrating the universality of the maxim of Linnæus, *Natura non facit saltum.* We see bodies possessing the most dissimilar physical characters, but agreeing in constitution, when arranged according to their chemical relations exhibiting such a gradation that it is difficult to say where the seeming dissimilarity begins or ends, and we may expect that future discoveries will show many bodies of which but one or two homologues are now known to be members of a complete series.

The examples which we have given, will illustrate the features of this classification; which founded as it is upon the natural affinities of bodies and the numerical relations of their elements, must necessarily be permanent.

(*To be continued.*)

---

* This Journal, ii Ser., Vol. iii, No. 8.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *Congelation of Mercury in three seconds, by virtue of the spheroidal state, in an incandescent crucible*, (Letter from M. Faraday to Boutigny, Ann. de Chim. et de Phys., xix, May, 1847, p. 383.)—In producing congelation of mercury by virtue of the spheroidal state, I first heated a crucible to redness and maintained it at this temperature; I then introduced some ether, and then solid carbonic acid; into this mixture in a spheroidal state, I inserted a metallic capsule containing about 31 grammes of mercury, and in two or three seconds it was solidified. It seemed strange indeed that mercury put into a red hot crucible should come out congealed.

2. *On a new Test for Prussic Acid, and on a simple Method of preparing the Sulphocyanid of Ammonium;* by Prof. Liebig, (Liebig's Annalen, Jan., 1847; Chem. Gaz., April, 1847.)—When some sulphuret of ammonium and caustic ammonia are added to a concentrated aqueous solution of prussic acid, and the mixture heated with the addition of pure flowers of sulphur, the prussic acid is converted in a few minutes into sulphocyanid of ammonium. This metamorphosis depends on the circumstance, that the higher sulphurets of ammonium are instantly deprived by the cyanid of ammonium of the excess of sulphur they contain above the monosulphuret; for instance, if a mixture of prussic acid and ammonia be added to the pentasulphuret of ammonium, the solution of which is of a deep yellow color, and the whole gently heated, the sulphuret of ammonium is soon decolorized; and when the clear colorless liquid is evaporated, and the admixture of sulphuret of ammonium expelled, a white saline mass is obtained which dissolves entirely in alcohol. The solution yields, on cooling or evaporation, colorless crystals of pure sulphocyanid of ammonium. Only a small quantity of sulphuret of ammonium is requisite to convert, in the presence of an excess of sulphur, unlimited quantities of cyanid of ammonium into sulphocyanid; because the sulphuret of ammonium, when reduced to the state of monosulphuret, constantly reacquires its powers of dissolving sulphur and transferring it to the cyanid of ammonium. The following proportions will be found to be advantageous:—2 oz. of solution of caustic ammonia of 0·95 spec. grav. are saturated with sulphuretted hydrogen gas; the hydrosulphuret of ammonium thus obtained is mixed with 6 oz. of the same solution of ammonia, and to this mixture 2 oz. of flowers of sulphur are added; and then the product resulting from the distillation of 6 oz. prussiate of potash, 3 oz. of the hydrate of sulphuric acid, and 18 oz. water. This mixture is digested in the water-bath until the sulphur is seen to be no longer altered and the liquid has assumed a yellow color; it is then heated to boiling, and kept at this temperature until the sulphuret of ammonium has been expelled and the liquid has again become colorless. The deposited, or excess of, sulphur is now removed by filtration, and the liquid evaporated to crystallization. In this way from $3\frac{1}{3}$ to $3\frac{1}{2}$ oz.

of dazzling white dry sulphocyanid of ammonium are obtained, which may be employed as a reagent, and for the same purpose as the sulphocyanid of potassium. Of the 2 oz. of sulphur added, ½ an oz. is left undissolved.

The behavior of the higher sulphurets of ammonium towards prussic acid furnishes an admirable test for this acid. A couple of drops of a prussic acid, which has been diluted with so much water that it no longer gives any certain reaction with salts of iron by the formation of prussian blue, when mixed with a drop of sulphuret of ammonium and heated upon a watch-glass until the mixture is become colorless, yields a liquid containing sulphocyanid of ammonium, which produces with persalts of iron a very deep blood-red color, and with persalts of copper, in the presence of sulphurous acid, a perceptible white precipitate of the sulphocyanid of copper.

3. *Separation of Alumina from Oxyd of Iron.*—Dr. W. Kuop (Jour. für Prakt. Chem., Oct. 9, 1846,) states that he has effected a complete separation of these two oxyds by precipitating with sulphuret of ammonium, washing the precipitate with water containing a little free sulphuret of ammonium, and then extracting the alumina by a solution of potash which also must have a little sulphuret of ammonium in it. In this way the alumina, on subsequent precipitation, is obtained on slow desiccation as a transparent mass, and on quickly drying and calcining it has so perfectly a white color as to leave no doubt of its being extremely pure.

4. *Detection of minute traces of Alcohol;* (Monthly Jour. Med. Sci., Dec., 1846.)—Dr. R. D. Thomson proposes in place of the distillation of a liquid suspected to contain alcohol, and trusting to the odor of alcohol in the product, which is the usual mode, to resort to the use of chromic acid, which as is well known, produces a characteristic emerald green solution of oxyd of chromium, in fluids containing alcohol. The characteristic odor of aldehyde given off from the dehydrogenation of the alcohol by the chromic acid, also aids materially in detecting minute quantities of spirits of wine. For this purpose a small quantity of bichromate of potash is placed in the bottom of a conical glass containing a portion of the suspected fluid, and sulphuric acid is poured on it by means of a tube funnel. If alcohol is present, the green oxyd will soon be observed on the surface of the undissolved salt, and the characteristic odor of aldehyde will speedily be perceptible.

5. *On the Acid Reaction of the Gastric Juice;* by Prof. C. G. Lehmann, (Bericht der Gesellschaft der Wissenschaften in Leipzig, p. 100–105; Chem. Gaz., March, 1847.)—Pelouze, and especially Bernard and Barreswil, have shown with certainty the absence of free muriatic acid in the gastric juice. The author has obtained the same result, and at the same time he has indisputably proved the presence of free lactic acid. To obtain the gastric juice of dogs in the greatest state of purity possible, these animals were kept without food for from twelve to sixteen hours, and then fed from ten to twenty-five minutes before death with bones freed as perfectly as possible from skin and fat. Immediately after they were killed, the stomach was tied at the cardia and pylorus, and removed from the body. It was then opened by an oblique incision near the pylorus, and the fluid poured out, without the stomach being at

the same time much moved. The gastric juice thus obtained was almost perfectly clear, scarcely opalescent. The stomach of a dog of the size of a poodle contained from fifteen to forty grms. of a liquid, which flowed out spontaneously; that of a large pointer, from thirty to ninety grms. The fresh gastric juice was poured into a shallow broad flask, the mouth of which was closed by a cork, and through this, a glass tube, bent four times at a right angle, was passed; the latter was covered with nitrate of silver on its inner side. The apparatus was placed under the air-pump with dry hydrate of potash, and exhaustion then applied. When the gastric juice had been evaporated until it was of a syrupy consistence, vapors of muriatic acid were evolved somewhat suddenly, so that the chlorid of silver formed could be determined qualitatively and quantitatively. Treated in this manner, a gastric juice which was but slightly opalescent for instance, yielded 1·808 per cent. of solid residue, 0·125 per cent. muriatic acid, and 98·067 per cent. of water. This muriatic acid is formed by the decomposing action of the lactic acid at a certain degree of concentration, even in the cold, upon many chlorids, especially those of calcium and magnesium, but not the chlorids of potassium and sodium. To prove the presence of the lactic acid itself with certainty, the gastric juice was concentrated *in vacuo* to one-twelfth its volume, the residue mixed with alcohol of 0·85 spec. grav., the spirituous solutions from several stomachs evaporated to the consistence of a syrup, and the residue exhausted with absolute alcohol. The residue of this was exhausted with ether, and the ethereal extract mixed with water to remove the fat, and filtered. On further concentration, more drops of oil separated from the filtrate; moreover, the fluid about to be tested still contained muriate of ammonia. The liquid was partly saturated with lime, partly with magnesia, and the salts formed were purified by several recrystallizations from alcohol and water. The magnesian salt, dried at 266° F., and then incinerated, gave 16·666 per cent. of magnesia, 61·906 per cent. lactic acid, and 21·428 per cent. water; the formula $MgO, \overline{La}+3HO$ requires 16·085 per cent. magnesia, 62·936 per cent. lactic acid, and 20·979 per cent. water. In some other experiments, fasting dogs were fed from twenty to forty-five minutes before death with horse-flesh containing but little fat. The fluid which flowed spontaneously from the stomach, when filtered, left 5·602 per cent. of residue, and thus contained nutritive matters already in solution, which were detected by the copious precipitate produced by alcohol, or the formation of yellowish-brown films on evaporation. The gastric fluid thus obtained yielded no muriatic acid under the air-pump. From this fluid a magnesian salt was also obtained. I. gave 16·666 per cent. of magnesia, 62·122 $\overline{La}$, and 21·212 HO; II., which was obtained by exhausting the contents of the stomach with water, gave 15·966 per cent. MgO, 62·026 $\overline{La}$, and 21·008 per cent. of HO.

6. *Equivalent number of Titanium*, (L'Institut, March 10, 1847.)—The equivalent of titanium has been determined from the bichlorid of titanium by M. Isidore Pierre, Professor at Bordeaux. He obtained, in a series of five experiments, the numbers 314·76, 314·37, 314·94, 311·84, 309·88; in a second series, 313·41, 311·30, and in a third 311·58, 309·41. Operating with the greatest care, some small pro-

portion of the chlorid is supposed to decompose during the experiment, through the humidity of the air; and in this way M. Pierre accounts for the variation in the above results. Believing that the first three results are most correct, he adopts the number 314·69 (or on the hydrogen scale, 25·13) for the equivalent.

7. *On the compounds of Iron with Carbon;* by M. KARSTEN, (Bericht Berlin Akad., Nov. 5, 1846; Chem. Gaz., March, 1847.)—The determination of the amount of carbon in the different kinds of bar iron, steel and pig iron, are still variable and uncertain, partly owing to the estimation of the amount of carbon being very tedious if not difficult, and partly because the limits between bar iron and steel, as well as between steel and pig iron, are wholly undetermined, and are merely assumed conventionally from certain physical properties of the product. Combinations in definite proportions between iron and carbon are not to be met with in the carburets of iron; for the union of these two substances takes place in indefinite proportions, uninterruptedly, from 0 to the maximum amount of carbon, which is about 5·93 per cent. The classification of the carburets of iron in three divisions, bar iron, steel, and pig iron, is consequently not necessary, i. e., not required, by the combining proportions, but wholly arbitrary.

To determine the amount of carbon, the best methods of separating the carbon from iron were employed; but in order to ascertain the degree of trust-worthiness belonging to each, white pig iron, with a bright metallic surface, smelted with charcoal from sparry iron ore at the Sayner works near Bendorf on the Rhine, was submitted to experiment. This pig iron contains no uncombined carbon (graphite), or at least but mere traces; and the amount of combined carbon approaches closely to the maximum amount which iron is capable of taking up.

The amount of carbon of this pig iron was found, by different methods of analysis, as follows:—

	Per cent.
By elementary analysis with oxyd of copper, the carbon being calculated from the carbonic acid gas, - -	4·2835
By elementary analysis with chlorate of potash and chromate of lead, - - - - - - - - -	5·7046
2d experiment, - - - - - - -	5·6987
By decomposition of chlorid of copper, - - -	5·5523
2d experiment, - - - - - - -	5·6978
By decomposition of perchlorid of iron:—	
1. Experiment with sublimed chlorid of iron, -	5·4232
2. With perchlorid prepared in the moist way,	5·2867
By decomposition of chlorid of silver, - - -	5·6056
2d experiment, - - - - - - -	5·7234

As all bar iron contains more or less carbon, some decision should be made as to the limits up to which it should be called bar iron, and below which steel. If the limits are fixed by calling that bar iron steel which becomes so hard by cooling in water after having been hardened that it gives sparks with quartz, this effect occurs only when the iron has taken up 0·5 of carbon. Iron which is perfectly free from foreign ingredients may even combine with 0·65 per cent. of carbon before attaining the above degree of hardness. The purer the iron and the less foreign substances (silicium, sulphur, phosphorus) it contains, the greater amount of carbon will it require in order to become much harder after the process of hardening than previous to it.

Iron which contains 0·5 to 0·65 per cent. of carbon is very soft steel; the hardness and tenacity of the steel increase with the amount of the carbon. From 1·4 to 1·5 per cent. appears to be the limit at which steel exhibits after hardening the greatest hardness with the greatest tenacity; with more carbon the hardness increases, but the malleability and tenacity of the steel are diminished; when it amounts to 1·75 per cent. the steel is very slightly malleable; with 1·9 it can scarcely be welded red-hot, and with 2 per cent. it breaks to pieces under the hammer. In this state the steel might already be called pig iron; but it may be beaten in the cold, and does not possess the property of separating a portion of its carbon in the form of graphite when allowed to cool very slowly after fusion. This occurs only when the carbon amounts to 2·25 or 2·3 per cent. If, therefore, a line of demarcation were to be drawn between steel and pig iron, which should be founded upon the combining proportions, 2·3 would characterize this limit.

The more carbon the pig iron takes up, from that minimum to the maximum of 5·93 per cent., the lighter does the color become, and the greater the hardness of the white variety, which is analogous to hardened steel. The gray variety, with an equal amount of carbon, which is analogous to unhardened steel, will be softer, that is, will separate the more graphite on solidification, the slower the cooling. The gray pig iron, which contains the same amount of carbon as the corresponding white kind, may consequently be sometimes a mixture of white pig iron with graphite, sometimes of soft steel or of hard bar iron and graphite, according as the solidification resulted more or less slowly, and the solidified mixture retained more or less carbon in the combined state. When the solidification is sudden, gray iron is scarcely formed, because the entire amount of carbon remains chemically combined with the iron, and is not separated as graphite.

In preparing cast steel, the process is purely empirical, the eye of the workmen being the weight and balance in determining the amount of carbon in the material to be employed. To manufacture cast steel with certain properties, those materials must be selected in which the amount of carbon is known, and which, by being fused together in accurately calculated proportions, produce a cast steel containing that amount of carbon which corresponds with the properties required of the cast steel to be prepared.

8. *Note on the Action of a Solution of Caustic Soda upon a Stoneware Jar;* by Mr. TRENHAM REEKS, (Chem. Gaz., April, 1847.)—The author's attention was drawn to this subject from the presence of a large quantity of alumina in the analyses of some bronzes and iron ores. On examining the reagents employed, it was found that it originated in the soda, which had been kept for some time in a stoneware jar, the alumina of which had been dissolved out by the soda, and a thick coating of silica left closely adhering to its surface.

9. *On the Detection of Cotton in Linen;* by G. C. Kindt, (Liebig's Annalen, Feb., 1846; Chem. Gaz., April, 1847.)—This subject has frequently engaged the attention of commercial and scientific men; many experiments have been made in order to detect cotton thread in linen; many processes have been recommended, but none have hitherto proved satisfactory. I was therefore much surprised when a stranger, a few weeks ago, showed me a sample of linen from the one-half of which all the cotton filaments had been eaten away. He had obtained it in Hamburg, and asked me whether I could give him a process for effecting this purpose. Now since, as far as I am aware, nothing has been published on this subject, and it is of very general interest, I consider it a duty to communicate the results of my experiments. I had already observed, in experimenting with explosive cotton, flax, &c., that these two substances behave somewhat differently towards concentrated acids; and although it has long been known that strong sulphuric acid converts all vegetable fibre into gum, and when the action is continued for a longer period, into sugar, I found that cotton was metamorphosed much more rapidly by the sulphuric acid than flax. It is therefore by means of *concentrated sulphuric acid* that cotton may be removed from linen when mixed with it; and this object may be effected by the following process:—

The sample to be examined must be freed as perfectly as possible from all dressing by repeated washing with hot rain or river-water, boiling for some length of time, and subsequent rinsing in the same water; and I may expressly observe, that its entire removal is requisite for the experiment to succeed. When it has been well dried, the sample is dipped for about half its length into common oil of vitriol, and kept there for about half a minute or to two minutes, according to the strength of the tissue. The immersed portion is seen to become transparent. It is now placed in water which dissolves out the gummy mass produced from the cotton; this solution may be expedited by a gentle rubbing with the fingers; but since it is not easy to remove the whole of the acid by repeated washing in fresh water, it is advisable to immerse the sample for a few instants in spirits of hartshorn, (purified potash or soda has the same effect,) and then to wash it again with water. After it has been freed from the greater portion of the moisture by gentle pressure between blotting-paper, it is dried. If it contained cotton, the cotton threads are found to be wanting in that portion which had been immersed in the acid; and by counting the threads of the two portions of the sample, its quantity may be very readily estimated.

If the sample has been allowed to remain too long in sulphuric acid, the linen threads likewise become brittle, or even eaten away; if it were not left a sufficient time in it, only a portion of the cotton threads have been removed; to make this sample useful, it must be washed, dried, and the immersion in the acid repeated. When the tissue under examination consists of pure linen, the portion immersed in the acid likewise becomes transparent, but more slowly and in a uniform manner, whereas in the mixed textures the cotton threads are already perfectly transparent, while the linen threads still continue white and opake. The sulphuric acid acts upon the flax thread of pure linen, and the sample is even somewhat transparent after drying as far as the acid acted upon it, but all the threads in the sample can be seen in their whole course.

Cotton stuffs containing no linen dissolve quickly and entirely in the acid; or if left but one instant in it, become so brittle and gummy that no one will fail to recognize it as cotton when treated in the above manner.

10. *Nitrification and the Fertilization of Soils;* by F. Kuhlmann, (Comptes Rendus, Nov., 1846.)—The researches of this author published in 1838 are well known. By these he demonstrated that all the gaseous or vaporizable compounds of nitrogen, were converted into ammonia by the hydrogen and hydrogenous gases in contact with heated spongy platinum, and that on the other hand, all these compounds were converted into nitric acid or peroxyd of nitrogen, by oxygen or oxydating gases.

Upon this foundation the following view is based. Animal substances exercise a beneficial effect only when carbonate of ammonia is disengaged by their decomposition; in like manner, according to Kuhlmann, the nitrates are effectual as manures, only when the nitric acid has been converted into ammonia by the deoxydizing influence of putrid fermentation.

Various recent experiments are brought to prove that this opinion is correct, and that similar conversions to those observed in gases take place in liquids. Nitre thrown into a mixture of zinc or iron and sulphuric or better dilute hydrochloric acid, retards or stops the disengagement of hydrogen until the whole of the nitric acid is converted into ammonia. Nascent sulphuretted hydrogen produces the same effect, with deposition of sulphur. A current of sulphuretted hydrogen passed through a solution of chlorid of antimony and a nitrate, in like manner transforms the nitric acid into ammonia.

The author entertains the opinion that the ammonia of the atmosphere or of manures, is converted at the surface of the soil into nitrates, and that this process of nitrification prevents the waste of ammonia; these nitrates are in their turn deoxydized by fermentation and afford ammonia to the plant.

The peroxyd of manganese is proposed as an agent for the perpetual transference of the oxygen of the air to ammonia, producing its conversion into nitric acid; MnO_2 being deoxydized by the ammonia and the resulting MnO being converted by the air into Mn_3O_4, which in its turn is deoxydated.

M. Kuhlmann considers it possible, in case of a deficient supply of nitre in Europe, to convert ammonia into nitric acid economically—and on the contrary with the nitrates from India and Chili to form ammonia, by turning to account the hydrogen or sulphuretted hydrogen, which is lost in many operations and is even a source of injury to health. He also proposes a new process for determining nitric acid, based upon the conversion of nitrates into ammonia, under the influence of nascent hydrogen. G. C. S.

11. *Anhydrous Alcohol;* by M. Casoria, (Phil. Mag., Nov., 1846, from Jour. de Chim. Med.)—Perfectly dry sulphate of copper is proposed as a means of rendering alcohol anhydrous, and as a test for the

presence of water in alcohol. The dry salt in combining with the water of the alcohol recovers its blue color, and when this color ceases to be produced, water is no longer present.

To obtain anhydrous alcohol, strong alcohol is to be saturated with chlorid of calcium, and the portion first distilled from it is to be treated with the dry sulphate until the blue color ceases to appear. These experiments should be performed in closed vessels, to prevent the interference of atmospheric moisture. G. C. S.

12. *On the Compounds of Phosphoric Acid with Aniline;* by Ed. C. Nicholson, (Phil. Mag., Jan., 1847.)—The facility with which the salts of aniline crystallize, led to the attempt to investigate its several phosphates, which might be supposed analogous to the phosphates of ammonia. Two tribasic phosphates were obtained, one being $2(HO, C_{12}H_7N)HO, PO_5$, the other $(HO, C_{12}H_7N,)\ 2HO, PO_5$, corresponding to the ammonia salts, and like them anhydrous. The attempt to form the salt with three equivalents of base or one containing soda (analogous to microcosmic salt) was unsuccessful. Two pyrophosphates were formed at the same time, acid and neutral; the latter could not be isolated; the former $(HO, C_{12}H_7N,)\ HO, PO_5$ corresponds to acid phyrophosphate of soda, but has no analogue in the ammonia series.

The metaphosphate was formed similar to the soda salt; the ammonia salt exists only in solution.

The conclusion is a natural one, that organic bases form series of salts with polybasic acids resembling those of the metallic oxyds.

G. C. S.

13. *On the relations of Glycocoll and Alcargene;* by Mr. Thomas S. Hunt.—We have received an interesting paper from Mr. Hunt on the relations of these two bodies, which we defer to our next number. He points out the fact that the formulas of the two bodies are the same, excepting the substitution of As for N, and instances some of the homologous compounds as follows:—

Glycocoll,	$C_4\ H_5\ NO_4$	Alcargene,	$C_4\ H_5\ AsO_4$
Argentic "	$C_4\ (H_4\ Ag)\ NO_4$	Argentic "	$C_4\ (H_4\ Ag)AsO_4$
Hydrochloric "	$C_4\ H_5\ NO_4, HCl$	Hydrochloric "	$C_4\ H_5\ AsO_4, HCl$

II. Mineralogy and Geology.

1. *Hauerite, a New Mineral Species;* by W. Haidinger, (Poggendorff's Annalen, Vol. lxx, p. 148.)—Hauerite belongs to Mohs's order of blende, and resembles very much several true brown zinc-blendes. Its crystals belong to the tessular system: they are partly perfect octahedrons, partly combinations of this form with faces of the hexahedron and other modifying planes.

One of the two crystals submitted to my examination by Mr. Berghofer, is a perfect and distinct octahedron, whose axis measures three quarters of an inch. The mineral cleaves with extreme facility parallel to the faces of the cube. Its lustre is between metallic adamantine and imperfectly metallic; the color ranges between dark reddish-brown and brownish-black, and in the thinnest films obtained by cleavage, it shows a low degree of brownish-red translucency ; streak brownish-red ; hardness =4·0, or that of fluor ; specific gravity, according to von Hauer, 3·463.

In a glass tube before the blowpipe, an abundance of sulphur is given off, leaving a green residue soluble in acids with a disengagement of sulphuretted hydrogen. This residue when treated alone becomes superficially brown again, before the blowpipe. A fragment treated with salt of phosphorus does not (as is also true of manganese-blende from Nagyág) become of a violet color in the outer flame, until the whole of the sulphuret of manganese is decomposed. Upon platina foil with soda, it gives the reaction of manganese. In composition, it would therefore seem to be a higher grade of sulphuret of manganese ; and guided by its isomorphism with iron pyrites, which is expressed by the formula $Fe\,S^2$, we may infer that the formula of Hauerite is $Mn\,S^2$.

According to the analysis of W. Adolphus Patera, the composition of the substance in question is as follows : sulphur 53·64, manganese 42·97, iron 1·30, silica 1·20 = 99·11, calculating the iron as sulphuret of iron, and deducting it, this would give, in one hundred parts,

	Analysis.	Calculation.
Sulphur,	54·801	53·7
Manganese,	45·198	46·3

It is remarkable that the form of the only sulphuret of manganese, with which we were hitherto acquainted, (manganese-blende, alabandine,) and whose composition is MnS, should likewise belong to the tessular system, and also show distinct cleavage parallel to the faces of the cube. Alabandine, however, is more semi-metallic in lustre, has a green streak, and gives off no sulphur in a glass tube before the blowpipe.

The writer first took the crystals from their color, form, streak, and manner of grouping, for weathered iron pyrites, when his attention was drawn by Mr. von Hauer to their perfect hexahedral cleavage ; further investigation then established the distinctness of this beautiful species beyond a doubt.

Hauerite occurs at the sulphur-pits at Kalinka near Végles, in the neighborhood of Altsohl in Hungary. The crystals are met with in clay and in gypsum, occasionally associated with sulphur of a fine yellow tint, which is nearly transparent. They occur either insulated or grouped together like certain varieties of globular iron pyrites.

The name proposed was given this species as an acknowledgment of the high merits of his excellency the Privy Counsellor and Vice President, von Hauer, and because of the part which his son, Mr. F. von Hauer, took in the determination of the species. The substance was first noticed by Mr. C. v. Adler, at that time employed at Kalinka, and from this gentleman several persons received specimens. Hauerite will perhaps always remain a mineralogical rarity. The writer however looks forward with pleasure to the receipt of further specimens direct from the mining authorities of Lower Hungary.

2. *Coal and Iron in India*, (Mining Journal, April 10, 1847.)—As it has now been determined by the East India Company, and supported by government, that the railway system shall be extended to India, and a guarantee given for a dividend on the capital invested, any in-

formation respecting the localities from which supplies of fuel can be drawn, must prove interesting, and not less so the capabilities for the manufacture of iron. Hitherto the iron mines of India—though yielding iron in no respect inferior to the famous mines of Dannemora—have been scarcely opened, from the deficiency of the means of transport; and the coal-fields, though of great richness and extent, have lain neglected, principally from the same cause. The coal-fields of India are largely distributed over its surface; coal has been traced from Burdwan to the westward, across the valley of Palamow, through the district of Sohagpore to Jubulpore, the neighborhood of Sak, and the Towa River, in Nerbudda—four hundred and twenty miles from Burdwan. In the same parallel of latitude it is found in the province of Cutch, and is extended across the centre of India, to the northeast extremity of Assam, forming a zone, which stretches from 69° to 93° east longitude, and from 20° to 25° north latitude. There are also two situations where coal has been found distinct from this extensive and well-defined belt—Hurdwar and Attock—the first near the source of the Ganges; the latter, near that of the Indus. The Nerbudda river extends seven hundred miles along the very centre of the above zone; and coal in three situations has already been found on its banks. The Burdwan coal-field is of immense importance; the collieries at present opened are situated one hundred and forty miles from Calcutta, and the district is traversed by two rivers—the Damooda and the Adjii; the face of the country is undulating, presenting a difference of level between the heights and valleys of about sixty feet. The surface is composed of a yellow clay, supporting a good soil—both slightly calcareous; this clay rests on a grey sandstone, which effervesces with acids, seven feet in thickness; and where exposed to the air, in many places an efflorescence of soda is found upon it. Beneath this rock, an inferior coal is found, accompanied by shale, containing impressions of plants, bending over the low hills, and descending deep beneath the valleys; beneath these, good coals are found: and this portion of the deposit has been traced in a southwest direction eleven or twelve miles, and in a northwest line for seven miles—thus forming a curve. At a depth of about fifty feet, two beds of excellent coal occur—one, eight feet, and the other nine feet in thickness; below these, thirteen beds of sandstone and shales occur; and the greatest depth reached is eighty-eight feet, where the excavation is terminated by a hard grey sandstone. The whole district abounds in rich and valuable iron ores of various kinds; and it has been proved, by the erection of temporary furnaces at Sheargur, that immense quantities of iron can be made at little expense. The average of the ores produce fifty per cent. of iron. A prospectus, drawn up in 1828, pointing out the benefits likely to arise from establishing iron-works in India, led to the formation of the Porto Novo Works, near Madras, now in succesful operation; and, as the subject is one of immense importance to the construction of railroads in India, we shall, in a future number, give the substance of a report by Capt. Campbell, which will, doubtless, throw much light on the present position of the coal and iron districts.

3. *On Slaty Cleavage;* by Daniel Sharpe, (Quart. Jour. Geol. Soc., No. 9, p. 74.)—Mr. Sharpe commences his very valuable article

on slaty cleavage by describing the various distorted forms of certain species of shells in fissile rocks, showing that these forms depend on the positions of the shells with relation to the direction of cleavage. He observes that the same shells in rocks that are not fissile are not thus distorted; and on a single slab or layer the various specimens are all distorted in the same direction. This observation led him to throw together many species which he had before considered distinct.

He illustrates the subject by figures of distorted forms of the *Spirifer giganteus* and *Sp. disjunctus* from Tintagel and South Petherwin, copies of which, reduced one-half, are here given. (We have collected together the several separate cuts of Mr. Sharpe for more convenient comparison.)

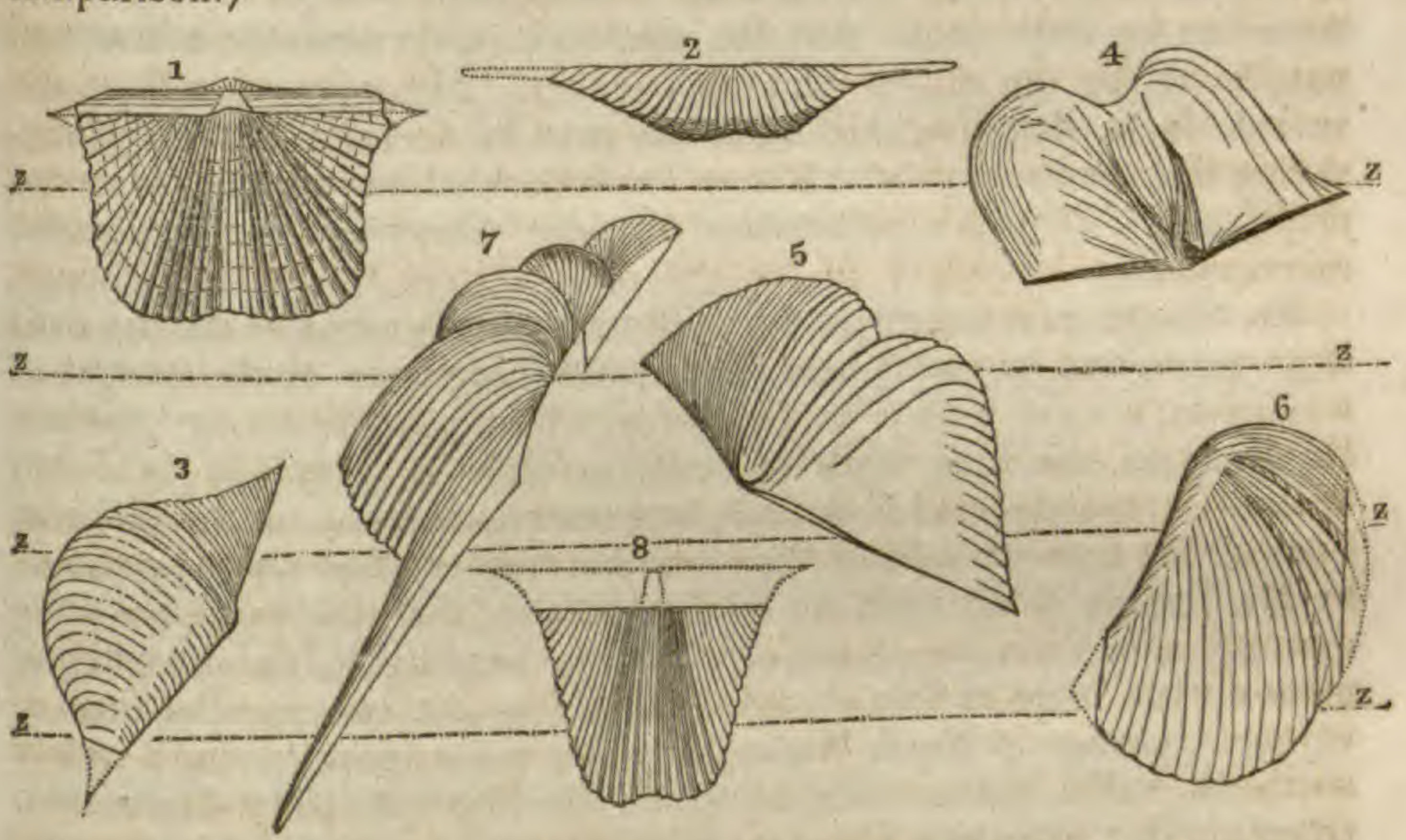
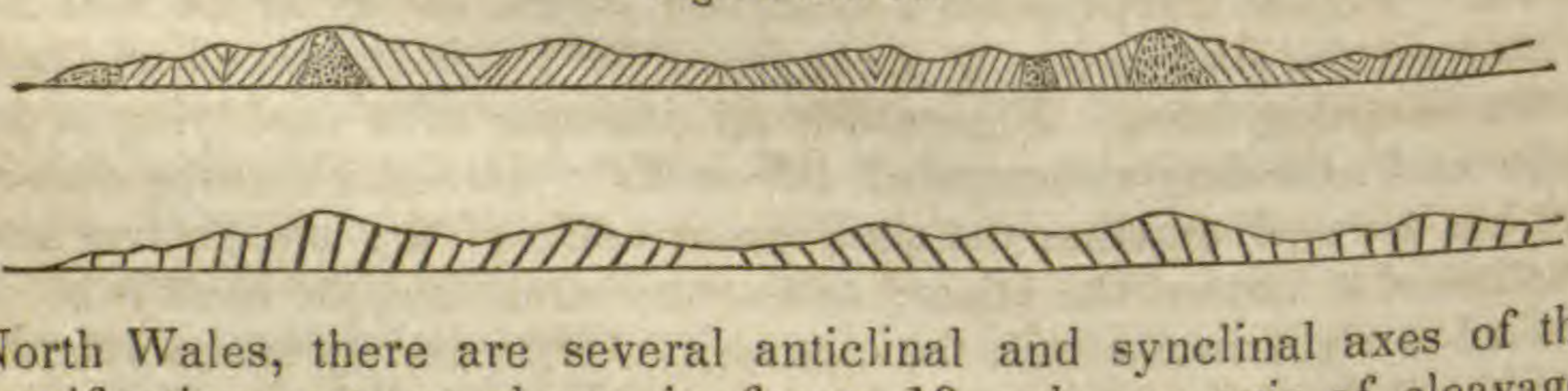


Figure 1 to 4, *Spirifer disjunctus;* 5 to 8, *Spirifer giganteus.* All reduced one-half, except fig. 8, which is reduced two-thirds.

Fig. 1 represents the *S. disjunctus* of its proper form, and the following are distorted shells of this species and *giganteus.* The lines zz mark the direction of the lines of cleavage. These shells, he remarks, are usually flattened or narrowed in a direction *perpendicular* to the cleavage, and drawn out, or pressed out, in the direction of the dip of the cleavage planes. Figure 2 represents a specimen which so lay in the rock as to intersect the slate layers at an angle of 60°; it is shortened one-half by the distorting force. Figure 3 is an example of a cast lying at an angle with the slaty structure of 10° or 15°; the force causing distortion has pressed together the shell on one side of the middle line and lengthened it out on the other; and at the same time the shell is compressed at right angles with the cleavage. Figure 4 represents another cast in a different position; the large part of the shell is pressed under the other part and concealed, and at the same time the remainder is so expanded that the impressions of the hinge portion are nearly double their usual length, this expansion taking place "as usual in the direction of the dip of the cleavage." Figure 5 (a cast of *Spirifer giganteus*) represents a case nearly like figure 3, in which the plane of bedding of the shell made an angle of less than 5° with the cleavage; the lower half is very much expanded in the plane of cleavage, and has lost thereby its radiations. In figure 6 there is the same angle between the plane of bedding and dip of cleavage, but a different position of the shell, in consequence of which one-half was extremely shortened, while the other was as remarkably widened. In figure 7 a still more singularly lengthened cast of *S. giganteus* is shown; it was from a bed where the cleavage intersected it at an angle of 1° only. The elongated half of the cast of the hinge is here three times the length of the other half, and the hinge area is singularly widened, while a great part of the cast of the body of the shell is lost. Figure 8 represents a specimen (imperfect in the hinge portion) expanded in the direction of its length; although not seen in place, Mr. Sharpe observes that there can be little doubt that the distortion took place in a direction parallel to the dip of the cleavage planes. He concludes from the various facts, that the existing forms may be accounted for by supposing that *the rocks* in which they are imbedded *have undergone compression in a direction perpendicular to the planes of cleavage, and a corresponding expansion in the direction of the dip of the cleavage.*

Mr. Sharpe next considers the uniformity of the strike of the dip over large areas, and its parallelism to the anticlinal axes or the ranges of mountains, a view which we believe was first brought out by Necker. He mentions the long lines of uniform strike of cleavage in North Wales, Devonshire, and Cornwall, and the opposite dip on the different sides of the lines of vertical dip; and he supports the view presented by Mr. Darwin in his work on South America, that this variation in the dip may arise from the planes of cleavage bending in the direction of great curves more or less abrupt. He points out two parallel lines of vertical cleavage in North Wales thirty-five miles apart, having a nearly northeast strike, either side of which the dip gradually diminishes. Other similar examples also are pointed out. A relation between the inclination of the cleavage planes and the elevation of the strata is apparent in the beds; the dip of the cleavage is greater the greater that of the bedding, though the two differ much. In North Wales the cleavage planes usually dip 20° or 30° more than the bedding; while in the middle of Devonshire and Cornwall they are less inclined than the bedding. In the following section (figure 9) in Carnarvonshire,

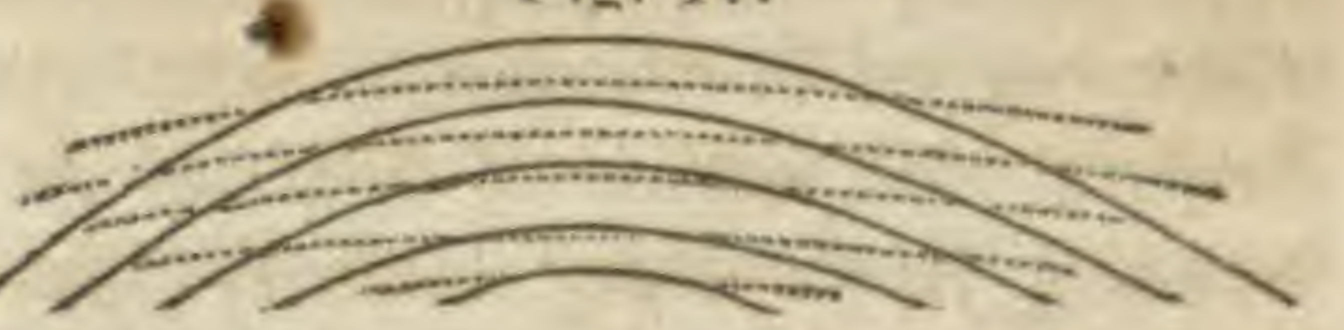
Figs. 9 and 10.



North Wales, there are several anticlinal and synclinal axes of the stratification, yet, as shown in figure 10, only one axis of cleavage. The several anticlinal and synclinal axes, excepting the central one, have not influenced the cleavage, which follows uniformly its own direction through beds dipping in opposite directions. "Still there is so much relation between the direction of the cleavage planes and the position of the beds, that we might infer from this section alone, that the cause which produced the cleavage of the rocks had helped to determine the elevation of the beds."

In Devonshire he establishes two lines of vertical cleavage, sixty miles apart, one at Stoke Fleming the other at Bickington; and they bound a broad area over which the cleavage planes undulate in low flat waves, the axes of which bear between E. and E.N.E. The annexed cut represents the relation of the planes of bedding and cleavage in these undulations near Launceston and on the coast near Tintagel.

Fig. 11.



The continuous lines represent the bedding and the dotted lines the cleavage. After stating other similar facts from different districts in England, Mr. Sharpe remarks as follows, with regard to the relation of the cleavage planes to the bedding in Devonshire:—

"Throughout the central area where the cleavage is nearly horizontal, the beds undulate in a succession of waves already described without offering any marked features. These undulations are sharper towards Bideford, where we may expect to find the cleavage highly inclined. At the Bickington limestone quarry, where the vertical line of cleavage passes, the beds are most violently contorted. Beyond this line is low ground at Barnstaple, in the band between the two lines of vertical cleavage. From Pilton to Ilfracombe, with cleavage highly inclined, the strata are elevated in high hills, and at Linton, where the inclination of the cleavage is only 35°, the beds seldom dip more than 5°. So again on the S. coast of Devonshire, disturbed and elevated strata occur in company with highly inclined cleavage. These observations are less complete than those relating to Carnarvonshire, but the theoretical conclusions to be derived from them are the same.

"The regularity of the direction of the cleavage is not at all broken in the neighborhood of the granite of these counties, from which it is to be inferred that the granitic eruptions had taken place and become solid before the cleavage was produced: indeed some remarks of Sir H. T. De la Beche lead me to suppose that the cleavage is continued through the granite."

Mr. Sharpe having deduced from the distorted shells that "the slaty rocks had undergone compression in a direction perpendicular to the planes of cleavage," and "that this compression was compensated by an expansion in the direction of the dip of the cleavage," enters upon an explanation of the non-conformity of the bedding to the cleavage planes. Assuming that the elevation was produced by an elevating force beneath the area, he argues that there will result from such elevating action, besides a grand central arch or anticlinal axis, other subordinate fractures and dislocations either side; and that thus the various anticlinal axes in figure 9 were produced, while only the main or central one influenced the direction of the cleavage planes. With regard to the manner in which the cleavage structure has been occasioned, or the cause of this peculiar feature, Mr. Sharpe simply enumerates some of the views which have been presented, expressing at the same time the hope that the observations he has made may hasten its discovery: an end which must surely be promoted by observations of so great interest followed out with the care and discrimination exhibited in the important memoir, of which a brief abstract has been here presented.

4. *Geological Society of London*, April 14th, 1847.—A paper was read, entitled, "On the Structure and probable Age of the Coal Field of the James river, near Richmond, Virginia;" by Charles Lyell, F.R.S., V.P.G.S.

This coal field, which is about twenty miles long from north to south and from four to twelve in breadth from east to west, is situated twelve miles west of Richmond in Virginia, in the midst of a granitic region. The rocks consisting of quartzose grits, sandstones, and shales, precisely agree in character with the ordinary coal measures of Europe. Several rich seams of bituminous coal (the principal one being occasionally from thirty to forty feet thick) occur in the lower division of the strata, which are arranged in a trough and are much disturbed and dislocated on the margin of the basin, where they have a steep dip, while they are horizontal towards the centre.

The fossil plants which have been determined by Mr. Charles Bunbury, differ specifically, and most of them generically, from those found fossil in the older or palæozoic coal formation of Europe and North America, and resemble, as Prof. W. B. Rogers first truly remarked in 1840, the plants of the oolite of Whitby in Yorkshire, some few however being allied to fossils of the European trias.

From the upright position of the Calamites and Equisetæ Mr. Lyell infers that the vegetables which produced the coal grew on the spots where the coal is now found, and that the strata were formed during the continued subsidence and repeated submergence of this part of Virginia. The shells consist of countless individuals of a species of Possidonomya, much resembling *P. minuta* of the English trias. The fossil fish are homocercal and differ from those previously found in the new red sandstone (trias?) of the United States. Two of them belong to a new genus and one to a Tetragonolepis, and they are considered by Prof. Agassiz and Sir P. Egerton to indicate the liassic period.

The analysis of the coal made by Dr. Percy and Mr. Henry, shows that it contains the same elements, carbon, oxygen, hydrogen and nitrogen, in the same proportions as the older bituminous coal of Europe and North America. Alternating layers of crystalline coal, and others like charcoal, are observed in many places, and in the charcoal, Dr. Hooker has detected vegetable structure not of Ferns or Zamites or any conifer, but perhaps of Calamites. The coal yields abundance of gas used for lighting the streets of New York and Philadelphia, and some fatal explosions have taken place in the mines, some of which are nine hundred feet deep.

Volcanic rocks (dikes and beds of intrusive greenstone) intersect the coal measures in several places, hardening the shale and altering the associated coal, the latter being in some places turned into a coke used largely for furnaces.

The author concludes by expressing his opinion that the evidence of the fossils, although some of them belong to forms usually found in the trias, preponderates upon the whole in favor of regarding the coal field of the James river as being of the age of the inferior oolite and lias.*

A paper was next read, entitled, "Descriptions of Fossil Plants from the Coal Field near Richmond, Virginia;" by Charles J. F. Bunbury, F.L.S., F.G.S.

---

* For the memoir of Prof. Wm. B. Rogers, in which this conclusion was sustained by the same arguments in 1842, see Report Assoc. Amer. Geol. and Nat., 1840–1842, p. 298.

The author describes fifteen different forms of vegetable remains, of which, however, only nine or ten are sufficiently well preserved to be determined with any precision. Six are Ferns, of which three belong to *Pecopteris*, one to *Tæniopteris*, one to *Neuropteris*, and the sixth appears not to be referable to any genus hitherto described. The *Neuropteris*, and one of the species of *Pecopteris*, are new. One of the ferns is believed to be identical with *Pecopteris whitbiensis*, a species characteristic of the oolites of the Yorkshire coast. There is one species of *Equisetum*,—*E. columnare*—likewise characteristic of the Yorkshire oolites; one, or perhaps two of *Calamites;* two (which may possibly be mere varieties) of *Zamites;* the remainder are obscure impressions of an equivocal nature, but of which one has a certain degree of resemblance to a *Stigmaria*, and another to a *Lepidodendron*.

Five of these fossil plants had previously been determined and described by Prof. W. B. Rogers, namely, *Tæniopteris magnifolia*, *Pecopteris whitbiensis*, *Equisetum columnare*, *Calamites arenaceus*, and *Zamites obtusifolius*. Prof. Rogers described also a few other species, which do not occur in the collection made by Mr. Lyell.

From a comparison of these vegetable remains with those found in European strata, of which the geological position is well known, it may be concluded with tolerable certainty, that the Richmond coal-field is of later date than the great carboniferous system, and that it must be referred either to the lower part of the Jurassic, or the upper part of the Triassic series,—more probably to the former.

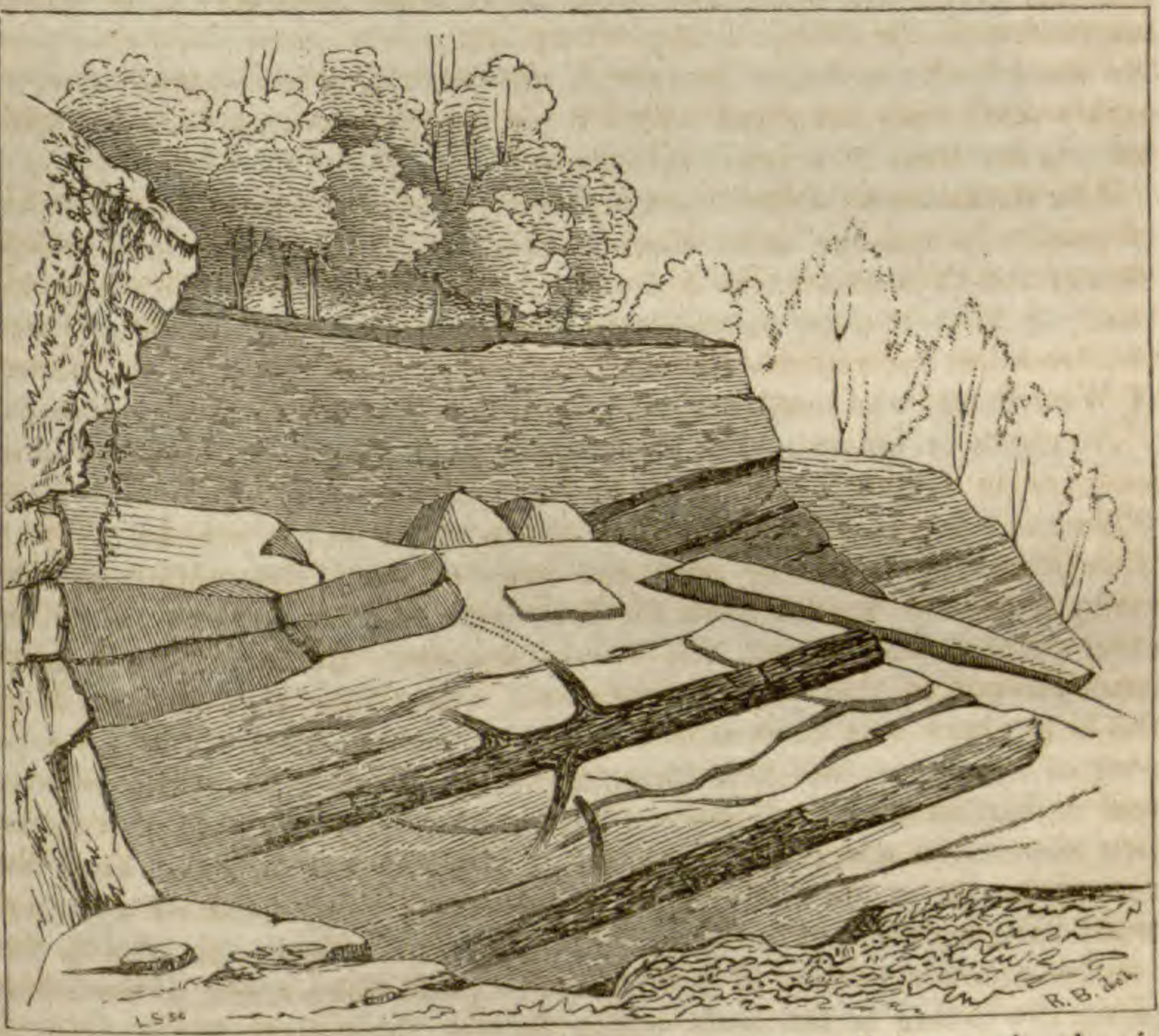
5. *Remarks on a Boulder Mass of Native Copper from the southern shore of Lake Superior;* by Forrest Shepherd, (communicated by request, to Prof. Silliman, for this Journal.)—The mass of native copper in my possession, was discovered on the southern shore of Lake Superior in July, 1845, by Tousant Piquette (an Indian of the Ojibwa tribe) in or near latitude 47° 5′ north, and longitude 88° 5′ west. It is composed almost entirely of pure native copper with spots of pure metallic silver upon its surface, together with a few water-worn pebbles of syenite, sandstone, &c., strongly imbedded and fastened in its cavities and sinuosities. Its length is about three feet and a half, its breadth two feet and a half, thickness from seven to eight inches, and its weight sixteen hundred and twenty-five pounds. As a specimen, its form and proportions could not well be better. One end is broader by a few inches than its opposite. One side discovers a slight natural rotundity and also a deep furrow cut obliquely into the solid metal, while the other side, nearly flat, appears much worn and polished in some places, whilst in other places it exhibits numerous grooves, scratches and broad longitudinal furrows, showing evidently that the mass has at some period been subject to great external violence. When found it was situated immediately upon the shore about three miles northeast of Elm river, not more than two or three feet above the water, and only about six feet from the broad side of the lake. It was standing on its smaller end, nearly in a perpendicular position, leaning slightly against a much larger boulder of sienite. The lower end was buried in the gravel of the shore about ten inches, and immediately underneath it were found pebbles and small boulders of porphyritic greenstone, syenite, sandstone, &c., and also an undecayed log of white cedar (arbor vitæ) on which it rested. Around it, both in the lake, and upon

the neighboring shore, and occupying a space of several acres, were seen in promiscuous assemblage, a multitude of boulders both large and small, composed chiefly of granite, syenite, greenstone, conglomerate, and red sandstone, apparently the companions of this extraordinary specimen. There is no stream of any magnitude or importance nearer than Elm river (three miles), which although called a river, is not more than twelve or fifteen feet in breadth. All along this coast and for many miles southward is a dense forest of large trees, such as white cedar, spruce, hemlock, pine, poplar, birch and maple; the growth of which, must have occupied four or five centuries.

The stratum of rock underneath this assemblage of boulders is red sandstone nearly horizontal, dipping northward into the lake at an angle of two or three degrees. About eight or ten miles southward is a ridge of stratified greenstone, generally called trap by explorers in this region. This ridge runs northeast and southwest nearly, and attains a height of five or six hundred feet. In this greenstone are numerous veins containing native copper with occasional spots of silver. These veins or lodes of copper, cut the above ridge at right angles and extend into a formation of conglomerate which reclines immediately upon the greenstone. Native copper is found also in the conglomerate. The red sandstone above mentioned reposes upon the conglomerate, so that there is a gradual descent from the summit of the greenstone ridge to the shore of the lake (a distance of eight or ten miles) where the copper boulder was discovered. From the adhesion of pebbles to the depressed and cavernous portions of this copper boulder, there is strong probability that it was derived from a vein in the conglomerate. But it could not have well been removed from the neighboring ridge, since the existence of the present forest; and it has evidently been deposited in the place where it was discovered, since the growth of the medium sized arbor vitæ on which it rested. The shore of the lake at this place is of moderate elevation varying from six to ten or twelve feet. The island of Isle Royal with its sandstone conglomerate, porphyry, and greenstone, is situated about fifty miles due north, and granite and syenite, similar to the boulders, accompanying the copper rock, exist in place on the northern shore of the lake, a distance of one hundred miles or upwards. No rocks of this description are known to exist nearer *in situ.*

6. *On Fossil Trees found at Bristol, Conn., in the New Red Sandstone.*—Two fossil trees have recently been discovered by the quarrymen who were excavating building stones in a sandstone quarry on the banks of the Pequabuck river in the town of Bristol, Connecticut. This town is on the western border of the greater secondary basin of Connecticut, and the locality where these fossil trees were found is not far from the junction of this deposit with the western primary ranges. The sandstone beds which crop out upon the banks of the Pequabuck, are fine grained, argillaceous and well adapted for many architectural purposes. No organic remains have before been observed in them, with the exception of a few ill characterized and obscure impressions of reed-like vegetation, upon the surface of a fissile stratum of argillaceous sandstone which is met with at a point about four feet above the bed containing the trees.

The writer's attention was called to these fossils by a letter from Mr. N. S. Manross of Bristol, (a member of the academical department of Yale College,) whose father owns the quarry where they were found. This gentleman had the consideration to preserve these interesting relics from destruction until they had been visited by the writer in company with R. Bakewell, Esq., to whom we are indebted for the accompanying sketch of the quarry with the two trees as they appeared, at the time of our visit.



It will be observed that the trunks are nearly parallel to each other in the plane of stratification of the beds, and nearly at right angles to the strike of the strata. Their buts point toward the river, while their heads are buried beneath the unopened sandstone. Several branches were to be traced from the principal trunk, one of which reached (in the dotted line) to the distance of eight or ten feet from the body and nearly at right angles with it. The bed in which these trunks were found is quite unlike the fine grained red deposits above and below them, being a rather coarse grained grey quartzose grit, sprinkled with mica and carbonaceous particles. It is very tender and friable when first exposed, and the trees which were imbedded in it were not properly petrified, but existed in the condition of soft lignite, in which the vegetable structure could be detected only on close observations. A rough exterior having the general appearance of the outer bark of the common yellow pine, was all the general character that could be observed. They were much flattened by the pressure of superincumbent rocks, not being over four inches thick in the thickest parts and thinning out to the edges. The greatest breadth of the trunk of the larger tree was about one foot, and it diminished from this very gradually for about fifteen feet, which is the extreme length to which they have been uncovered. The stem of the larger tree was divided transversely at nearly regular intervals of about fourteen inches by a cleft or notch, which corresponded to a similar ridge or prominence in the sandstone, both above and below. The two trees are not in the same plane, as may be seen in the sketch which correctly represents the smaller tree in the foreground as about two feet below the larger and three feet distant from it. The cast or impression of the larger tree gives its characters more distinctly than the stem itself: and this impression also measures in diameter considerably more than the trunk which it represents, showing that the latter has shrunk from its original dimensions.

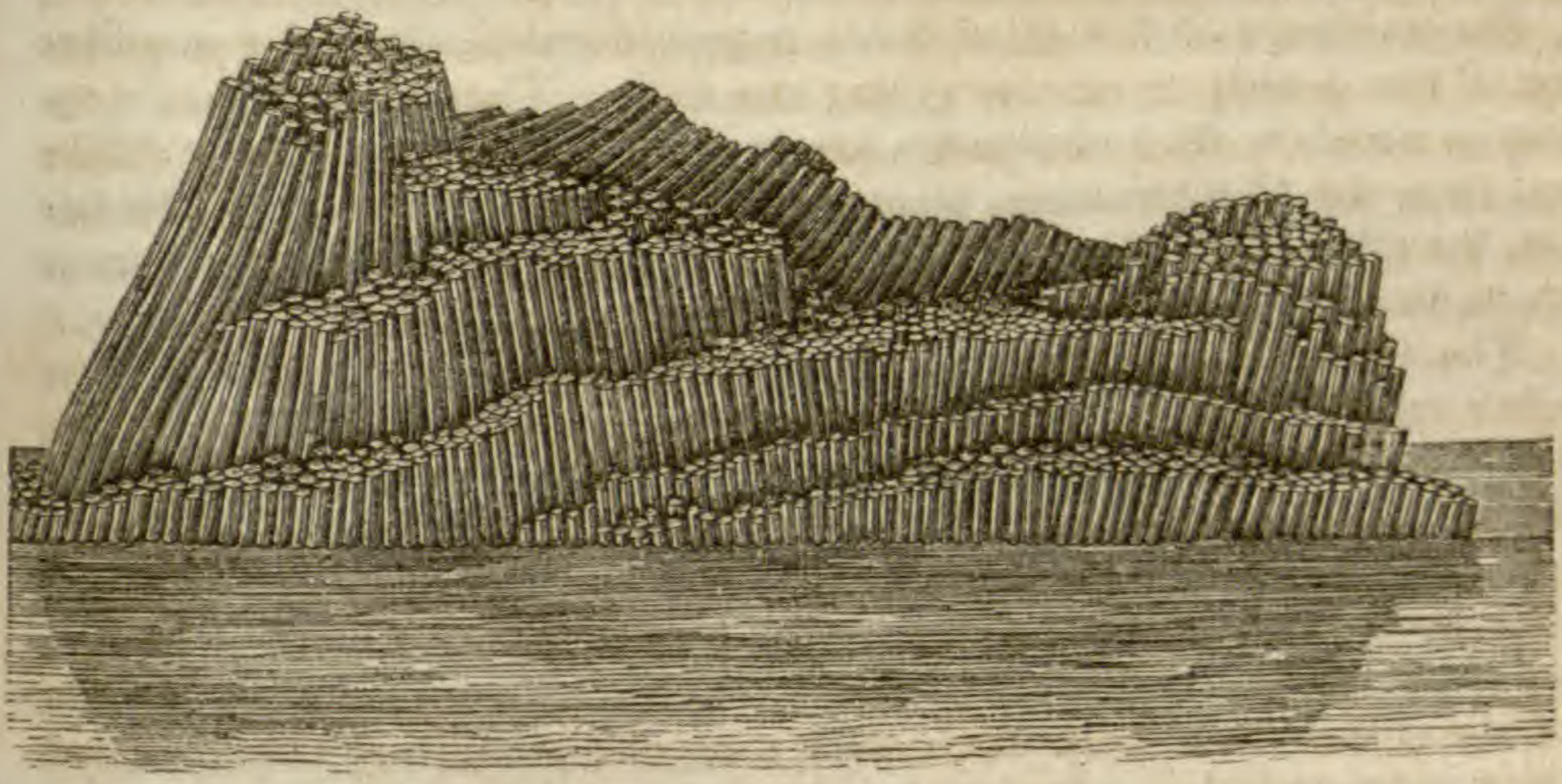
The thickness of deposits over these trees is not more than six feet of sandstone and the same amount of diluvium; but this gives us no idea of the thickness which has undoubtedly been removed by denudation. A microscopical examination of specimens of the trunks of these two trees has been kindly undertaken by my friend, Prof. J. W. Bailey of West Point, who confirms the supposition that they were coniferous.

No cones or leaves could be detected in this locality, nor had any such, or in fact any other fossils, been obtained by the quarrymen, although there is a tradition that many years since, trunks of trees were found in a quarry near the present one. Mr. Manross has made particular search here for footmarks similar to those found in other parts of this deposit, but without success. By the zeal and good management of this young gentleman, about four feet in length of the larger tree was successfully removed with its corresponding capping of sandstone, and now forms one of the ornaments of the geological collection of Yale College. The writer supposes that this is the first instance in which the trunks of hard-wooded trees have been observed *in situ* in the Connecticut sandstone. Fragments of agatized wood have been found in Massachusetts by Prof. Hitchcock, and in the smaller secondary basin of Southbury, Ct., and large stems of reed-like plants are found in the beds which furnish the fish at Middlefield in the same state. B. SILLIMAN, Jr.

Yale College Laboratory, June 1, 1847.

7. *Observation on the Basaltic Formation on the northern shore of Lake Superior;* by T. R. DUTTON, (communicated for this Journal.)—The display of igneous rocks on the north shore of Lake Superior is one of great interest to the geologist, both on account of the variety of the different formations, their relations to the adjacent slates, and the fact that some of them are the repositories of copper and silver.—Among these instructive rocks may be found, granite of a more recent date than the Devonian strata, sienite, porphyry, greenstone and trap, both compact, amygdaloidal and basaltic. It is of the last-mentioned formation that we now speak.

The numerous islands which occupy the most northern part of the lake are composed of trap and porphyry with underlying sandstone, and must be considered as one of the most important parts of the metalliferous region of the northern shore. On the southern shore of Simpson's Island and the southeastern of St. Ignace, the two largest of these islands, the trap presents the columnar form which is represented in the accompanying cut (drawn by Capt. Stannard) of a section forty feet long and twenty feet high.



The cliffs of this formation which extend for a distance of about three miles, are rarely more than sixty feet in height, and are composed of columns which are usually pentagonal or hexagonal in form, and which, though they are for the most part nearly perpendicular, are often inclined at different angles and sometimes bent. They are twenty or thirty feet long, and from six to eighteen inches in diameter; but they seldom present that distinctness in their columnar structure, and the transverse joints, which characterize the basalt of the Giant's Causeway.

III. Botany and Zoology.

1. *Notes on a Tour to Madeira, Teneriffe and Cape Verds, from the Journal of the Voyage of* Dr. J. R. T. Vogel *to the Niger*, (Lond. Jour. Bot., No. lxiii, March 1, 1847, p. 125.)—The Island of Madeira contains six hundred and seventy-two species of flowering plants and Ferns, of which eighty-five are absolutely peculiar, and four hundred and eighty common to Europe; two hundred and eighty are common to Madeira and the Azores (whose Flora is estimated at four hundred and twenty-five species); three hundred and twelve (or probably more) to Madeira and the Canaries; and one hundred and seventy to the neighborhood of Gibraltar (where four hundred and fifty-six have been collected).

It is remarkable that out of four hundred European (and these Mediterranean) species, indigenous to Madeira, not more than one hundred and seventy occur in Gibraltar; for it were natural to suppose that the majority of four hundred and eighty species which are very widely dispersed throughout the S. of Europe, should have migrated by way of Gibraltar, if transported across the ocean to Madeira. It is further worthy of observation, that the Azores, though very far to the westward, and the Canaries to the south, both contain many more of the Mediterranean plants seen in Madeira, than does Gibraltar.

A considerable number of the Madeira plants belong to genera not found in the adjacent continent, but in the Canaries, Azores, or Cape de Verd Islands; thus indicating a botanical affinity between these groups, and confined to them.

The evidence of this relationship is very decided, from the peculiarity of the genera or species giving rise to it. Though comparatively few in number, their characters are so prominent and so widely different from the Mediterranean plants which accompany them, that the latter, though numerically much the greatest, seem superadded, and, as it were, intruders on the former.

The Canaries and Madeira, from their central position and various other causes, are the centre of this botanical region, called by Mr. Webb the "Macronesian," and exhibit more peculiarity than the Cape de Verds, (as far as they are at present known,) or the Azores. There can be little doubt that Madeira was even more peculiar in its vegetation than now, previous to the destruction by fire of the luxuriant forests, which, according to historic evidence, clothed almost all the lower parts of the island. Not only would such a catastrophe destroy species, but their place would be afterwards occupied by strong-growing imported weeds, which would prevent the reappearance of the native plants by monopolizing the soil.

With very few exceptions, the Mediterranean are the only plants found in Madeira and the Canaries besides what are confined to those islands; in the Azores, on the other hand, some Northern European species are associated with them. In the Cape de Verds, far to the south, W. African and W. Indian plants replace those of the Mediterranean.

The Island of Madeira participates in the flora of the W. Indies to a much greater degree than does any part of the adjacent continent:—that this is in a great measure due to the dampness of its insular climate, is clear, from the plants in question being almost entirely Ferns, viz.:—Acrostichum squamosum, *Sw.* Aspidium molle, *Sw.* Asplenium monanthemum, *Sw.* Asplenium furcatum, *Sw.* Trichomanes radicans, *Sw.*, species found no where on the continent of Europe, nor in N. Africa. The presence of a plant belonging to the otherwise exclusively American genus, *Clethra*, is striking, because indicating a further relationship with the Flora of the New World, but of a very different character from the above.

The *Helichrysa* of Madeira are allied in rather a remarkable degree to the S. African species of that genus; a fact which reminds us that the *Myrsine Africana*, a Cape of Good Hope plant, is a native of the Azores, but of no intervening latitude on the West coast of Africa or the Atlantic Islands, or indeed any where else but Abyssinia. Though not a subject falling immediately within the province of the pure botanist, it may not be amiss here to state, that the four Island-groups in question have been conceived by my friend, Professor Forbes, to be the remains of one continuous and extended tract of land, which formed the western prolongation of the European and African shores. He points to the identity of species between these islands and Europe, as affording botanical evidence of this ingenious theory, which, however, he chiefly rests on geological grounds. Regarded in this light, the question will resolve itself, in the opinion of most botanists, into one, concerning the power of migration, and the probability of migration having taken place, to a very great extent, over the Atlantic Ocean, and against the prevailing direction of the winds. It may be contended that such a migration would have peopled these islands solely, or mainly, with certain of the more transportable classes of plants; and that the result must be, that the number of species belonging to each natural order would be great in proportion to the facility with which they bear transportation; while only those orders could be numerous, which possess that faculty in an eminent degree. But such are not the characteristics of the Mediterranean plants found in Madeira.

On the other hand, the existence of such a continent, during the period when these islands bore the plants which they now produce, would argue the former presence of a very large Flora belonging to the type which now distinguishes the islands in question from the Mediterranean, and of whose previous existence the remaining species, peculiar to them, are the indication. Against this theory it might be urged, that more specific identity between the plants of the several insular groups than now is seen, would then be the natural consequence; for the affinity of vegetation between the different islands consists, not in identical species, but in representatives. The same agent, in short, which effected the peopling of the several groups with the plants of continental Europe, would also have distributed more equally the non-European species over the same area.

It is, however, to the lofty peaks of Atlas that we must look, if any where, for the continental representatives of those peculiar plants which mark the North Atlantic Insular Floras. Thus, we expect to find the productions of the Galapagos Archipelago on the higher levels of the Cordillera; and the mountains of St. Thomas, Fernando Po and the Cameroons, on the west coast of tropical Africa, may yet exhibit to us the botanical features of St. Helena. Outlying and high islands commonly partake in the peculiar vegetation of a climate cooler than belongs to the low lands of the adjacent continent; though, in the case of Juan Fernandez, they sometimes exhibit genera equally isolated in botanical affinities as their habitats are in geographical position.

Teneriffe.—The next point visited by the Niger Expedition, after leaving Madeira, was the Island of Teneriffe, where the vessel in which Vogel had embarked remained but a few hours. The same island, and the same port, Santa Cruz, had been touched at by the Antarctic Expedition during the previous winter. Teneriffe is always held to be classic ground by the naturalist, as the opening scene of the labors of Humboldt, who there first appreciated in their full extent the laws governing the geographical distribution of plants. His lifelike pictures of the natural phenomena, observed during an ascent of the famous peak, have given an impulse to many succeeding scientific travellers, which has turned their thoughts and steps from closet studies and the pursuit of natural history at home, to seek far distant scenes, in the West, the East and the South.

The Peak itself is seldom descried: one hurried glimpse of its very apex, from upwards of sixty miles distance, was all we obtained: it then appeared like a little short and broad cone high in the clouds, or rather, as an opaque triangular spot on the firmament. It is difficult to imagine this, the culminant point, to be that mighty mass, at whose base the toil-worn traveller pauses; when, having surmounted four-fifths of the mountain, his heart quails at beholding a "Pelion upon Ossa piled" so sternly, so stony and so steep.

Much and deeply did the officers of Captain Ross and Trotter's Expeditions deplore the necessity of hurrying from this spot, so interesting to the sailor, it being the point to which every circumnavigator first steers, and from whence, with chronometers carefully corrected at its well-determined position, he takes his departure. For years, too, this was the prime meridian; distance in longitude at sea being reckoned from Teneriffe as zero, by all the seafaring nations of Europe at one period: and by some it is so still. From the days of the earliest circumnavigators, to the present, "we sighted the Peak of Teneriffe" marks that page in the narrative, at which all that is interesting in the voyage commences.

In the history of geology, the Canary Islands hold a conspicuous position: von Buch developed his theory of craters of elevation from what he there observed: his name too recalls, and most appropriately, that of his fellow-laborer in the same shores, Christian Smith, the amiable and gifted Swede, who first after Humboldt, explored their botany. Christian Smith returned to Europe to embark in the ill-fated Congo Expedition: when he again saw the Peak of Teneriffe, he welcomed it as a familiar object, and bade it adieu, rejoicing that a still more novel field of inquiry was opened to him, beyond this scene of his early exertions. A few short months terminated his life and hopes: like Vogel, he fell a victim to the dreaded fever of the pestilential coast of Africa: like him, too, he was a martyr in the cause of botanical science.

Possessed of so many and such touching associations, no naturalist-voyager can see the Fortunate Isles rising, one by one, on the horizon of the mighty Atlantic, without some feeling of melancholy, while reflecting on the fate of these his two predecessors, both most accomplished naturalists of their age and day; and whose prospects and hopes were in every respect as bright, perhaps brighter, than his own.

The excellent and beautiful work of Mr. Webb, on the Natural History of the Canaries, leaves little to be said, especially of their botany; and renders even an enumeration of the few species gathered by Vogel and the Botanist of the Antarctic Expedition unnecessary; for they were all collected within a few miles of Santa Cruz, during a very hurried walk, and scarcely include a dozen kinds. This locality is one of the most barren of the whole group, especially in the immediate neighborhood of the sea. The broad frontage of cliff and mountain, reaching upwards for several thousand feet above the town, and fore-shortened to the view from seaward, presents a progressive increase of verdure from the water's edge to the mountains. At this season, when the vines are out of leaf, nothing green meets the eye; the trees, either isolated or in very small clumps, only dot the alternate ridges and steep gullies with which the slopes are everywhere cut like the edge of a saw, producing that spotty effect in the landscape so admirably transferred to the phytographical illustrations of the work alluded to, and which is eminently characteristic both of the Canaries and Madeira.

The *Kleinia*, *Euphorbia* and *Plocama* are three plants which the voyager recognizes long before reaching the shore; and they are so singular, whether as regards habit, habitat, or botanical characters, that the opportunity of seeing them in a wild state, even from the sea, must be deemed a privilege by the botanist.

Cape de Verd Islands.—The voyage, from the Canaries to the Cape de Verd Islands, generally presents a hiatus in the journals of those sea-faring naturalists who have followed this route. Before arriving at the Canaries, landsmen have scarcely recovered from the novelty of ship-board and its effects; nor has there been time, since leaving these islands, to become thoroughly inured to the monotony of a sailing life. At first sight, the Cape de Verd Islands are very disappointing. It is true that we had passed from an extra-tropical latitude to far within the tropics; but the change in position was not accompanied with a corresponding difference, still less with luxuriance, in the vegetation and scenery. Yet these apparently barren islands have associations of great interest; and their examination yields both pleasure and profit. They afford us the first glimpses of the fever-smitten coast of Africa, and of slavery. Even the black man here, deprived of freedom, and an alien to the land in which, though guiltless, he is a prisoner for life, is apt to be regarded as a mere object of natural history by his Caucasian fellow-creature; who, before he has time for reflection, may perhaps be excused for pausing to consider, whether a being so different in features and social position, be really of the same origin as himself; whether, in short, the poor African is a race of the same stock, or a species apart.

There are many other circumstances, connected with these islands, calculated to keep the mind busy while in their neighborhood. They form the western extreme of the Old World, of what was the whole world to civilized man, till within the last very few hundred years; and hence these, the North Cape and Cape of Good Hope, constitute the three salient points in the geography of the eastern Atlantic. In many of their physical features, they form a continuation of the great Sahara desert; that mysterious blank on our maps, upon whose sea of sand so many of our venturesome countrymen have embarked, to be heard of no more. The hitherto unexplored mountains rise eight thousand feet and upwards above the sea, in serried ridges and isolated peaks, promising a rich harvest to some botanist, who may in these higher and cooler parts of the islands rely on immunity from disease and on a temperate climate. There he may expect to find new types of plants; for the Mountain Flora of Western Tropical Africa is wholly unknown; and of its probable nature even we can form no guess. To conclude, the Linnæan axiom of "semper aliquid novi ex Africa" has never yet proved false. A naturalist cannot see the shores of that continent without feeling that no other spur is required to exertion, in a field to which such a motto still applies with so much force.

2. *On the fundamental type and homologies of the Vertebrate Skeleton;* by Prof. OWEN, (from the Literary Gazette; Ann. Mag. Nat. Hist., xix, 202, March, 1847.)—The Professor commenced by alluding

to the origin of anatomy in the investigation of the human structure, in relation to the relief and cure of disease and injuries; and to the consequent creation of an anatomical nomenclature, having reference solely to the forms, proportions, likenesses and supposed functions of the parts of the human body; which were originally studied from an insulated point of view, and irrespective of any other animal structure or any common type. So, likewise, the veterinary surgeon had begun the study of the anatomy of the horse in an equally independent manner, and had given as arbitrary names to the parts which he observed. Thus, in the head of a horse there was the "os quadratum;" and in the foot the "cannon-bone," the "great" and "small pastern-bones," the "coronet," and "coffin-bones," &c. When the naturalist first sought to penetrate beneath the superficial characters of the objects of his study, their anatomy had often been conducted in the same insulated and irrelative way. The ornithotomist, or dissector of birds, describes his "ossa homoidea," "ossa communicantia" seu "interarticularia," his "columella," his "os furcatorium" and "os quadratum," the latter being quite a distinct bone from the "os quadratum" of the hippotomist. The anatomizer of reptiles described "hatchet-bones" and "chevron-bones," an "os cinguliforme" or "os en ceinture," and an "os transversum;" he had also his "columella," but which was a bone distinct from that so called in the bird. The icthyotomist described the "os discoideum," "os transversum," "os cœnosteon," "os mystaceum," "ossa simplectica," "prima," "secunda," "tertia," "quarta," &c. Each at first viewed his subject independently and irrelatively; and finding, therefore, apparently new organs, created a new and arbitrary nomenclature for them.

After pointing out the impediments to a philosophical knowledge of anatomy, from such disconnected attempts to master its complexities, and the almost impossibility of retaining in the memory such an enormous load of names, many distinct ones signifying the same essential part, whilst different parts had received the same name, Prof. Owen proceeded to demonstrate the principal results of the philosophical researches of Cuvier, and other comparative anatomists, in tracing the same or homologous parts through the animal series, as they were exemplified in the osseous system, and principally in the bones of the head. When any bones in the human skull, for example, had been thus traced and determined in the skulls of the lower vertebrate animals, the same name was applied to it there as it bore in human anatomy, but understood in an arbitrary sense; and when the part had no name in human anatomy, but was indicated, as often happened, by a descriptive phrase, it received a name having a close relation to such phrase; and thus a uniform nomenclature had arisen out of the investigation of the homologies of the bones of the skeleton, applicable alike to the human subject, the quadruped, the bird, and the fish. The corresponding parts have been sometimes called *analogues*, and sometimes *homologues;* the latter being the appropriate term, since the parts are in fact namesakes. The essential difference between the relations of *analogy* and *homology* was illustrated by reference to a diagram of the skeletons of the ancient and modern flying dragons. The wings of the extinct pterodactyle were sustained by a modification of the bones of the fore-arm or pectoral limb, which bones were long and slender, like those of the bat; and one of the fingers, answering to our little finger, was enormously elongated. The wings of the little *Draco volans*, the species which now flits about the trees of the Indian tropics, were supported by its ribs, which were liberated from an attachment to a sternum, and were much elongated and attenuated for that purpose. The wing of the pterodactyle was *analogous* to the wing of the Draco, inasmuch as it had a similar relation of subserviency to flight; but it was not *homologous* with it, inasmuch as it was composed of distinct parts. The true homologue of the wing of the pterodactyle was the foreleg of the little *Draco volans*.

The recognition of the same part in different species, Prof. Owen called the "determination of a special homology;" the recognition of its relation to a primary segment of the typical skeleton of the vertebrata, he called the "determination of its general homology." Before entering upon the higher generalization involved in the consideration of the common or fundamental type, Prof. Owen gave many illustrations of the extent to which the determination of special homologies had been carried, dwelling upon those which explained the nature and signification of the separate points of ossification at which some of the single cranial bones in anthropotomy began to be formed; as in the so-called "occipital," "sphenoid," and "temporal" bones. More than ninety per cent. of the bones in the human skeleton had had their namesakes or homologues recognized by common consent in the skeletons of all vertebrate animals; and Prof. Owen believed the differences of opinion on the small residuum, capable with one or two exceptions, of satisfactory adjustment. The question then naturally arose in the philosophical mind, upon what cause or condition does the existence of these relations of *special homology* depend? Upon this point the anatomical world was divided. The majority of existing authors on comparative anatomy appeared either to have tacitly abandoned, or, with Cuvier and Agassiz had directly opposed, the idea of the law of special homologies being included in a higher and more general law of uniformity of type, such as has been illustrated by the theory of the cranium consisting of a series of false or anchylosed vertebræ. Profs. de Blainville and Grant, however, teach the vertebral theory of the skull; the one adopting the four vertebræ of Bojanus and the gifted propounder of the theory, Oken; the other regarding the hypothesis of Geoffroy St. Hilaire of the cranial vertebræ as more conformable to nature. Prof. Carus of Dresden has beautifully illustrated the poet Goethe's idea of the skull being composed of six vertebræ. But these authors had left the objections of Cuvier and Agassiz unrebutted; and judging from the recent works of Profs. Wagner, Müller, Stannius, Hallmann, and others of the modern German school, and those of Milne Edwards, the doctrine of unity of organization, as illustrated by the vertebral theory of the skull, seemed to be on the decline on the continent. To account for the law of special homologies on the hypothesis of the subserviency of the parts so determined to similar ends in different animals—to say that the same bones occur in them because they have to perform similar functions—involve many difficulties, and are opposed by numerous phenomena. Admitting that the multiplied points of ossification in the skull of the human fœtus facilitate, and were designed to facilitate, child-birth, yet something more than a final purpose lies beneath the fact, that all these points represent permanently distinct bones in the cold-blooded vertebrata. And again, the cranium of the bird, which is composed in the adult of a single bone, is ossified from the same number of points as the human embryo, without any possibility of a similar final purpose being subserved thereby. Moreover, in the bird, as in the human subject, the different points of ossification have the same relative position and plan of arrangement as in the skull of the young crocodile; in which animal they always maintain, as in most fishes, their primitive distinctness. A few errors, some exaggerated transcendentalisms and metaphorical expressions of the earlier German homologists, and a too obvious tendency to *à-priori* assumptions and neglect of rigorous induction on the part of Geoffroy St. Hilaire, had afforded Cuvier apt subjects for the terse sarcasm and polished satire which he directed against the school of "Unity of Organization." The tone also which the discussions gradually assumed towards the latter period of the career of the two celebrated anatomists of the French Academy, seems to have led to a prejudice in the mind of Cuvier against the entire theory and transcendental views generally; and he finally withdrew, in the second edition of his 'Leçons d'Anatomie Comparée,' that small degree of countenance to the vertebral theory of the skull which he had given by the admission of the three successive bony cinctures of the cranial cavity in the 'Règne Animal.'

Prof. Owen then briefly alluded to the researches which he had undertaken, with a view to obtain conviction as to the existence or otherwise of one determinate plan or type of the skeletons of the vertebrata generally; and stated, that after many years' consideration given to the subject, he had convinced himself of the accuracy of the idea that the endo-skeleton of all vertebrate animals was arranged in a series of segments, succeeding each other in the direction of the axis of the body. For these segments or "osteocommata" of the endoskeleton, he thought the term "vertebræ" might well be retained, although used in a somewhat wider sense than it is understood by a human anatomist. The parts of a typical vertebra were then defined, according to the views explained in the Professor's 'Lectures on Vertebrata;' and he proceeded to apply its characters to the four segments into which the cranial bones were naturally resolvable. The views of the lecturer were illustrated by diagrams of the disarticulated skulls of a fish, a bird, a marsupial quadruped, and the human fœtus. The common type was most closely adhered to in the fish, as belonging to that lower class of vertebrata in which "vegetative repetition"* most prevailed, and the type was least obscured by modifications and combinations of parts for mutual subservience to special functions. The bones of the skull were arranged into four segments or vertebræ, answering to the four primary divisions of the brain, and to the nerves

* The general principle of animal organizations, which Prof. Owen has termed "the law of vegetative or irrelative repetition," is explained in the first volume of his 'Hunterian Lectures,—on the Invertebrate Animals.'

transmitted to the four organs of special sense seated in the head. Prof. Owen adopted the names which had been assigned to these vertebræ from the bones constituting their neural spines, viz., occipital, parietal, frontal, and nasal; and enumerated them from behind forwards, because, like the vertebræ of the tail, they lose their typical character as they recede from the common centre or trunk. The general results of the Professor's analysis may be thrown into the following tabular form :—

Primary Segments of the Skull-bones of the Endo-skeleton.

VERTEBRÆ.	OCCIPITAL.	PARIETAL.	FRONTAL.	NASAL.
Centrums.	Basioccipital.	Basisphenoid.	Presphenoid.	Vomer.
Neurapophyses.	Exoccipital.	Alisphenoid.	Orbitosphenoid.	Prefrontals.
Neural Spines.	Supraoccipital.	Parietal.	Frontal.	Nasal.
Parapophyses.	Paroccipital.	Mastoid.	Postfrontal.	None.
Pleurapophyses.	Scapula.	Stylohyal.	Tympanic.	Palatal.
Hæmapophyses.	Coracoid.	Ceratohyal.	Articular.	Maxillary.
Hæmal Spines.	Episternum.	Basihyal.	Dentary.	Premaxillary.
Diverging appendage.	Fore-limb or fin.	Branchiostegals.	Operculum.	Pterygoids &Zygoma.

The upper or neural arch of the occipital vertebra protected the *epencephalon*, or medulla oblongata and cerebellum; that of the parietal vertebra protected the *mesencephalon*, or third ventricle, optic lobes, conarium and hypophysis; that of the frontal vertebra the *prosencephalon*, or cerebral hemispheres; that of the nasal vertebra the *rhinencephalon*, or olfactory crura and ganglions.

The superior development of the cerebral hemispheres in the warm-blooded class, and their enormous expansion in them, occasions corresponding development of the neural spines, not only of their proper vertebra, but, by their backward folding over the other primary segments, of those of all the other vertebræ; whilst the more important parts of the neural arch, as the neurapophyses, undergo comparatively little change.

The acoustic nerve escapes between the occipital and parietal vertebræ, but the organ itself is intercalated between the neural arches of these segments and its ossified capsule; the petrosal projects into the cranial cavity between the exoccipital and alisphenoid in the warm-blooded vertebrata. The gustatory nerve (part of the third division of the fifth pair) perforates or notches the alisphenoid, and in crocodiles and many fishes passes through an intervertebral foramen between the alisphenoid and orbitosphenoid; but the gustatory organ is far removed from the neural arches or cranium proper, and is united with its fellow to form the apparently single organ called the tongue. The optic nerve perforates or grooves the orbitosphenoid, and the eyeball intervenes between the frontal and nasal vertebræ, as the earball does between the occipital and parietal: the vertebral elements are modified to form cavities for these organs of sense; that lodging the eye being called the "orbit," that for the ear the "otocrane."

The divergence of the olfactory crura, and the absence of any union or commissure between the olfactory ganglia, leads to an extension of ossification from their neurapophyses, which are always perforated by the olfactory crura or nerves, to the median line between those parts; and the neurapophyses themselves coalesce together there in batrachia, birds, and mammals. This extreme modification was to be expected in a vertebra forming the anterior extremity of the series; and the typical condition of the prefrontals, so well shown in fishes and saurians, is marked in mammals by the enormous development of the capsules of the organ of smell anterior to them, which become ossified and partially anchylosed to the compressed, shrunken and coalesced prefrontals; the whole forming the composite bone called "æthmoid" in anthropotomy. The vomer, or body of the nasal vertebra, has undergone an analogous modification to that which the terminal vertebra of the tail presents in birds; whence its special name, referring to the likeness to a ploughshare, in human anatomy. The spine, or nasal bone, is sometimes single, sometimes divided, like the frontal, the parietal and the supraoccipital bones. Their special adaptive modifications have obtained for them special names.

The hæmal arches corresponding with the above neural arches retain most of their natural position and proportions, as might be expected, in fishes; they are called the scapular, hyoid, mandibular, and maxillary arches. The pleurapophysis of the occipital vertebra is the scapula, and is commonly attached by a head and tubercle to the centrum and parapophysis of its proper occipital vertebra.

The hyoid arch is suspended by the medium of the epitympanic to the mastoid parapophysis of the parietal vertebra, the epitympanic, in fishes, intervening and separating the hæmal arch from its proper vertebra, just as the squamosal intervenes to detach the tympanic pleurapophysis of the mandibular arch from its proper vertebra in mammals; which vertebra the squamosal attains in man by articulating with the process representing the coalesced postfrontal. In return, we find the hyoidean arch resuming its normal connexions in many mammalia, the stylo-hyal element being directly articulated to the mastoid: in man the large petrosal capsule intervenes, and contracts that anchylosis with the proximal or pleurapophysial element of the hyoid arch, which has led to the description of the stylohyal as a process of the temporal bone, in works on human anatomy.

In fishes, the tympanic, which is the true pleurapophysis of the mandibular arch, always articulates with the postfrontal, besides its accessory joint with the mastoid. The maxillary arch is articulated by its pleurapophysis, the palatine bone, with the centrum and neurapophysis (vomer and prefrontal) of the nasal vertebra. This is the normal and constant point of suspension of the maxillary arch; other accessory attachments to ensure its fixation and strength are successively superinduced upon this primary and essential one. Through this knowledge of the general homology of the palatine, an insight was gained into its singular disposition in man, creeping up, as it were, into the orbit, to touch the pars plana of the æthmoid; this secret affinity with the modified neurapophysis of the nasal vertebra becomes intelligible by a recognition of its relations to the general type of the vertebrate skeleton, by its determination as the rib or pleurapophysis of the nasal vertebra, and therefore retaining, as such, more or less of its essential connexion with the centrum (vomer) and neurapophyses (æthmoid or prefrontal) of the nasal vertebra throughout the vertebrate series.

The tympano-mandibular and the hyoidean arches had both been recognized as resembling ribs. A like homology of the scapula had early been detected by Oken; but its relation to the skull or occiput had been masked, and had escaped previous notice, by its displacement from its natural or typical connexions in all the air-breathing vertebrata.

The enunciation of these correspondences has sometimes been received by anatomists conversant with one particular modification of the general type, with as little favor as those of the "cannon-bone" to the metacarpus, of the "great and small pastern" and the "coffin-bones" to the digital phalanges of the human hand, may be supposed to have been by the earlier veterinarians.

Prof. Owen adduced instances of the displacement of different vertebral elements to subserve special exigencies, as that of the neurapophyses in the bird's sacrum, and that of the ribs of the human thorax, in which there could be, and had been, no question as to the reference of such displaced parts severally to their proper vertebral segments. The displacement of the scapular arch from the occiput was a modification of precisely the same kind, and differed only in degree. In the crocodile every cervical as well as every dorsal vertebra had its ribs; and in the immature animal the same elements existed, as distinct parts, in the lumbar, sacral, and in several caudal vertebræ. The occipital vertebra would be represented only by its "centrum" and "neural arch," unless the loose and obviously displaced scapulo-coracoid arch were recognized as its pleurapophysial and hæmapophysial elements. This arch made its first appearance in every vertebrate embryo close to the occiput; and in fishes—the representatives of the embryo-state of higher vertebrata, where the principle of vegetative repetition most prevailed, and the primitive type was least obscured by teleological or adaptive modifications—the scapular arch retained its true and typical connexions with the occiput.

The general homology of the locomotive members as developments of the diverging appendages of the inferior vertebral arches, was illustrated, and the parallelism in the course of the modifications of all such appendages pointed out. As the scapular arch belongs to the skull, so its appendages, the pectoral or anterior members, were essentially parts of the same division of the skeleton segments.

As a corollary to the generalization that the vertebrate skeleton consisted of a series of essentially similar segments, was the power of tracing the corresponding parts from segment to segment in the same skeleton. The study of such "serial homologies" had been commenced by the unfortunate Vicq. d'Azyr, in his memoir "on the parallelism of the fore and hind extremities;" and similar relations could be traced through the more important elements of the series of vertebræ. Prof. Owen believed it to be an appreciation of some of these homologies that lay at the bottom of the epithets, "scapula of the head," "ilium of the head," "femur of the head," &c., applied to certain cranial bones by Oken and Spix. To Cuvier this language had seemed unintelligible jargon; yet the error consisted merely in assigning a special instead of a general name to express the serial homology rightly discerned, in some of the instances, by the acute German anatomists.

"Scapula," "ilium," "rib," &c., were names indicative of particular modifications of one and the same vertebral element. Such element, understood and spoken of in a general sense, ought to have a general name. Had Oken stated that the tympanic bone of the bird, for example, was a "pleurapophysis" (or by any other equivalent term) of the head, his language would not only have been accurate, but intelligible, perhaps, to Cuvier. When Oken called it the "scapula of the head," he then unduly extended such special name, and transferred it to a particularly and differently modified pleurapophysis, which equally required to have its own specific name.

Professor Owen dwelt on the necessity of having clearly-defined terms for distinct ideas, in order to ensure the progress of science; and alluded to the advancement of human anatomy by accurate determinations of the general type, of which man's frame was a modification.

3. *On the Minhocâo of the Goyanes;* by M. AUGUSTE DE SAINT HILAIRE, (Comptes Rendus, Dec. 28, 1846; Ann. Mag. Nat. Hist., xix, 140.)—Luiz Antonio da Silva e Souza, whose acquaintance I made during my travels, and to whom we owe the most valuable researches on the history and statistics of Goyaz, says, in speaking of the lake of Padre Aranda, situated in this vast province, that it is inhabited by minhocôes; then he adds that these monsters—it is thus he expresses himself—dwell in the deepest parts of the lake, and have often drawn horses and horned cattle under the water. The industrious Pizarro, who is so well acquainted with all that relates to Brazil, mentions nearly the same thing, and points out the lake Feia, which is likewise situated in Goyaz, as also being inhabited by minhocôes.

I had already heard of these animals several times, and I considered them as fabulous, when the disappearance of horses, mules and cattle, in fording the rivers, was certified by so many persons, that it became impossible for me altogether to doubt it.

When I was at the Rio dos Pilôes, I also heard much of the minhocôes; I was told that there were some in this river, and that at the period when the waters had risen, they had often dragged in horses and mules whilst swimming across the river.

The word *minhocâo* is an augmentative of *minhoca*, which in Portuguese signifies *earth-worm;* and indeed they state that the monster in question absolutely resembles these worms, with this difference, that it has a visible mouth; they also add, that it is black, short, and of enormous size; that it does not rise to the surface of the water, but that it causes animals to disappear by seizing them by the belly.

When, about twenty days after, having left the village and the river of Pilôes, I was staying with the Governor of Meiapont, M. Joaquim Alvez de Oliveira, I asked him about these minhocôes: he confirmed what I had already been told, mentioned several recent accidents caused by these animals, and assured me at the same time, from the report of several fishermen, that the minhocâo, notwithstanding its very round form, was a true fish provided with fins.

I at first thought that the minhocâo might be the *Gymnotus carapa*, which according to Pohl is found in the Rio Vermelho, which is near to the Rio dos Pilôes; but it appears from the Austrian writer that this species of fish bears the name of *Terma termi* in the country; and moreover the effects produced by the Gymnoti are, according to Pohl, well known to the mulattos and negroes who often felt them, and have nothing in common with what is related of the minhocâo. Professor Gervais, to whom I mentioned my doubts, directed my attention to the description which P. L. Bischoff has given of the *Lepidosiren;* and indeed the little we know of the minhocâo agrees well enough with what is said of the rare and singular animal discovered by M. Natterer.

That naturalist found his *Lepidosiren* in some stagnant waters near the Rio da Madeira and of the Amazon: the minhocâo is not only said to be in rivers, but also in lakes. It is, without doubt, very far from the lake Feia to the two localities mentioned by the Austrian traveller; but we know that the heats are excessive at Goyaz. *La Serra da Paranahyba e do Tocantim*, which crosses this province, is one of the most remarkable dividers of the gigantic water-courses of the north of Brazil from those of the south; the Rio dos Pilôes belongs to the former, as does the Rio da Madeira. The *Lepidosiren paradoxa* of M. Natterer has actually the form of a worm, like the minhocâo. Both have fins; but it is not astonishing that they have not always been recognized in the minhocâo, if, as in the *Lepidosiren*, they are in the animal of the Rio dos Pilôes reduced to simple rudiments. "The teeth of the *Lepidosiren*," says Bischoff, "are well-fitted for seizing and tearing its prey; and to judge of them from their structure and from the muscles of their jaw, they must move with considerable force." These characters agree extremely well with those which we must of necessity admit in the minhocâo, since it seizes very powerfully upon large animals and drags them away to devour them. It is therefore probable that the minhocâo is an enormous species of *Lepidosiren;* and we might, if this conjecture were changed into certainty, join this name to that of the minhocâo to designate the animal of the lake Feia and of the Rio dos Pilôes. Zoologists who travel over these distant countries will do well to sojourn on the borders of the lake Feia, of the lake Padre Aranda, or of the Rio dos Pilôes, in order to ascertain the perfect truth—to learn precisely what the minhocâo is; or whether, notwithstanding the testimony of so many persons, even of the most enlightened men, its existence should be, which is not very likely, rejected as fabulous.

4. *Ear of the Limnæus stagnalis*, (Weigm. Archiv.; L'Institut, March 10, 1847.)—According to observations by M. Frey, the auricular vesicle is visible in the Limnæus stagnalis soon after the rotary movements of the embryo have ceased and the animal has commenced to become coiled in the interior of its shell. There may then be easily observed in the interior part of the body, the rudiments of tentacles, the eyes with their pigment, and the tongue with its characteristic epithelium; and on each side of the base of the tongue, the auditive vesicles may be distinguished. These vesicles are spherical, with a simple contour, and have a diameter of $\frac{1}{60}$ to $\frac{1}{56}$ of a line (French). They appear at first to contain in the interior only a transparent liquid, and are then, like the eyes, without any connection with the central parts of the nervous system. But soon one or two small corpuscles are formed in the liquid interior, whose form, size, and oscillatory move-

ments are wholly similar to those of the otolites pertaining to the ears in the perfect animal. The size of these otolites varies from $\frac{1}{450}$ to $\frac{1}{300}$ of a line. The number increases gradually to twenty, when the animal quits its shell, and at this time the diameter of the vesicle is $\frac{1}{40}$ of a line. They continue multiplying, and are one to two hundred in number in the adult, when the vesicle is $\frac{1}{16}$ to $\frac{1}{10}$ of a line in diameter. The development of the hearing apparatus is the same essentially in the Physa, Paludina, and other terrestrial Gasteropods. In bivalves, the vesicle contains only one otolite of large size, which fills the cavity of the vesicle.

IV. Astronomy.

1. *The Planet Neptune, and its Relations to the Perturbations of Uranus.*—In the Boston Courier of April 30, 1847, Prof. Benjamin Peirce, of Harvard University, announces the following conclusions:

"The problem of the perturbations of Uranus admits of three solutions, which are decidedly different from each other, and from those of LeVerrier and Adams, and equally complete with theirs. The present place of the theoretical planet, which might have caused the observed irregularities in the motions of Uranus, would, in two of them, be about one hundred and twenty degrees from that of Neptune, the one being behind and the other before this planet. If the above geometers had fallen upon either of these solutions, instead of that which was obtained, Neptune would not have been discovered in consequence of geometrical prediction. The following are the approximate elements for the three solutions at the epoch of Jan. 1, 1847:—

	I.	II.	III.
Mean longitude, - -	319°	79°	199°
Long. of perihelion, - -	148	219	188
Eccentricity, - -	0·12	0·07	0·16

In each of them (the mass of the sun being unity) the mass is 0·0001187. The period of sidereal revolution is double that of Uranus. It will be observed that the mean distance in all these cases is the same with that of Neptune, and that in the first of them, the present direction is not more than seven degrees from it; and in another solution which I have obtained, the present direction is almost identical with Neptune's. But the coincidence fails in a most important point; for, whereas Walker and Adams both demonstrate, from incontrovertible data, and a simple but indisputable argument, that the new planet cannot be more than 90° from its perihelion, either of these two latter geometrical planets would now be in aphelion and at much too great a distance from the sun.

"All my attempts to reconcile the observed motions of Neptune with the assumption that it is the principal source of the unexplained irregularities in the motions of Uranus, have been frustrated. Whatever orbit is attributed to this planet in my analysis, whether Walker's, or Valz's, or Encke's, or Adams's, or any other which I can suppose, and which is not unquestionably irreconcilable with observation; and whatever may be supposed to be its mass, I cannot materially diminish the amount of residual perturbation, but leave it full as great as it was previous to Galle's discovery. Notwithstanding my repeated examinations, it would be presumptuous in me to claim for my investigations a freedom from error which the greatest geometers have not escaped, especially in the face of the vastly improbable conclusion to which my analysis tends, viz. that the influence of the new planet is wholly different from that demanded by the problem whose solution led to its discovery. It may however be asked whether the attraction of Uranus might not be exhibited in the motions of Neptune, in such a way as to modify the orbit deduced from observation, and thus to reconcile it with theory; but this question cannot be answered without further investigation."

Mr. Walker's important discovery of the identity of Neptune with a star observed by Lalande, May 10, 1795, (Vol. iii, ii Ser., p. 441,) seems now amply confirmed. An examination of the original observations of Lalande, shows that he also observed the body two days previous, but as the two observations disagreed, the earlier was rejected, and the latter marked doubtful. The following communication on the subject, by Mr. Walker, appeared in the National Intelligencer, (Washington,) of June 4, 1847.

Gentlemen,—In my letter of May 22d, announcing the confirmation of my discovery of the Lalande observation of Neptune, I remarked that the elements can now be completed, and that the computation of Neptune's perturbations would afford the means of obtaining the pure elliptic orbit round the sun from the perturbed orbit presented in elements V.

I have just completed this research by freeing them from the effect of the present action of the three great planets, (that of the others is nearly insensible,) and am now able to offer to the public the definitive elements of Neptune's orbit. They are as follows, referred as before to the mean equinox of January 1, 1847, and to mean noon Greenwich:

Elements VII. of Neptune, completed June 1st.

Perihelion point, ...	1° 45′ 32″·90
Ascending node, ...	129 51 13 ·53
Epoch, January 1, 1847, ...	326 2 1 ·34
Inclination, ...	1 45 38 ·10
Eccentricity, ...	0·005052917
Mean distance, ...	30·17775
Mean daily sidereal motion, . . .	21″·41144
Period in tropical years, ...	165y·7175

Elements VII. are derived entirely from the planet's recent path for nine months. The test of their correctness is, that they should represent within reasonable limits the two observations of Lalande of May 8th and May 10th, 1795. The great pains bestowed on the reduction of these observations of Lalande, by M. Victor Mauvais of the Institute of France, induce me to adopt his places of Neptune for those dates as published in the *Comptes Rendus* for 1847, No. 16. I have referred them to the mean equinox of January 1, 1847. I have corrected them for parallax, but not for aberration, and have compared them with my ephemeris from Elements VII. The result is as follows:

Comparison with Lalande's Observations.

Date, 1795. Mean time, Paris.	Lalande's two observations of Neptune. R. A.	Dec.	Correction of Ephemeris VII. R. A.	Dec.
h. m. s.				
May 8th—11 10 57 .	213° 41′ 3″·89	South 11° 35′ 4″·96	+141″·1	+39″·5
May 10th—11 2 55 .	213 38 5 ·16	South 11 34 5 ·64	+147 ·8	+36 ·4
Observed motion in two days,	178″·73	59″·32		
Computed do. Elements VII,	185 ·42	62 ·38		
Discrepancy, . .	6″·69	3″·06		

The small difference of three minutes of arc between theory and observation for 1795, may be ascribed to the perturbations for that date, and for the fifty-two years' interval, which have been neglected.

The tropical period falls short by nearly a year of that which Professor Peirce has pointed out as necessary, in order that the Laplacian Libration should take effect. It is quite possible that a more full discussion of the perturbations may show the necessity of the Libration.

The eccentricity of Venus is 0·007, the smallest before known; that of Neptune is 0·005.

Hence it appears that the orbit of Neptune approaches nearer to a perfect circle than that of any other planet. I regard this value of the eccentricity of Neptune as conclusively established, and with this view will quote from LeVerrier's communication made to the Institute of France on the 29th of March last on the occasion of announcing my discovery. M. LeVerrier remarks:

"We confine ourselves for the present to the remark that this smallness of the eccentricity, which would result from the calculations of M. Walker, would be incompatible with the nature of the perturbations of the planet of Herschel. But it may be that this smallness of eccentricity is not a necessary consequence of the representation of Lalande's observation."

While I feel myself honored by the notice taken of my labors by the French astronomers, I think it just to express my full belief that when they have bestowed on its present orbit the same pains as myself, they will agree with me that this smallness of eccentricity is an unavoidable consequence of the direct observations.

If we admit for the moment that my views are correct, then LeVerrier's announcement of March 29th is in perfect accordance with that of Professor Peirce of the 16th of the same month, viz. that the present visible planet Neptune is not the mathematical planet to which theory had directed the telescope. None of its elements conform to the theoretical limits. Nor does it perform the functions on which alone its existence was predicted, viz. those of removing that opprobrium of astronomers, the unexplained perturbations of Uranus.

We have it on the authority of Professor Peirce that if we ascribe to Neptune a mass of three-fourths of the amount predicted by LeVerrier, it will have the best possible effect in reducing the residual perturbations of Uranus below their former value; but will nevertheless leave them on the average two-thirds as great as before.

It is indeed remarkable that the two distinguished European astronomers, LeVerrier and Adams, should, by a wrong hypothesis, have been led to a right conclusion respecting the actual position of a planet in the heavens. It required for their success a compensation of errors. The unforeseen error of sixty years in their assumed period was compensated by the other unforeseen error of their assumed office of the planet. If both of them had committed only one theoretical error, (not then, but now believed to be such,) they would, according to Prof. Peirce's computations, have agreed in pointing the telescope in the wrong direction, and Neptune might have been unknown for years to come. Yours, respectfully, SEARS C. WALKER.

Washington, June 1, 1847.

V. MISCELLANEOUS INTELLIGENCE.

1. *Facts in Physiological Chemistry;* by J. LIEBIG, (from a letter addressed by Baron von Liebig, to President Everett, of Harvard University.)—I ought several months since to have replied to your letter communicating the interesting intelligence in relation to the action of the vapor of ether. The result of your letter to me, you have doubtless seen in the European papers. The world is filled with the magnitude of this discovery, and we are looking for the most important applications of it in surgical practice. It is a benefaction to suffering humanity, when painful operations, through a medium so simple and safe, can be performed with diminished pain; and the world is most deeply indebted to the man who first employed ether for this purpose.

I have long intended to write in acknowledgment of your friendly letter; but I desired by way of return to incorporate in reply the results of an investigation, which has been brought to a conclusion only within the last few days. It is a chemical investigation of muscle-flesh; in which I have been led to some interesting results.

The fluid in the meat of recently slaughtered animals—the *flesh-fluid* —is *sour* and contains two free acids, whose nature up to this time has been but imperfectly known. I have found that one of the acids is an *organic acid*, and is the same that appears in the process of the souring of milk. The other acid is phosphoric acid. Both acids are but partially free. A part is united to potash, magnesia and lime. They have been recognized in all muscle-flesh thus far examined, as well of carnivorous as of herbivorous animals.

A second ingredient, which I have found in all kinds of flesh, is a crystalline body, which was discovered in broth by Chevreul, eleven years ago, and described by him under the name *Creatine*. It was supposed, inasmuch as Berzelius could find nothing in the fluid expressed from flesh, that this was an accidental ingredient. But this opinion rested upon an error. Creatine is found in the flesh of all healthy animals.

The composition of the body is such that creatine may be regarded as a compound of the body, *Glycocoll*—so accurately studied by Mr. Horsford—and ammonia.*

---

* *Note from Prof. Horsford.*—One atom of creatine equals two atoms of glycocoll and one atom of ammonia.

$$C_8H_{11}N_3O_6=2(C_4H_4NO_3)+NH_3.$$

It contains also the elements of urea, glycocoll and wood-spirit.

$$C_8H_{11}N_3O_6=C_2H_4N_2O_2+C_4H_4NO_3+C_2H_3O.$$

Liebig, by boiling creatine a length of time with baryta, separated the urea (doubtless as carbonic acid and ammonia;—$C_2H_4N_2O_2+2HO=2CO_2+2NH_3$,) A third ingredient which is never wanting in fresh meat is a positive organic base of constitution analogous to that of *chinin*, or perhaps more nearly to that of *codein*, which is found in opium. There are also in meat two nitrogenous acids;—altogether, a variety of bodies whose existence in the living body could have been scarcely suspected. I have described these bodies and their chemical relations in a paper which is now in press, and will detail only a few results that may be practically applied.

The presence of two fluids throughout the body of opposite chemical nature, one acid, (the flesh-fluid,) the other alkaline, (the blood and lymph), separated from each other by membranes permeable to both, must satisfy any one that in this arrangement there is a source of electricity or of an electric current. I will not herewith say, that, by consequence, electrical effects must be recognizable in the body, for we know that these as such (electrical) disappear when through any result of motion, chemical action (decomposition or composition) is produced, and I regard the latter as dependent upon an electrical stream.

Moreover, the occurrence in flesh of creatine,—of a substance whose properties are allied to those of the active ingredient of coffee (caffeine), as also of another which has all the properties of an organic base, makes the action of medicines appear no longer so dark and mysterious. The most efficient of all medicines from the vegetable kingdom are organic bases.

If you leach finely chopped meat with cold water, you procure a red fluid and a white residue. The latter is the actual muscular fibre, and the solution contains, beside the above named bodies, a considerable quantity of albumen that may be separated as coagulum by heating the fluid to boiling.

I have found that the residue (the muscular fibre) either for itself or boiled with water is tasteless, and that the water in which the fibre has been boiled derives no taste. The fibre, by boiling, becomes hard and altogether unpalatable.

All the ingredients having odor or taste, may of course, be abstracted with cold water. They are contained in the flesh-fluid of slaughtered animals.

You will not wonder, my most Respected Sir, if I now turn to receipts for the kitchen.

It follows from the above, that one can make for himself, in a few minutes, the best and strongest broth (Fleisch-brühe, Bouillon de viande): if, e. g. a pound of finely chopped beef (mince) with a pound (pint) of *cold* water, be carefully mixed and then slowly heated to boiling, and the fluid separated from the solid parts by pressing through clean cloth. This broth, with the usual condiments—(broiled onions, vegetables, salt, etc.) added, will furnish a dish beyond the criticism of the most fastidious gourmand.

---

and there remained the organic base, mentioned in the paragraph which follows above. Its constitution, as given in a letter to Gay Lussac, and published in the Comptes Rendus for Feb. 6, is $C_6H_7NO_4$—and contains the elements of the Lactamide of Pelouze, a product of the action of dry ammonia gas upon lactic acid,—$C_6H_4O_4+NH_2$. It contains also the elements of Glycocoll and wood-spirit, as above intimated.

$$C_6H_7NO_4=C_4H_4NO_3+C_2H_3O.$$

Longer boiling will *not* necessarily make the extract stronger.

If the broth be slowly evaporated over a water bath, it will become brown, and assume a fine taste like broiled meat. If evaporated (by exceedingly gentle heat) to dryness, it yields a brown mass, of which, upon a journey, for example, half an ounce would convert a pound (pint) of water into the strongest broth.

By boiling a piece of meat in the water, a separation of the solution from the insoluble ingredients takes place. The soluble ingredients go into the extract—the broth—the soup. Among these beside those bodies mentioned above, are the alkaline phosphates. The thoroughly boiled meat contains no alkaline phosphates.

Now as these salts are necessary for the formation of the blood, it is clear that the fully boiled* meat, by the loss of them, loses its capacity to become either blood, or through blood to become flesh: *it loses its nutriment when eaten without the juices—the extract.*

In the extract the materials for the formation of albumen and fibrin, are both wanting. *Alone* also, it is not nourishing. Both must be eaten together. *The method of roasting is obviously the best to make flesh most nutritious.* But as the extract—the broth,—contains *all the ingredients of the acid gastric juice*, it may perhaps be the best agent to aid the process of digestion in cases of dyspepsia.

Finally, I have found that the brine which forms in the salting of meat, contains all the ingredients of the flesh-fluid. The composition of salted meat is essentially different from that of fresh meat—inasmuch as phosphoric acid, lactic acid, and the salts of these acids—together with creatine and creatinine are abstracted by being packed down in salt. The salted meat becomes partly reduced by this process to a mere supporter of respiration.† This may be a source of scrofula, where, by eating salt meat, the replacement of the wasted organism is but imperfectly effected—where it loses its constitution without regaining it from the food.

The temperature in the interior of a piece of meat to be boiled or roasted, rarely exceeds 100° C. (= 212° F.) The meat is done and palatable when it has been exposed to a temperature of 62° C. (144° F.), but it is in this condition, red like blood. The blood-red places—the undone portions,—were subjected at the highest to a temperature only of 60° C. (= 140° F.) At 70° to 72° C. (= 158° to 162° F.) all these places disappear. At 100° C. (= 212° F.) the fibre breaks up and becomes harder. The crusty property of the meat in chewing, depends upon the quantity of albumen, which, in a coagulated condition, permeates the fibre. The flesh of old animals is deficient in albumen.

If a piece of meat be put in *cold* water, and this heated to boiling, and boiled till it is "done," it will become harder and have less taste, than if the same piece had been thrown into water already boiling. In the first case the matters grateful to the smell and taste, go

---

* By this term it is intended to convey the idea of boiled till no further change occurs, or nothing more is extracted.

† Liebig divides food into two kinds. One serves in the formation of tissues; the other burns to sustain animal heat—as sugar and fat. The latter supports respiration.

into the extract—the soup; in the second, the albumen of the meat coagulates from the surface inward, and envelopes the interior with a layer which is impermeable to water. In the latter case the soup will be indifferent, but the meat delicious.

Giessen, 24th March, 1847.

2. *Inhalation of Ether*, (L'Institut, March 10, 1847.)—Experiments on the inhalation of ether by animals, have been extensively prosecuted in Paris, and have led to interesting results. M. Flourens observes from his investigations, that ether acts first upon the cerebrum, and disturbs the intellect; then upon the cerebellum affecting the equilibrium of movement; next upon the spinal cord, when it extinguishes successively sensibility and the power of motion, and finally upon the medulla oblongata, when it extinguishes life. In his late experiments, the action of ether has been pushed to the extinction of life.

M. Flourens, in order to compare the effects with those of asphyxia, subjected two dogs to the simplest kind of asphyxia produced by the gradual consumption of the oxygen contained in a given volume of atmospheric air. When the asphyxia had reached the required point, the spinal marrow, exposed, showed no signs of feeling when cut or lacerated, and only feeble muscular contractions on pinching the motor portion. M. Flourens hence infers that there is a marked analogy between etherization and asphyxia. But in ordinary asphyxia, the nervous system loses its forces under the action of the black blood, the blood deprived of oxygen; and in etherization this takes place, at first, under the quiet influence of the singular agent to which it is subjected.

3. *Gun-Cotton;* M. Schönbein's Patent, (Mechanics' Magazine; Mining Journal, April 10, 1847.)—The specification of this patent (taken out in the name of Mr. John Taylor, of the Adelphi) became due, and was enrolled on the 8th inst. The following is a correct abstract of its contents:—The patentee states, that the invention consists in the manufacture of explosive compounds applicable to mining purposes and to projectiles, and as substitutes for gunpowder, by treating and combining matters of vegetable origin with nitric and sulphuric acids.

The matter of vegetable origin which he prefers, as being best suited for the purposes of the invention, is cotton, as it comes into this country, freed from extraneous matters; and it is stated to be desirable to operate on the clean fibres of the cotton in a dry state.

The acids are—nitric acid of from 1·45 to 1·50 specific gravity, and sulphuric acid of 1·85 specific gravity.

The acids are mixed together in the proportion of one measure of nitric acid to three of sulphuric acid, in any suitable or convenient vessel not liable to be affected by the acids. A great degree of heat being generated by the mixture, it is left to cool until its temperature falls to 60° or 50° Fahr. The cotton is then immersed in it, and, so that it may become thoroughly impregnated or saturated with the acids, it is stirred with a rod of glass or other material not affected by the acids. The cotton should be introduced in as open a state as practicable. The acids are then poured or drawn off, and the cotton gently pressed by a presser of glazed earthen ware to press out the acids, after which it is covered up in the vessel, and allowed to stand for about an hour. It is subsequently washed in a continuous flow of water, until the presence of the acids is not indicated by the ordinary test of litmus paper. To remove any uncombined portions of the acids which may remain after the cleansing process, the patentee dips the cotton in a weak solution of carbonate of potash, composed of one ounce of carbonate of potash to one gallon of water, and partially dries by pressing, as before. The cotton is then highly explosive, and may be used in that state, but, to increase its explosive power, it is dipped in a weak solution of nitrate of potash; and, lastly, dried in a room heated by hot air or steam to about 160° Fah. It is considered probable that the use of the solutions of carbonate of potash and nitrate of potash may be dispensed with, although actual experience does not warrant such an omission.

The patentee remarks, that nitric acid may be employed alone in the manufacture of explosive compounds; but that, as far as his experience goes, the article, when so manufactured, is not so good and far more costly.

When used, care should be taken to employ a much less quantity by weight, to produce the same result, than of gunpowder; and it has been found that three parts by weight of the cotton produce the same effect as eight parts by weight of the Tower-proof gunpowder. The cotton, when prepared in the manner before mentioned, may be rammed into a piece of ordnance, a fowling-piece, or musket; or may be made up into the shape of cartridges; or may be pressed, when damp, into moulds of the form of the bore of the piece of ordnance for which it is intended—so that, when dried, it shall retain the required figure; and it may also be placed in caps, like percussion caps, and made to explode by impact. Lastly, the patentee states, that although he prefers the use of cotton, other matters of vegetable origin may be similarly treated with acids to form an explosive compound, and that acids of an inferior specific gravity may be employed.

The patentee having thus described the nature of the invention, and in what manner the same is to be performed, states, that he does not confine himself to any of the details above specified, so long as the peculiar character of the invention is retained—viz., the manufacture of explosive compounds from matters of vegetable origin by means of acids. But, to adopt the patentee's own expression—"What I claim, is the manufacture of explosive compounds from matters of vegetable origin by means of nitric acid, or nitric and sulphuric acids."

4. *Experiments on the use of Gun-Cotton for blasting—its value compared with that of blasting Powder;* by Thomas B. Adams.—The difficulties to be surmounted in ascertaining the relative values of the new and old explosives are neither few nor small. Different qualities of powder are used in different quarries. That which is made in the same mill will produce different effects according to its chemical proportions, and its coarse or fine graining; powder of the same grain will act differently upon different kinds of rock. The powder used for blasting is the coarsest and slowest burning variety.

Gun-cotton is uniform in strength, and fires quicker than the finest gunpowder.

The rock is variable in texture, and liable to be crossed by seams which, if they be slight, may destroy the correctness of the result without being discovered by the operator.

The difference in the action of the two agents, that of the powder being slow, that of the cotton sudden, the imperfections of the mass upon which they act, are causes which render useless many comparisons and weaken our confidence in inferences drawn from a small number of experiments. Great care was taken in the experiments described below, to compare fairly the two explosives.

The gun-cotton was prepared with the strongest acids of commerce; sulphuric, sp. gr. 1·85; nitric, sp. gr. 1·49; time of immersion about twenty minutes. After the superfluous acid was thoroughly removed or neutralized, the cotton was immersed in one of the oxygenating solutions described by Prof. Schönbein, and dyed a light straw color. In short, it was the article of commerce, prepared by Messrs. C. & F. Lennig of Philadelphia, who are patentees of gun-cotton for the United States. A sample accompanies this note.

In May last the writer entered the collieries at Pottsville, Pa., examined and measured the bores in which the blasts were to be discharged, obtained and weighed the quantity of powder intended for each blast; (and upon examination it was found that the miners almost universally underrated the weight of their charges of gunpowder from 33 to 100 per cent.) and carefully noted, on the spot, all the circumstances alluded to in the table below. In noting the *effect*, the opinion of the miners themselves is given. When the results were better than were expected from the proposed charge of powder, they were marked *superior.* When less, *moderate;* and when equal, *good.*

The following extract from the tables is believed to be a fair sample of the whole. In every instance the writer was present during the charging, and discharging of the blasts, and all were made at least 500 feet below the surface.

Extract from Table of Experiments.

No. of discharge.	Kind of explosive.	Rock.	Depth of bore.	Diameter of bore.	Material of cartridge powder.	Depth allowed for powder.	Depth occupied by cotton.	Weight of powder.	Weight of cotton.	Effect.	Smoke.	Vitiation.
			Inch.	Inch.		Inch.	Inch.	Oz.	Oz.			
3	C.	tough slate with iron ore,	18	1½	paper	. .	6	9¾	1	good	none	none.
4	C.	"	16	1¾	"	. .	6	9¾	1	good	none	none.
5	powd.	"	18	1¾	. .	. .	. .	6	.	mod.	dense	considerable.
7	"	"	15½	1¾	. .	5	. .	.	.	mod.	dense	considerable.
8	C.	"	17	1¾	. .	8	6	10	1½	sup.	none	none.
9	C.	red ash coal,	45	1½	. .	19	16	18¼	2¼	sup.	"	"
10	C.	"	27	1½	paper	12	10	9¼	1¼	"	"	"
12	C.	white ash coal,	36	1½	"	10	6	10	1	good	"	"
13	C.	"	36	1¾	"	14	6	13½	1¼	mod.	"	"

June 7, 1847.

5. *Pyroxyline*, (Comptes Rendus, March 8, 1847.)—MM. Flores Domonte and Menard, on submitting gun-cotton to alcoholized ether, obtained an incomplete solution; and on analysis the part dissolved gave the formula $C_{12}H_8O_8+2NO_5$, (that of Xyloidine according to these authors,) and the insoluble, the formula $C_{12}H_9O_9+3NO_5$. The

two added together, make $C_{24}H_{17}O_{17}+5NO_5$, Pelouze's formula for pyroxyline.* With cane sugar, glucose, mannite, sugar of milk, dextrine, and gum, analogous fulminating compounds have been formed by these chemists. They have succeeded in crystallizing the nitric mannite, and obtained for it the formula $C_{12}O_7H_7+5NO_5$.

6. *Process for Photographs upon paper;* by M. Blanquart-Evrard, (Comptes Rendus, Jan., 1847.)—This process is in part a modification of the Calotype, and is, according to its author, susceptible of many variations. The principles upon which it depends, are, 1st, the thorough impregnation of the paper by the photographic agent, so that the image is formed within the paper; and 2d, the perfection of surface given to a moist paper by placing it upon a glass, which, in the camera, is turned toward the lens, the image being formed on the wet surface of paper in contact with the glass.

As this process seems to be more simple than any other, and within the reach of persons of moderate skill, we give it somewhat in detail. For the first or negative proof, the very best letter paper is to be taken; its texture should be close and uniform; the surface very smooth. This paper is to be floated on the surface of a solution of one part nitrate of silver in thirty parts distilled water, observing the usual precautions of not including air bubbles, &c. After one minute the paper is removed, held up to drain by a corner, and then laid upon some impermeable surface and allowed to dry slowly.

Another solution is prepared of 25 parts iodid of potassium, 1 part bromid of potassium, and 560 parts distilled water. In this solution the paper is entirely immersed, with the silver side up, and suffered to remain from one and a half to two minutes, according to the temperature; it is then carefully withdrawn, holding it by two corners, and placed in a large vessel full of pure water; it is next hung up to dry upon a string, being fastened by one corner.

Paper thus prepared should be protected from the light and preserved in a pasteboard case, but not packed too closely. It will keep for months. The solutions kept in vessels covered by opaque paper may be used to exhaustion.

To take a proof, a smooth glass is made quite level upon a suitable support, and upon it are poured a few drops of a solution of 6 parts nitrate of silver, 11 parts crystallizable acetic acid, and 64 parts distilled water; (half of the water should be taken to dissolve the nitrate, and the remainder added about an hour after the acid has been mixed with the first portion.)

The paper is next to be applied to this liquid on the glass, the nitrated side downwards, and smoothed by the hand until there is a perfect contact with the glass without any folds or bubbles. One or more pieces of moist paper, according to the thickness, are then to be placed upon this; next a second glass of the same size, and the whole being properly secured, is used in the camera as a daguerreotype plate. The time of exposure varies according to the temperature, and is about one-fourth that required for plates prepared with chlorid of iodine.

---

* In Vol. iii, p. 295, there is an error arising from including with the formula of pyroxyline, the 8HO, which is separated in the process of formation.

When taken from the camera the proof is to be placed upon a plate of glass or porcelain, which has been slightly moistened in order that the paper may adhere to it. A saturated solution of gallic acid being poured over the proof, the image appears at once. The acid is allowed to act until all the details are brought out, but not until the white portions are discolored; to prevent this, the acid is removed by pouring a large quantity of pure water over the proof, which is finally entirely covered by a solution of 1 part bromid of potassium in 40 pts. distilled water. The paper remains in this last solution for a quarter of an hour, and is then well washed with clean water and dried between sheets of filtering paper. To render this negative impression more transparent, for the purpose of copying, a little wax may be scraped upon it and melted by a hot smoothing iron, some sheets of letter paper being placed between.

The paper for the positive proof should be very stout and as smooth as possible. Prepare a solution of 3 parts water saturated with common salt and 10 pts. distilled water; upon this float the paper for two or three minutes, and then dry it as much as possible by absorbent paper; and next float it upon a solution of 1 part nit. silver and 5 pts. water, until another sheet having undergone the previous process is ready to take its place; it is then to be removed, drained, and dried as before directed. In this way a quantity may be prepared in a short time. The positive paper is to be preserved in the way directed for the other, but must not be kept more than one or two weeks, or it will lose its delicacy and become discolored.

The positive proof is made by the usual process, the expose being as far as possible to the direct sunlight; about twenty minutes being the average time.

To fix this proof, it is to be taken into a darkened apartment, soaked for fifteen minutes in pure water, and then put into a solution of 1 part hyposulphate of soda and 8 pts. distilled water. It may now be examined by daylight, and the action of the hyposulphate watched. Gradually the lights become more brilliant, and the shades pass from a dirty red to a bistre and finally come to resemble those of an aquatint. When the desired tint is reached, the operation is stopped and the salt removed by soaking in water for five or six hours to a whole day. Several proofs can be immersed at the same time in the hyposulphate, and those which do not stand its action for two hours must be rejected. The operations although in appearance complicated, are in reality quite simple and of easy execution. G. C. S.

7. *Report on the Aurora Borealis.—Aurores Boréales*, 1 vol., 8vo. Accompagné d'un Atlas de 12 planches in folio; par MM. LOTTIN, BRAVAIS, LILLIEHÖÖK, et SILJESTRÖM.*

The following notice of this great work is from M. Bravais. He remarks:—

I have divided my general review of the subject into eight paragraphs. In the first, I examine the much controverted question, as to the nature

---

* This is one of a series of twenty-six volumes of large 8vo, and seven folio atlases, published as the results of "Voyages de la Commission Scientifique du Nord, en Scandinavie, en Laponie, au Spitzburg et aux Feröe, pendant les années

of the dark segments lying generally below the auroral arches, or at their base. This segment, according to some, is merely an effect of contrast; according to others it is something material, (or real,) but independent of the aurora, caused perhaps by the polar fogs; and others consider it the generating source of the auroral light. I next show, that the light cannot be an effect of reflection, except in rare cases, and actually exists where it is observed.

In the second paragraph I consider the forms and portions of arches, their movements, light, and apparent structure. According to Hansteen, an auroral arch is a luminous ring situated in the upper regions of the atmosphere, sustained in all its parts at the same height, above the earth's surface, and whose axis corresponds nearly with the magnetic axis of the globe. Such a ring ought to appear more or less elevated above the horizon according to the position of the observer, and it ought to be seen to cut the plane of the magnetic meridian at right angles. The hypothesis of Hansteen, which is altogether the most probable, has been made the basis of our investigations with regard to the orientation, the height, and the amplitude of the arches. I understand by amplitude, the angular distance between the east and west sides measured on the plane of the horizon and on the north sides of the sky. At Bossekop, the summit of the arc is not only eight to ten degrees to the left of the *magnetic north*, but the deviation goes on increasing as the arch rises from the north toward the zenith and from the zenith to the south. The amplitude increases quite regularly during this movement of the arc. It does not become one hundred and eighty degrees until the arch has passed the zenith to the southern part of the sky.

It also results from our observations, that the curve of the arch is very similar to that of a small circle of the celestial sphere. This small circle projected upon the vertical plane which contains the culminant point of the arch is a straight line; and I show that on approaching the horizon, this right line becomes a hyperbolic curve though scarcely appreciable, and important only in a theoretical point of view, from its connection with the theory assumed.

From the simultaneous variation of the heights and amplitudes, (adopting the theory of Hansteen,) I have found the mean elevation above the earth to be 227 kilometers, (140 miles Eng. statute,) which corresponds to the upper limits of our atmosphere, or the region of falling stars, &c.

The third paragraph is devoted to the rays of the aurora borealis.

The rays (streamers) are columns of light suspended in the air; they undergo rapid movement or changes, and appear to converge towards the magnetic zenith, where they thus form what is called the corona.

1838, 1839 et 1840, sur la corvette La Recherche commandée par M. Fabvre, Lieut. de Vaisseau; publiés par ordre du Roi sous la direction de M. Paul Gaimard, President de la Commission Scientifique du Nord." They include Reports on Astronomy, Pendulum Observations, Hydrography, Tides, 1 vol.; Meteorology, 3 vols.; Terrestrial Magnetism, 2 vols.; Aurora Borealis, 1 vol.; Geology, Mineralogy, Metallurgy, and Chemistry, 2 vols.; Botany, Physical Geography, Physiology, and Medicine, 2 vols.; Zoology, 3 vols.; History of Scandinavia and its Literature, and History of the Voyage, 4 vols.

With reference to the relation between the column and the arches, I have shown, in discussing our observations on partial corona, that even when the rays appear isolated and independent, they have a general arrangement in files or ranges, parallel to the direction of the arches. I have also shown a tendency in the arches to dissolve into columns; whence it is obvious that the simple ray is the result of an arrangement of the auroral light in lines parallel to the dipping needle. The arched form results from this, that if two rays exist simultaneously, they tend to place themselves so that their common place shall be perpendicular to the magnetic meridian, as if the equilibrium of two rays were not stable except in this position. But how this condition of stability is consistent with the idea that the rays have an electric nature and origin, is yet enveloped in mystery.

The luminous currents, exhibited in the ranges of columns, passing either from the east to the west or the reverse, are not equally frequent in the different directions; the same remark applies to the modes of progression in the arches from the north to the south and from the south to the north. I state the facts on this subject without pretending to offer any explanation.

We have observed the extra-zenith corona so frequently, as to be able to affirm that the coronas may appear in all possible directions in relation to the observer, and that their connection with the magnetic zenith is a simple result of linear perspective.

In the fourth paragraph I have treated of the auroral sheets. They are allied to the rays, but differ in their flickering or palpitating light and also in appearing only at a later hour of the night.

The fifth paragraph relates to the colors of the auroral light, which are less varied than generally supposed; for but three or four distinct shades were observed by us.

In the sixth paragraph I consider the facts which may lead the observer to suppose that the aurora is situated but a small distance from him. Although believing that their appearances are mostly deceptive, I do not affirm that all observations of this kind hitherto made are necessarily incorrect. I next treat of a resemblance, between the mean orientation of cirro-cumuli clouds in parallel bands optically convergent, and auroral arches.

In order to determine the altitude of auroral arches, M. Lottin and myself observed simultaneously, at opposite extremities of a base of 16 kilometers (10 miles); and we arrived at the result that the height at least exceeded 50 kilometers (31 miles). A longer base is necessary for a more precise determination. For such investigations, the base line should be about 100 kilometers long (60 miles), and in the direction of a terrestrial magnetic meridian.

The last paragraph contains general remarks on the frequency of the phenomena, its duration, hour of appearance, its possible continuance during a succession of days. I show that the progressive movements of the arches are wholly independent of the motion of the earth, which sets aside any theory founded on the idea of the cosmical origin of the Aurora, and sustains the view that it belongs to our atmosphere and almost exclusively to its upper regions.

8. *Hieroglyphical Mica Plates from the Mounds;* by E. Geo. Squier, (in a letter to Prof. Silliman.)—You have probably observed a paragraph, going the rounds of the newspapers, credited to a journal published at Lower Sandusky in this state, to the effect that a number of inscribed plates of mica were recently discovered, in excavating an ancient mound near that place. These plates are represented, in the account, as oval in shape, measuring seven by ten inches, and "covered with *hieroglyphics* of different and beautiful colors, betokening a more advanced and entirely different state of the arts than has heretofore been discovered in the remains of the Indian tribes!" As this announcement has created some degree of interest, and elicited some inquiries, it will not be out of place to observe, that one of the plates has been placed in our hands, through the kindness of a friend, residing at the point mentioned. The form of the plates and their size are correctly represented, but the hieroglyphics are nothing more nor less than *discolorations* caused either by the infiltration of a mineral solution between the laminæ, or by its presence at the period of crystallization. The material is very well known as *graphic* or *hieroglyphic mica*, a deposit of which occurs upon the Schuylkill, not far above Philadelphia. Although the discoloration, following the planes of crystallization, falls, in places, into right lines, it seems utterly unaccountable that they were mistaken for the work of man! This is another illustration of the very loose manner in which facts relating to our antiquities have been placed before the world :—a looseness, unfortunately, not entirely peculiar to newspaper statements. The plates are very pretty specimens of the mineral, and are each perforated, near one of the ends, with a small hole. They were undoubtedly used for purposes of ornament. Mica is common in the mounds, sometimes cut into the form of scrolls and other ornamental plates. I have taken a bushel of the sheets from a single mound.

9. *Water-Power of Europe*, (Mining Journal, April 10, 1847.)—A curious communication has been addressed to the Paris Academy of Sciences, from M. Daubrée, containing a calculation of the quantity of heat annually applied to the evaporation of the water on the surface of the globe, and of the dynamic force of the streams of continents. He finds that the evaporation employs a quantity of heat about equal to one-third of what is received from the sun; or, in other words, equal to melting a bed of ice of nearly thirty-five feet in thickness, if spread over the globe. The motive force of the streams in Europe is, according to M. Daubrée, equal to between 273,508,970 and 364,678,620 horses, working incessantly during the whole period of the year.

10. *Auroral Belt of April* 7, 1847.—Observations made at Hartford, Conn., by P. W. Ellsworth, M.D., combined with those made at New Haven, show that the auroral bow or arch of April 7, 1847, was elevated not less than 100 miles, nor more than 120, above the earth's surface. The observations will be published in the next number.

A similar auroral bow or arch was seen at various places in England, on the 19th March, 1847. According to the mean of various observations, its elevation was about 177 miles. A brilliant display of the Aurora Borealis was seen at New Haven, on that evening, but no such arch was visible here up to $11^{h.}\,30^{m.}$ P. M. E. C. H.

11. *Volcanic Eruption at the Cape Verds.*—There was a volcanic eruption about the 1st of April, on the island of Fogo, (of the Cape Verd group,) which continued ten or fifteen days, throwing out showers of earth and stones to a great height, and emitting huge streams of lava, which, running down the mountain, destroyed many houses and plantations, and caused some loss of life. All vegetation and many goats and cattle were destroyed by the heat of the earth, the showers of stones and the lava. The shock was distinctly felt on the neighboring islands, and caused much alarm at Port Praya, where the vibrations were very violent and almost unceasing for seven or eight days. The crater of Fogo is 12,000 feet above the sea, and eruptions occur once in twenty or thirty years.—*Salem Reg.*

12. *Science and the Arts at Harvard.*—The Hon. ABBOTT LAWRENCE of Boston, has presented to the Corporation of Harvard University, the sum of fifty thousand dollars, to be expended in establishing a school for the purpose of teaching the practical sciences, embracing Engineering, Mining in its extended sense, including Metallurgy, and the invention and manufacture of Machinery. One department is already occupied by the Rumford Professor in that institution, Prof. E. N. Horsford.

13. *Association of American Geologists and Naturalists.*—The eighth annual meeting of the Association of American Geologists and Naturalists, will be held in Boston, commencing on the third Monday (20th) of September, 1847, at 10, A. M., continuing for one week thereafter.

Officers of the Association elected at the last meeting:

Chairman, Dr. AMOS BINNEY.*
Treasurer, Prof. B. SILLIMAN, Jr.
Secretary, Dr. J. WYMAN.

Standing Committee.—The President, Treasurer, and Secretary, *ex officio.* Dr. J. E. HOLBROOK. Prof. H. D. ROGERS. Prof. B. SILLIMAN. Pres. E. HITCHCOCK. WILLIAM C. REDFIELD, Esq. LARDNER VANUXEM, Esq. L. C. BECK. JOHN L. HAYES.

Local Committee.

Hon. NATHAN APPLETON.	Dr. A. A. GOULD.
Hon. ABBOTT LAWRENCE.	Dr. D. H. STORER.
JOHN A. LOWELL, Esq.	Dr. S. CABOT, Jr.
Dr. JOHN C. WARREN.	Dr. C. T. JACKSON.
Prof. A. GRAY.	FRANCIS ALGER, Esq.

VI. BIBLIOGRAPHY.

1. *Elementary Geology;* by EDWARD HITCHCOCK, D.D., LL.D., President of Amherst College; eighth edition, revised, enlarged and adapted to the present advanced state of the science, with an introductory notice by John Pye Smith, D.D., F.R.S., and F.G.S., &c. New York, 1847.—This work has long sustained its well deserved reputation.

* Since deceased.

It is in some respects peculiar; its structure is highly methodical; the subjects are presented in distinct propositions, with definitions, principles, proofs, remarks, inferences, descriptions, illustrations, causes, &c., all drawn out under distinct heads, and distinguished by larger and smaller type. If this construction presents a page more broken up than is agreeable to the eye, and less readable as a straight forward treatise, it presents important advantages, as a book for classical study and recitation. The pupil will know what to study and how to study, and the instructor what to enquire for. The unsolicited expressions of approbation from many geologists and reviews which are prefixed to the work, especially the beautiful notice of the distinguished Dr. John Pye Smith, of London, himself the author of an important work on the relation of geology to the Mosaic cosmogony, are to be regarded as decisive proofs of the approbation of those who are the best qualified to judge. The work bears throughout, the impress of a working, thinking man, of strong powers of observation and reasoning; of one whose impressions are obtained from nature quite as much as from books; whose facts are correct, whose views are sound and tenable, and who is therefore a safe guide.

2. *Dr. Mantell's Geology of the Isle of Wight.*—At the moment of closing the present number, we have received a copy of this new and beautiful work of Dr. Mantell, of which a fuller notice will be given hereafter.

3. *Medical Botany, or descriptions of the more important Plants used in Medicine, with their history, properties, and mode of administration;* by R. Eglesfeld Griffith, M.D. Philadelphia: Lea and Blanchard. 1847; pp. 704, 8vo. Illustrated by 338 wood-cuts.—The author of this volume is well known to be particularly qualified for this undertaking, by his botanical, as well as medical and pharmaceutical knowledge; and it strikes us, on a cursory examination, that it has been prepared with much care and faithfulness, and that it will take its place at once as the standard work on the subject in this country. A succinct introductory chapter is devoted to the anatomy and structure of plants, their chemical composition and products, and the outlines of classification. The officinal plants are introduced under their several natural orders, which, with the general systematic arrangement of De Candolle, are thrown into groups after the manner of Lindley. The class of *Sporogens* is retained, as is still done by the last named author, although it has been abundantly shown that its assumed character is without foundation in nature. The plants which are really important in the materia medica are described in full, as well as the officinal part or production; the others are more briefly noticed; and the references which are faithfully made, both to the botanical and medical authorities, will serve in all cases to direct the inquirer to the original sources of information. A. Gr.

4. *Principles of Geology—or, the Modern Changes of the Earth and its Inhabitants, considered as illustrative of Geology;* by Charles Lyell. Seventh edition, entirely revised, with plates, maps and wood-cuts. London: John Murray. 1847.—This work, heretofore published in three and four duodecimo volumes, now appears in one thick 8vo of 810 pages, agreeably to a modern usage in scientific works of frequent reference.

It is unnecessary to say any thing of the excellence of a work, whose reputation has been long established and which no one can read without both pleasure and instruction. One of the most striking peculiarities in this edition is seen in the more frequent reference to American facts with which the author's two visits to this country and extensive travels in it have made him acquainted.

5. *A Dictionary of Modern Gardening*; by Geo. Wm. Johnson. London. Edited by Wm. Landreth of Philadelphia. Lea & Blanchard. 1847. 1 vol. 12mo. pp. 635.—This is a useful compendium of all that description of information which is valuable to the modern gardener. It quotes largely from the best standard authors, journals, and transactions of societies; and the labors of the American editor have fitted it for the United States, by judicious additions and omissions. The volume is abundantly illustrated with figures in the text. The articles, 'apple,' 'pear,' 'cherry,' 'plum,' 'peach,' embrace a brief and judicious selection of those varieties of fruits which experience has shown to be well suited to the United States.

6. *A Manual of Road Making, comprising the location, construction, and improvement of Roads (common, Macadam, paved, plank, etc.) and Railroads*; by Wm. Gillespie, A.M., C.E., Professor of Civil Engineering in Union College. New York: A. S. Barnes & Co. 1 vol. 12mo. pp. 336. 1847.—If the well established principles of road building, which are so plainly set forth in Prof. Gillespie's valuable work, and so well illustrated, could be once put into general use in this country, every traveller would bear testimony to the fact, that the author is a public benefactor.

7. *Transactions of the American Philosophical Society, Philadelphia*, Vol. ix, New Series, part iii.—p. 275. Description of New Fresh Water and Land Shells, with figures; by *I. Lea.*—p. 283. Observations made in the years 1838–1843, to determine the magnetic dip and intensity in the United States; by *John Locke*, M.D., Prof. Chem. and Pharm. in the Med. College of Ohio.—p. 329. Observations of the magnetic dip made at several positions, chiefly on the southwestern and northeastern frontiers of the United States, and the magnetic declination at two positions on the river Sabine, in 1840; by Maj. *J. D. Graham*, U. S. Corps of Topographical Engineers.

The following officers of this Society were elected on January last.

President—Nathaniel Chapman, M.D.

Vice-Presidents—R. M. Patterson, M.D., Franklin Bache, M.D., A. Dallas Bache, LL.D.

Secretaries—Hon. J. K. Kane, Robley Dunglison, M.D., A. L. Elwyn, M.D., J. F. Frazer.

Counsellors for Three Years—Robert Hare, M.D., Wm. Hembel, C. D. Meigs, M.D., Henry Vethake.

Curators—E. Peale, J. P. Wetherill, John C. Cresson.

Treasurer—George Ord.

Proceedings of the American Philosophical Society.—Vol. iv, No. 36, *July—December*, 1846.—p. 279, Letter from Dr. *Franklin* to Dr. Kimmersly, on "the effect of lightning on Mr. Holder's House."—p. 285, Observation by *Prof. Henry* on the interference of rays of heat, including his result that two rays may be thrown on each other so as to produce a reduction of temperature.—p. 287, Remarks on the Corpuscular theory; *Prof. Henry.*

No. 37. Jan., Feb. and March, 1847.—p. 299, List of officers for the year.—p. 305, On the Corpus luteum; *Dr. Meigs.*—p. 311, A missing star in Lalande's Chart, shown probably to be LeVerrier's planet, and determining the position of this planet in 1795; *S. C. Walker.*

Proceedings of the Academy of Natural Sciences of Philadelphia.—Vol. iii, No. 7, *Jan. and Feb.*, 1847.—p. 143, Observation on fossil trees in the Nova Scotia coal mines, by *R. Brown*, Esq.; in which he remarks of one tree, "it has exposed two long roots, one branching to the north and the other to the south, about seven feet each way. They are very broad and flat, and are genuine *Stigmaria*. I could not trace any rootlets, but the areolæ are not to be mistaken. I have preserved some large pieces, as also some of the bark of the tree, which is apparently an irregularly fluted *Sigillaria*."—p. 149, Description of new Insects; *S. S. Haldeman:* Blethsia quadricollis, Chorea (n. gen.) pulsator, Eburia distincta, Enapholodes simplicicollis, Stenura? cyanea, Ploiaria maculata.—On the Cranium of the Zeuglodon from the Upper Eocene of South Carolina; *M. Tuomey.* "Length 14½ inches; greatest breadth 7½ in.; height 5½. It was evidently a young individual. The double occipital condyle shows it to have been a mammal, while the squamous sutures and a symmetrical form refer it to the Cetacea."—p. 154, Remarks on the birds observed in Upper California; *Wm. Gambel:* includes the new genus Chamæa, instituted for Parus fasciatus, (Proc. Acad. Nat. Sci., ii, 265,) and various valuable observations on known species.—New Coleoptera of the United States; *F. E. Melsheimer:* includes species of the genera Donacia, Orsodaena, Microrhopala, Galeruca, Calomicrus, Œdionychis, Pachyonychus, Disonycha, Graptodera, Systena, Crepidodera, Psylliodes, Aphthona, Thyamis, Dibolia, Chætocnema, Sphæroderma, Metachroma, Eumolpus, Cryptocephalus, Monachus, Gastrophysa, Phædon, Tritoma, Triplax, Lycoperdina, Coccinella, Brachiacantha, Hyperaspis, Exochomus, Chilocorus, Scymnus. This closes the descriptions of Dr. Melsheimer, which were begun in Vol. ii, No. 2, (April, 1844,) of the Proceedings.

No. 8, March and April.—p. 185, On living hybrids in Pennsylvania between the Guinea fowl and the Turkey; *A. Sharpless* and *W. Kite.*—p. 190, Larva of the Cicada septendecim; *Miss Morris.*—p. 191, Composition of the dust of anthracite furnace flues; *Prof. Johnson.*—p. 199, Cyminidis Wilsonii, a new rapacious bird from Cuba; *J. Cassin.*—p. 200, Remarks on the birds observed in Upper California; *Wm. Gambel.*

Proceedings of the Boston Society of Natural History, February, 1847.—p. 193, Blind Crawfish of the Mammoth Cave, (Astacus pellucidus;) *W. F. Channing.*—Prof. Agassiz mentioned the fact ascertained by Erichson, that the Crawfishes of America have all one pair of gills less than those of the old world.—p. 195, Microscopic examination of Gun-cotton; *Dr. Bacon.*—p. 196 and 200, Description of New Shells of the Exploring Expedition, (three species of Partula, two of Pupa, one of Balea, five of Achatinella, seven of Helicina, nine of Cyclostoma, and four of Truncatella; *A. A. Gould* —p. 198, A new species of Manatus, from Cape Palmas, (M. nasutus;) *G. A. Perkins.*

Ann. and Mag. Nat. Hist., Vol. xix, No. 126, April, 1847.—On Genus of Insects, Trachyphlœus; *J. Walton.*—A new species of Dawsonia; *R. K. Greville.*—On some Chalcidites and Cynipites in the collection of Rev. F. W. Hope; *F. Walker.*—Birds of Calcutta; *C. J. Sundevall.*—Development of the Lycopodiaceæ; *K. Müller.*—On the Siliceous Bodies of the Chalk and other formations; *J. S. Bowerbank.*—A new species of Penella.—Development of Echinidæ; *M. Dufossé.*—Zoological Society.—*L. Pfeiffer* on new land shells; *L. Reeve* on new species of Chama; *J. H. Jonas* on two new shells.—Bot. Soc. of Edinb.—*Rev. Dr. Fleming* on the defoliation of trees; *Dr. Balfour* on Carex saxatilis and C. Grahami.

Annales des Sciences Naturelles.—*September.*—Forms of the Crania of the inhabitants of the North; *Retzius, Creplin.*—On the Nemertidæ; *de Quatrefages.*—On the Arceuthobium Oxycedri; *A. R. de Fonvert.*—On grafting of Gramineæ; *J. Calderini.*—Conspectus of the genus Biebersteinia; *Joubert* and *Spach.*—On varieties, subspecies and species; *Chevreul.*

October.—On the Nemertidæ; *de Quatrefages.*—On species, &c.; *Chevreul.*—Development of leaves; *C. E. de Mercklin.*—On the genus Godoya and its analogues; *E. Planchon.*

November.—On the Nemertidæ; *de Quatrefages.*—Pulmograde Medusæ of the British Seas; *E. Forbes.*—Genera and species of Echinodermata; *Agassiz* and *Desor.*—Genus Godoya and its analogues; *E. Planchon.*—On the Development of the embryo and anomalous corolla in the Ranunculaceæ and Violariæ; *F. M. Barneoul:* ibid, *A. Brongniart.*—On the origin of roots; *A. Trécul.*

December.—Agassiz's Echinodermata continued.—Metamorphosis of the Scathopses nigra; *Dufour.*—Origin of roots; *A. Trécul.*—Analecta Boliviana; *J. Remy.*—Note on the Zamia muricata; *de Vriese.*—Flora of Colombia; *L. R. Tulasne.* —On the duration of the faculty of germinating in grains of different families.

January, 1847.—Metamorphosis of the Subula citripes and Cassida maculata; *Dufour.*—On the petrifaction of shells in the Mediterranean; *M. de Serres* and *L. Figuier.*—Development of the Echini; *Dufossé.*—Lobiger and Lophocercus, new genera of Gasteropoda; *Krohn.*—On the circulation of the blood in the Coleoptera; *Nicolet.*—Development of the ovule in the Avicennia; *W. Griffith.*—On the Ustilagineæ, compared with the Uredineæ; *L. R. and C. Tulasne.*

Comptes Rendus Acad. Sci. Paris.—*Dec.* 28, 1846.—On the Trilobites of the schist of Brittany; *M. Rouault.*—On the elasticity and cohesion of the principal tissues of the human body; *G. Wertheim.*—*Jan.* 4, 1847.—On pyroxyline; *Pelouze.* —Microscopic anatomical researches on the shell of Decapod Crustacea; *J. Lavalle.*—*Jan.* 11.—On the relation between charges of powder and the initial force they communicate to balls, &c.; *Morin.*—Provisional elements of Leverrier's planet; *Valz.*—*Jan.* 18.—Essay on tidal currents and liquid waves; *Keller.*—*Jan.* 25. —On pyroxyline, hypoazotic cotton and xyloidine; *Payen.*—Compounds with Mannite, &c. analogous to pyroxyline; *Flores Domonte* and *Menard.*—Effects of ether in respiration; *Roux, Velpeau, Langier, Gerdy.*—On the borates; *A. Laurent.*—*Feb.* 1.—Effects of ether; *Velpeau, Magendie, Milne Edwards, Roux, Lallemand.*—New system of aerial locomotion; *van Hencke.*—*Feb.* 8.—Effects of ether on animals; *Gruby.*—New series of acids of sulphur; *Plessy.*—Inhalation of ether; *Bouvier, Hutin, Tavernier.*—*Feb.* 15.—Memoir on a new mode of treating nitrates, and especially saltpetre; *Pelouze.*—Action of chlorated alkalies on polarized light and on the animal economy; *A. Laurent.*—Effects of ether; *Serres, Magendie, Velpeau, Roux, Flourens.*—M. Civiale elected a member in place of M. Bory de Saint Vincent, deceased.—On detonating products from nitric acid and sugar, dextrine, &c.; *A. Sobrero.*—*Feb.* 22.—Effects of inhalation of ether on the medulla oblongata; *Flourens, Magendie.*—Connection between the difference in constitution of sulphuric and nitric ethers, and their different effects on the animal economy; *Balard.*—Equilibrium of bodies; *de Saint-Venant.*—Influence of alkalies in different natural phenomena, and especially of ammonia in nutrition; *F. Kuhlmann.*—Inhalation of ether; *Laugier, Gerdy, Amussat, Landouzy.*—On the compounds of phosphorus; *Wurtz.*—Formation of the Aorta.—Elements of Hind's comet of Feb. 6.—*March* 1.—On the decease of B. Delessert.—On the Artesian well near Calais.—On the movements of a system of molecules; *Cauchy:*—on some properties of complex factors; *Cauchy.*—*March* 8.—On the Hipparitherium, new genus of Solipeds; *Christol.*—Researches on electric conductility; *Becquerel.* —On the use of ether for distinguishing pretended disorders from real; *Baudens.* —Effects of ether; *Flourens, Joly, Amussat, Cardan, Bourguet, Mayor.*—Pyroxyline; *Richier.*—*March* 15.—On the mineral water of the Paramo de Ruiz, N. Granada; *Boussingault, Lewy.*—Compositions of different kinds of wood; *Chevandier.*—On the true nature of anhydrous fluohydric acid; *Louyet.*—Compounds of cyanogen; *Wurtz.*—On terrestrial magnetism, or a new principle of celestial physics; *Lion.*—Glaciers of the north and center of Europe; *Durocher.*—Hind's comet.—*March* 22.—Polynomial radicals; *Cauchy.*—Ether injected into the veins; *Flourens.*—Effects of ether.—Hind's comet.—*March* 29.—Simple electro-chemical currents formed of liquids; *Becquerel.*—Polynomial radicals; *Cauchy.*—Identity of Leverrier's planet with a star observed by Lalande.—Theory of dew; *Melloni.* On the potato disease; *Payen.*—Mechanical properties of different kinds of wood; *Chevandier and Wertheim.*—Method of determining the nitrogen in organic substances; *Peligot.*—Apparatus for determining the velocity of electricity; *Silbermann.*

Archiv für Naturgeschichte, *Berlin, 4th Heft*, 1846.—On a new species of Proteus; *H. Freyer.*—On the contractile cells of the embryo of Planaria; *A. Kölliker.*—Gammarus ambulans, n. sp.; *A. F. Müller.*—Acanthocerus rigidus, n. sp. of Crustacea, Fam. Cladocera; *J. E. Shödler.*—Notice of works and memoirs on mammalia and birds, for the year 1845; *A. Wagner.*

APPENDIX.

Descriptions of Fossil Shells of the Collections of the Exploring Expedition under the command of Charles Wilkes, U.S.N., *obtained in Australia, from the lower layers of the coal formation in Illawarra, and from a deposit probably of nearly the same age at Harper's Hill, valley of the Hunter;* by James D. Dana, Geologist of the Expedition.*

1. *Bellerophon undulatus.*—Sparingly compressed, back of whorls rounded, surface smooth, having a series of distant plications crossing the back parallel with the lines of growth, (or nearly V shape with the angle rounded,) giving it an undulate outline, plicæ most abrupt on posterior side, becoming obsolete laterally, aperture deltoido-lunate, a little dilated laterally.—Diameter of species $\frac{3}{4}$ inch; thickness through the centre $\frac{3}{8}$ of an inch; about four plications in a distance of half an inch. —*Harper's Hill.*

2. *Bellerophon strictus.*—Discoid, much compressed, smooth and without markings, aperture narrow compressed-lunate, not dilated, the part of the aperture either side of the included body of the shell very narrow; back of the whorls rotund. Thickness at middle half the diameter. Resembles a Goniatite, but there are no septa.—*Illawarra.*

3. *Platyschisma? depressum.*—Large, very much depressed, suborbicular, spire very low; whorls three or four, much flattened, back somewhat truncate, surface without markings excepting striæ of growth. —Diameter $4\frac{1}{2}$ inches.—*Harper's Hill.*

4. *Pleurotomaria tri-filata.*—Shell rather short turreted; whorls four, separated by a distinct suture, back tri-carinate, the middle carina largest, subacute; aperture orbicular.—Large specimens are eight lines long, and five broad at base.—*Harper's Hill* and *Illawarra.*

5. *Pleurotomaria nuda.*—Shell much depressed, whorls four or five, smooth, rounded, low-carinate, with an obsolete sulcus either side of carina; volutions separated by a distinct suture.—Specimen is $\frac{3}{4}$ of an inch in diameter, and about half an inch in length.—*Harper's Hill.*

6. *Natica* ——?—*Illawarra.*

7. *Patella tenella.*—Short conical, apex pointed, slightly recurved, not projecting beyond base; base oblong ovate, narrowest beneath the beak, length about twice greatest breadth. Length of base $\frac{5}{8}$ of an inch; height $\frac{3}{8}$ of an inch. On the specimen, which is a neatly pre-

---

* A detailed account of these and other fossils from Australia, illustrated by figures, will appear in the Government Geological Report by the writer, now nearly ready for publication. As interesting associations of species and genera will be perceived, the writer would remark, that the species with few exceptions were obtained by himself at the localities. He offers here no opinion as to the particular age of the deposits.

The writer would acknowledge the very essential aid he has kindly received from Prof. Agassiz in the study of many of the species.

served cast, only a small portion of the original shell remains, from which it appears that the surface was smooth, and marked only by faint lines of growth.—*Harper's Hill.*

Pentadia, (nov. gen.)—This name is proposed for singular flat fossils, which have one side quite smooth, the other delicately and closely marked with parallel subcrenulate ridges having the angles of a regular pentagon and concentric. Two of the specimens are casts of the exterior, and the other is a calcareous petrifaction. As the last mentioned is quite solid, having the oblique cleavage of many calcareous fossils, (the spines of Echini, &c.) it is evident that the original was solid, and could not have been a *Porpita*, which one of the specimens somewhat resembles. And since, besides, there is no appearance of a mouth or any opening, or organs of motion, and the form varies very much, we may infer that the fossils were an internal secretion probably of some mollusk, and more allied to the cuttle-fish bone than any thing else we can suggest. The first species here described has much the appearance of a Spatangus.

8. *Pentadia spatangus.*—Form pentagonal or approximately twelve-sided, suborbicular, with five broad and rounded folds (one largest) radiating from the centre. The concentric pentagonal markings have the five angles at the centres of the triangular sections; and at the centres of four of the sides of the pentagon, there is a reëntering angle.—Diameter 2 inches; thickness $\frac{1}{8}$ inch.—*Illawarra.*

9. *Pentadia reniformis.*—Resembles a single segment of the preceding, with a broad lateral wing-like prolongation, nearly as large as the segment. It is quite thin, and its shape is reniform, though somewhat arcuately flexed. The specimen is undoubtedly a perfect individual.—Length $\frac{3}{4}$ inch; breadth $1\frac{1}{4}$ inch; thickness 1 line.—*Illawarra.*

10. *Pentadia trigona.*—Shape triangular, slightly arcuately flexed. It is thicker than either of the preceding, and has a rounded margin. It resembles the last in its markings, having the same angle of intersection (that of a pentagon) between two sets of parallel lines.—Breadth 1 inch; thickness $\frac{1}{4}$ inch.—*Illawarra.*

11. *Lingula ovata.*—Quite small, regularly broad ovate, acute at beak, margin not at all truncate; valves thin, very convex; surface smooth with faint concentric lines of growth.—Dimensions, from the beak to the opposite margin $\frac{1}{3}$ of an inch; transverse line a fourth less.—Very near the *L. lata* of Murchison, (Sil. Syst., pl. 8, fig. 11,) but not at all "squarish."—*Illawarra.*

12. *Terebratula amygdala.*—Oblong ovate, attenuate above, thickest about the centre, valves about equally and regularly convex, inferior margin arcuate, ventral valve very regularly ovate in outline; beak reflexed close to apex of ventral valve; aperture round and rather large; line of junction of valves in side view almost straight, very slightly bent above, the cardinal edges being little concave; surface smooth with a few concentric folds and some faint radiations.—Cardinal angle 82°; height $1\frac{1}{8}$ inch; breadth $\frac{72}{100}$ H.; thickness $\frac{46}{100}$ H. Near the *T. hastata.*—*Illawarra.*

13. *Terebratula elongata.*—(*Verneuil*, Palæozoic Rocks of Russia, p. 63, pl. ix, fig. 9.)—Scarcely differs from this species as described and figured by Verneuil.—*Illawarra.*

14. *Productus fragilis.*—Subquadrate, with front angles rounded, rather broader than long, hinge line straight, nearly of the breadth of the shell, front straight, upper valve very convex, irregularly longitudinally striated, with some concentric plications, sometimes with occasional rudiments of spines, front and sides rather abruptly reflexed; beak small, projecting but little below the hinge line, and the apex not much inflexed.—Length of hinge line $1\frac{1}{2}$ inches; depth of concavity below, over half an inch.—This species is very unlike the *brachythærus* in its less prominent beak and longer hinge line. It is near the *rugosus*, but is much thicker and more convex above.—*Illawarra.*

15. *Solen* (*Solecurtus?*) *ellipticus.*—Shell very slightly convex, very regularly elliptical, with no trace of a beak, breadth little less than half the length, anterior part rather more than one-third the whole length; smooth with fine scarcely apparent concentric striæ, supero-anterior margin slightly depressed, and perhaps two or three faint radiations from the hinge over the lateral surface (apparent in the cast of the under surface of the valve, but not of the upper); cast of the hinge showing no teeth though apparently perfect.—Length 1·4 inches; height $\frac{48}{100}$ L.—*Illawarra.*

16. *Solen* (*Solecurtus?*) *planulatus.*—Shell flat except a slight bending over the postero-dorsal portion; no beak, elliptical in outline with the inferior and dorsal margins straight, and the anterior and posterior extremities of equal breadth; breadth more than half the length; surface smooth with some faint concentric undulations and lines of growth, apparent especially near inferior margin; no palleal or muscular impressions visible.—Length $1\frac{2}{3}$ inch; height $\frac{48}{100}$ L.—*Harper's Hill.*

17. *Pholadomya undata.*—Nearly or quite equivalve, oblong transverse, subelliptical; beak projecting but little; thinning to an acute edge in front, prolonged and narrowing somewhat behind; sides flattened, posterior surface from the beak to the posterior angle obliquely truncate and exteriorly subcarinate; cardinal area linear, circumscribed; surface with a few irregular obsolescent longitudinal plicæ or undulations, smooth, crossed, especially below, by faint radiations.—Length $3\frac{1}{16}$ inches; height $\frac{59}{100}$ L; thickness $\frac{35}{100}$ L; distance of summit of beak from anterior margin $\frac{33}{100}$ L; apical angle 138°; projection of beak above cardinal margin one-eighth of an inch.—*Illawarra.*

18. *Allorisma audax.*—Transverse, very inequilateral, left valve largest, front very broad and flattened, and having a narrow area adjoining the margin extending down from the beaks which is a little concave; posterior prolonged and much compressed, narrowing and somewhat recurved, gaping; beaks very large and prominent, incurved, contiguous; lateral surface anterior to middle strongly flattened, or even concave; surface unevenly plicate and having some faint radiations laterally and posteriorly, plications large rounded and smooth, the alternate mostly becoming obsolete towards middle of lateral surface.

Length $4\frac{3}{4}$ inches; height $\frac{63}{100}$ L; thickness $\frac{47}{100}$ L; the beaks are much more prominent than in the *A. curvatum*, the posterior extremity much narrower, the flank less inflated, and the front more abruptly truncate.—*Illawarra.*

Cleobis, (nov. gen.)—Shell inequivalve, inequilateral, thick, transverse subovate, closed (or nearly so.) Beaks large, salient and incurved. Posterior margin broadly rounded and a little dilated: Ligament internal. Hinge line flexed to one side at middle and passing beneath the lower of the beaks. Valves thin. Surface marked unevenly with regular concentric striæ of growth and without radiations.—This genus appears to be near the Ceromya of Agassiz; but of this we cannot be certain, as the palleal and muscular impressions are not visible. There is much external resemblance to the *Avicula cuneiformis* of Verneuil, (Russia, pl. xli.) The beaks are prominent and incurved, but are not flexed at all forward; they project over or overhang the cardinal line, the summit being separated from it by an intervening space. The valves are quite thin, the thickness being less than a line in a large species measuring seven inches in length.

19. *Cleobis grandis.*—Thick, very convex, right valve largest; front very abrupt; anterior part about one-third the whole length; inferior margin regularly arcuate; surface concentrically striate and a little undulate.—Length of large specimens seven inches, height $\frac{69}{100}$ L; thickness $\frac{60}{100}$ L; apical angle 105° —*Illawarra.*

20. *Cleobis gracilis.*—Resembling *C. grandis*, but more projecting anteriorly; anterior portion, about two-fifths the whole length.—Length 2·9 inches; height $\frac{72}{100}$ L; thickness $\frac{50}{100}$ L; apical angle 125°.—*Illawarra.*

21. *Cleobis? recta.*—Subelliptical, somewhat compressed; lateral surface flattened; marked with concentric lines of growth; inferior margin straight at middle, parallel with dorsal; postero-dorsal margin much dilated.—Length $3\frac{1}{2}$ inches; height probably $\frac{60}{100}$ L; thickness $\frac{41}{100}$ L. The straight lines of growth over the medio-lateral surface, and straight medio-inferior margin give a peculiar character to this species.—*Illawarra.*

22. *Astarte gemma.*—Transverse, very nearly equilateral, surface evenly convex, delicately marked with deep concentric striæ, margin of the valves crenulate within; large anterior muscular impression a little excavate, transverse and suboval; smaller anterior excavate, oblong; posterior rather faint; palleal impression faint but distinctly without a sinus, and quite reaching the anterior muscular impression; surface of cast smooth.—Length $\frac{3}{5}$ inch; height $\frac{83}{100}$ L; thickness $\frac{45}{100}$ L; anterior part $\frac{7}{15}$ of the whole length; apical angle 140°. The impression of two divergent teeth is finely preserved.—*Illawarra.*

The following species have the entire palleal impression, two anterior and one posterior muscular impressions, and the external ligament of *Astarte.* Yet the form is more transverse and inequilateral than is characteristic of that genus, and the ligament is longer, occupying the whole cardinal area. The beak of an interior cast has the summit obliquely truncate, and the lateral surface just posterior to middle is more or less flattened. The large muscular impressions are broad subelliptical or suborbicular, with the upper side often straight. The smaller anterior is situated under the beaks as in Astarte. The exterior surface is concentrically striate. The valves at middle are quite thin, hardly $\frac{1}{60}$ of an inch in the first of the following species, and they thicken below towards the margin, where the same species is half a line thick. Although we have not yet made out the teeth of the hinge, we propose to describe the species under the generic name *Astartila*.

23. *Astartila intrepida*.—Thick, somewhat transverse, neatly but somewhat unevenly concentric striate; anterior part about $\frac{1}{3}$ the whole length. Anterior muscular impression excavate; smaller subquadrate or a little oblong; larger marked with a number of fine vertical striæ on the lower posterior quarter; antero-lateral surface of the interior with two parallel flattened areas, the one adjoining the muscular impression convex, (concave in the cast.)—Length $1\frac{3}{4}$ inch; height $\frac{80}{100}$ L; thickness $\frac{52}{100}$ L; apical angle about 120°.—*Illawarra.*

24. *Astartila cyprina*.—Thick, transverse, length more than one third greater than height; palleal impression very distinct, inner surface of valve very minutely rugose, below palleal impression radiately subplicate; posterior muscular impression not excavate, crossed vertically by a fold; large anterior deeply excavate, convex, crossed by a few faint vertical lines, which are closer towards the posterior margin; smaller somewhat excavate, oblong sigmoid. Cast with antero-lateral surface simply a little flattened.—Length $2\frac{1}{12}$ inches; height $\frac{72}{100}$ L; thickness $\frac{58}{100}$ L; apical angle about 118°.—*Illawarra.*

25. *Astartila cytherea*.—Thick, slightly longer than the height; inner surface smooth, palleal impression rather faint; posterior muscular impression large and very distinct, very slightly excavated, not intersected by a vertical fold; larger of the two anterior deeply excavate, the excavation deep and very abrupt on the upper side, four or five striæ crossing the muscular impression vertically near posterior margin; smaller anterior oblong sigmoid, but not excavate. Cast with antero-lateral surface simply somewhat flattened.—Length of *cast* $1\frac{1}{2}$ inch; height $\frac{90}{100}$ L; thickness $\frac{66}{100}$ L; apical angle 112°.—*Illawarra.*

26. *Astartila polita*.—Rather thin, somewhat transverse; surface smooth and shining, with faint lines of growth; muscular impressions scarcely excavate and palleal impression faint; the larger anterior very even and without vertical striæ or plications; a slight fold in the surface just anterior to posterior muscular impression, and a smaller one crossing this muscular impression. Cast with antero-lateral surface simply very slightly flattened.—Length 1 to $1\frac{3}{4}$ inch; height $\frac{74}{100}$ L; thickness $\frac{50}{100}$ L; apical angle about 113°.—*Illawarra.*

27. *Astartila cyclas*.—Rather thin, slightly transverse; surface marked unevenly with concentric striæ; posterior muscular impression very distinct but hardly excavate, a fold in the inner surface of the valve just anterior to it; both of the anterior muscular impressions strongly excavate; the larger without vertical striæ; the smaller placed obliquely so that the cast of it is a linear trenchant ridge; palleal impression very distinct, somewhat plicatulate. Cast with summits of beaks quite thin, the lateral surface strongly flattened, and another flattened area adjoining anterior muscular impression.—Length $1\frac{1}{3}$ inch; height $\frac{90}{100}$ L; thickness $\frac{45}{100}$ L; thickness of cast $\frac{40}{100}$ L; apical angle 135°.—*Illawarra.*

28. *Astartila transversa*.—Thick, transverse, length full a third greater than height; posterior muscular impression faint; crossed by a fold vertically, and another more distinct in the surface just anterior to

the muscle; large anterior somewhat excavate, without vertical striæ, small anterior obliquely excavate; palleal impression not very distinct. Cast with antero-lateral surface of beak strongly flattened in two parallel planes, that adjoining the anterior muscular impression a little concave. —Length of cast $1\frac{1}{2}$ inch; height $\frac{73}{100}$ L; thickness $\frac{55}{100}$ L; apical angle of cast 105°, of shell about 115°. This species has two parallel flattened areas on the lateral surface like the *intrepida* and *cyclas;* but its form, the absence of vertical striæ from the anterior muscular impression and other characters distinguish it.—*Illawarra.*

Genus CARDINIA, (*Ag.*)—Form of the species below-described, transverse, and dorsal margin more or less convex without a salient beak; two strong anterior muscular impressions, and one posterior less distinct, the smaller anterior linear, and situated vertically on the front; the palleal impression entire, and not quite reaching to the anterior muscular impression. No cardinal area to the shell, but a strongly defined one to the cast of the interior. The species differ from Cardinia in having the lateral surface posteriorly marked with radiations; the front of an interior cast is strongly truncate, and the flat truncate surface extends on and separates the anterior margins of the large anterior muscular impressions from the medial line; the cardinal areas in the cast are very long linear, and but slightly widen posteriorly. We refer the *Orthonota? costata*, of Morris, to this genus.

29. *Cardinia recta.*—Very inequilateral, narrowing much posteriorly, length $2\frac{1}{2}$ times the breadth, dorsal margin a little convex, inferior straight at middle; lateral surface not depressed, marked with concentric striæ and faint radiations, these radiations producing slight undulations in the lines of growth; palleal and posterior muscular impressions very faint, both of the anterior strong, a convex linear area adjoining the larger extending upward. Interior cast having a very neat, narrow and quite flat cardinal area, with the dorsal margin prominent; lower edge of the cast very thin; surface quite smooth with faint radiations.—Length 2 inches; height $\frac{45}{100}$ L; thickness $\frac{20}{100}$ L; apical angle 125°. The cast resembles much Verneuil's *Solemya primæva*, pl. xix, fig. 5.—*Illawarra.*

30. *Cardinia cuneata.*—Very inequilateral, length about twice the breadth, diminishing posteriorly, and thinning below; superior margin arcuate, interior strongly concave just posterior to middle, and lateral surface depressed; palleal impression distinct; anterior and posterior muscular impressions excavate. Cast with cardinal areas concave and separated from lateral surface by a strong carina, very long, extending to posterior margin.—Length of cast $1\frac{1}{4}$ inch; height $\frac{53}{100}$ L; thickness $\frac{30}{100}$ L; apical angle of cast 110°.—*Illawarra.*

Genus PYRAMUS, (nov. gen.)—Equivalve, somewhat inequilateral, transverse, elliptical, with the front and posterior margins nearly alike, entirely closed; beak somewhat prominent. Ligament external. Palleal impression entire, distant from the margin. Three muscular impressions to each valve, two anterior and one posterior; the larger anterior, suborbicular, smaller anterior, facing the same way with the larger, and situated just above its upper angle; posterior faint. Surface marked with concentric lines of growth. Cast of summit of beak a slender point. Shape nearly of Donacilla and Sanguinolaria, but it differs in its entire palleal impression, and has also two anterior muscular impressions which belong together, to each valve, as in *Corbis.* From the impression of the hinge of a left valve, there appear to be no prominent teeth; it has a very oblique shallow sulcus, directed posteriorly from the centre of the hinge, and a slight excavation anterior to the centre. The form is more transverse and the teeth less distinct than in *Corbis.* It has not the long lunate muscular impression of *Lucina.*

31. *Pyramus ellipticus.*—Oblong, length half greater than breadth, lower margin arcuate, sides evenly convex, surface strongly but unevenly marked with regular concentric striæ, posterior and large anterior muscular impressions rather indistinct, not excavate; palleal impression perceptible and posteriorly plicatulate. Cast of beak acute at apex.—Length $1\frac{3}{4}$ inch; height $\frac{70}{100}$ L; thickness $\frac{41}{100}$ L; apical angle 137°. Another specimen, probably same species, three inches long.—*Harper's Hill.*

32. *Pyramus myiformis.*—Oblong, length two-thirds greater than breadth; exterior smooth, with faint striæ of growth; lower margin nearly straight, lateral surface below somewhat flattened; muscular impressions distinct, posterior not excavate, large anterior a little so above, smaller anterior deeply excavate, and the surface of attachment facing the same way with the larger; palleal impression faint. Cast having the beak terminate in a minute cylinder, and having the lateral surface, from the summit obliquely downward and backward, depressed.—Length 2 inches; height $\frac{61}{100}$ L; thickness about $\frac{35}{100}$ L; apical angle 148° or 150°. The front and posterior margin are more broadly rounded than in the preceding, the lower margin straiter, the apical angle much larger.—*Illawarra.*

33. *Nucula abrupta.*—Thick, elongate, transverse, rather abruptly narrowing behind the summit, and diminishing posteriorly; posterior dorsal margin much concave; anterior margin rounded; cast strongly carinate from the beak to the posterior angle, and having a wide and flat cardinal area; palleal impression distinct, somewhat excavate, smooth; anterior muscular impression somewhat excavate, smooth; posterior strongly excavate in the upper part, (in the cast it lies around the posterior carina, and the upper extremity forms an abrupt angle on the outline of the carina;) surface of cast smooth, some faint radiations hardly distinguishable.—Length $1\frac{1}{3}$ inch; height $\frac{77}{100}$ L; thickness $\frac{40}{100}$ or $\frac{45}{100}$ L; apical angle about 135°; height in the line of the upper part of posterior muscle, about half greatest height.—*Illawarra.*

34. *Nucula* —— ? *Harper's Hill.*

35. *Cypricardia rugulosa.*—Oblong transverse, anterior part one-third whole length, narrowing rather abruptly from the beak posteriorly, posterior surface (flank) broad and flat truncate, with a carinate margin extending from the beak to the lower posterior angle; cardinal area distinct, profound; lateral surface marked with longitudinal striæ of growth, which are quite irregular or undulate, making a right angle (and in some parts a less angle) at the carina; also a few large obsolescent longitudinal folds.—Length 2·9 inches; height $\frac{55}{100}$ L; thickness $\frac{33}{100}$ L; apical angle 132°.—*Illawarra.*

36. *Cypricardia sinuosa.*—Oblong transverse, anterior part about $\frac{2}{5}$ whole length; posterior rather rapidly narrowing but not abruptly;

flank nearly flat and rounding broadly into the lateral surface; lateral surface with a depressed area, extending from the beak to middle of inferior margin; inferior margin straight at middle; surface marked unevenly with fine striæ of growth which are regularly concentric.—
—Length $3\frac{2}{3}$ inches; height $\frac{58}{100}$ L; thickness $\frac{35}{100}$ L; apical angle about 142°.—*Illawarra.*

MYONIA, (nov. gen.)—Shell thick, oblong transverse, inequivalve, very inequilateral, much gaping behind. Palleal impression strong, entire. Muscular impressions three to each valve; two anterior and one posterior, all excavate, smaller anterior on the front, posterior on the rounded carina between the flank and lateral surface. Valves thick. Lateral surface strongly flattened at middle or even concave.—Resembles much Panopæa and Pholadomya, especially Agassiz's Arcomya; but differs in its *entire* palleal impression, its second anterior muscle, as well as other characters.

37. *Myonia elongata.*—Thick, right valve rather the larger; greatest height half the length; gradually narrowing behind the beak, inferior margin just posterior to middle somewhat concave, carina from beak to posterior angle broadly rounded, not bent, flank flat, cardinal area long and circumscribed; surface strongly marked unevenly with regular concentric striæ of growth.—Length $6\frac{1}{5}$ inches; height $\frac{53}{100}$ L; thickness $\frac{42}{100}$ L; anterior part about half the posterior; apical angle 145°. —*Illawarra.*

38. *Myonia valida.*—General form of the *M. elongata*:—but greatest height much less than half the length; flank in cast flattened and distinctly bent near the posterior muscular impression; muscular impressions deeply excavate, and marked with deep vertical sulcations; palleal impression very strong with slender vermiform erosions extending upward from it; also scattered muscular impressions over lateral surface. —Of the same length with the preceding; but greatest height $\frac{58}{100}$ L; apical angle of cast 128°.—*Illawarra.*

39. *Eurydesma elliptica.*—Somewhat compressed, and dilated anteriorly and posteriorly, transverse, right valve largest; beaks contiguous; lateral surface not flattened; surface nearly smooth with occasional faint lines of growth and no trace of radiations; inferior margin arcuate.—Length $2\frac{3}{4}$ inches; height $\frac{89}{100}$ L; thickness $\frac{55}{100}$ L; apical angle 124°.—*Harper's Hill.*

40. *Eurydesma globosa.*—Thick, tumid, suborbicular, not transverse, very evenly convex; beaks contiguous; lateral surface every where convex; surface smooth with faint concentric lines of growth and no trace of radiations; inferior margin and lines of growth, regularly orbiculate.—Length and breadth $1\frac{9}{10}$ inch; thickness $\frac{70}{100}$ L; apical angle 97°.—*Harper's Hill? Illawarra.*

41. *Modiolopsis simplex.*—Elongate, length rather more than twice the height, very inequilateral, enlarging a little posteriorly; dorsal line horizontal, straight, and rounding into the posterior margin; obliquely truncate in front; inferior margin arcuate; lateral surface evenly convex without a depression anteriorly, or a carina posteriorly; surface marked rather faintly with lines of growth, a little uneven. —Length $1\frac{1}{2}$ inch; height $\frac{44}{100}$ L; apical angle about 132°.—*Illawarra.*

42. *Modiolopsis siliqua.*—Elongate, length nearly twice the height, very inequilateral, enlarging a little posteriorly; front obliquely truncate; anterior part less than a fourth whole length; dorsal margin straight and nearly horizontal, inferior margin straight; lateral surface flattened but not concave; posterior surface rounded or scarcely carinate near summit of beak; surface marked with irregular obsolescent plicæ and showing also lines of growth.—Length $1\frac{1}{4}$ inch; height (greatest) $\frac{52}{100}$ L; apical angle about 130°. Near *Mytilus Teplofi* of Verneuil, (Russia, pl. xix, 17,) and *Modiolopsis faba*, of J. Hall, (N. Y. Palæont. Report, pl. xxxv, fig. 6.)—*Illawarra.*

43. *Modiolopsis prærupta.*—Elongate (length about twice the greatest height), enlarging somewhat posteriorly, dorsal margin straight or very slightly arcuate, rounding into the posterior margin; inferior excavate anterior to middle; front abruptly truncate; lateral surface excavate from the beak posteriorly downward, also an oblique depression adjoining anterior muscular impression; a few faint rays from the beak over the posterior surface, concentric striæ of growth distinct; anterior muscular impression marginal, excavate, but small and suborbicular. —Length $1\frac{4}{10}$ inch; greatest height $\frac{53}{100}$ L; apical angle 100°. Near *M. faba* of Hall.—*Illawarra.*

44. *Modiolopsis imbricata.*—Moderately elongate, enlarging posteriorly, very inequilateral; dorsal margin straight, and prolonged; inferior margin straight anteriorly, front rounded; lateral surface depressed or somewhat excavate from the beak obliquely backward and downward, having neat concentric subimbricate markings (and some fine radiations on the posterior surface of cast near beak); from beak to posterior margin scarcely carinate; anterior muscular impression very large, oblong, marginal; beaks of cast thin at summit. Texture of shell delicately fibrous and apparently no nacre below.*—Length $2\frac{1}{8}$ inches; greatest height about half the length.—*Harper's Hill.*

45. *Modiolopsis arcodes.*—A thick species resembling the preceding in form and in external markings; but it is much broader in proportion, lateral surface is less flattened anteriorly, cardinal line much shorter than shell, being much less prolonged posteriorly than in *M. imbricata*; line from beak posteriorly more decidedly carinate, beaks thicker. The fibrous texture is very distinct. The anterior muscular impression is very oblong vertically, and projects anterior to the beaks, nearly as in the *Myophora* of Bronn.—Length $1\frac{2}{3}$ inch; height much less than half length. Looks much like an Arca in general form.—*Harper's Hill.*

46. *Modiolopsis acutifrons.*—Thick, elongate, very much broader posteriorly; cardinal line straight, very oblique, very much shorter than shell; front acuminate, posterior broadly rounded; inferior margin excavate near anterior extremity and also just posterior to beak; lateral surface from beak downward and backward excavate, from beak to posterior margin very convex, hardly carinate; surface marked with a few concentric folds, and some lines of growth. Anterior muscular impres-

---

* Judging from this texture, the species of Modiolopsis (Hall) are more allied to Avicula than Mytilus, although having a large and strong anterior muscular impression.

sion large and deeply excavate, scarcely marginal. Texture of shell finely fibrous as in preceding species.—Length $3\frac{3}{4}$ inches; angle between cardinal line and line of elongation of shell about 32°. Resembles much a Gervillia in its oblique form.—*Illawarra.*

47. *Avicula* —— ?—Very near *A. volgensis* of Verneuil, Russia, p. 473, pl. xli, fig. 13.—Specimen from *Illawarra.*

48. *Pecten comptus.*—Suborbicular, costæ 20 to 22, without markings, regular, prominent, low triangular with shallow concave furrows, which have usually at middle a slender costa and one or two similar less prominent either side; ears rather large and longitudinally striate. —Length and height $2\frac{1}{4}$ inches; distance at lower margin between middle of two costæ a fifth of an inch. Only one valve was obtained and that was convex. Near *P. Fittoni* of Morris, (Strzelecki, p. 277, pl. 14, fig. 2,) but rays much more numerous.—*Harper's Hill.*

49. *Pecten tenuicollis.*—Nearly orbicular; costæ about twenty-four, very slender and smooth with nearly flat smooth interstices having an intermediate smaller costa.—Length of specimen $1\frac{1}{8}$ inch; height $1\frac{1}{5}$ inch nearly; distance of middle of two costæ at lower margin about $\frac{4}{5}$ of a line. Only a single valve was obtained and that was very convex.—*Harper's Hill.*

50. *Pecten leniusculus.*—Large, nearly orbicular, one valve nearly flat, the other convex; flat valve having concentric undulations; surface very nearly smooth with fine obsolescent striations; striations more distant and rather more distinct on the convex valve; ears large, crossed obliquely by a few folds and striate longitudinally.—Length and height $4\frac{1}{2}$ inches; thickness $1\frac{1}{2}$ inch.—*Illawarra.*

The following additional species of fossil shells from Australia in our collections are described by Morris in *Strzelecki's N. S. Wales and Van Dieman's Land*, Mr. J. D. Sowerby in *Mitchell's Australia*, or G. Sowerby in Darwin *on Volcanic Islands.*

From *Harper's Hill*:—Bellerophon micromphalus (*M.*); Platyschisma oculus (*J. S.*) *M.*, P. rotundatum (*M.*); Theca lanceolata (*M.*); Spirifer subradiatus (*G. S.*); Eurydesma cordata (*M.*); Eurydesma (Isocardia? *J. D. S.*); Pecten illawarrensis (*M.*); Pachydomus antiquatus (*J. D. S.*) *M.*, P. cuneatus (*J. D. S.*) *M.*, Conularia levigata, (*M.*)

From Illawarra:—Pleurotomaria Strzeleckiana (*M.*); Spirifer Darwinii (*M.*); S. subradiatus (*G. S.*), S. avicula (*G. S.*), S. vespertilio (*G. S.*); Productus brachythærus (*G. S.*); Allorisma curvatum (M.); Orthonota (Cardinia) costata (*M.*); Pterinea macroptera (*M.*)

Our collections contain also other undetermined species from these localities, besides several species from Glendon, the species of corals described by Lonsdale, and several new species of coal plants from Illawarra and Newcastle.