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PALÆONTOLOGY.

SECTION I.

DESCRIPTIONS OF INVERTEBRATE FOSSILS OF THE SILURIAN AND DEVONIAN SYSTEMS.

BY

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TO DR. J. S. NEWBERRY, *State Geologist:*

DEAR SIR: In respectfully submitting this Report on some of the Invertebrate fossils of Ohio, I desire to acknowledge here my obligations to the following gentlemen for the loan of numerous fine specimens from the Cincinnati rocks, viz: Messrs. C. B. Dyer, U. P. James, S. A. and Dr. Miller, D. H. Shaffer, and Drs. Hill and Byrnes. To Mr. James and Mr. Dyer, as well as to some of the others, I am likewise indebted for much interesting information in regard to the vertical range, etc., of the species and varieties in the Cincinnati beds. These gentlemen have been collecting the fossils of this exceedingly rich locality for many years past, and now possess extensive and valuable collections, from which they generously allowed me to select any specimens I wanted for study or illustration. Some of those thus borrowed from Mr. Dyer, are types of species described by others, but not hitherto figured.

I am also under obligations to the Rev. Mr. H. Hertzer, and Prof. Edward Orton, of the Ohio Survey, for the loan of some interesting Devonian and Upper Silurian fossils, belonging to their own private collections, from near Columbus and Yellow Springs, Ohio.

Among parties living out of the State, to whom I am indebted for the loan of specimens for comparison and study, I would mention Prof. C. F. Hartt, of Cornell University, New York; Prof. Oliver Marcy, of Evanston University, Illinois; Prof. Frank H. Bradley, of Knoxville University; Dr. E. Billings, of Montreal, Canada; Dr. I. A. Lapham, of Milwaukee, and Dr. F. H. Day, of Wamatosa, Wisconsin.

I am also under special obligations to Prof. Joseph Henry, for important facilities at the Smithsonian Institution, during the preparation of this Report.

It is due to myself to remark here, that I have labored under the disadvantage of having to form conclusions in regard to the relations of many Ohio forms to species that have been described by others from this and adjoining States, without having typical or well authenticated examples of the named species for comparison. This difficulty was most particularly felt in the study of the fossils from the Devonian and Upper Silurian beds, from which many species have been described (often very briefly), and either not yet figured at all, or only imperfectly illustrated.

Very respectfully yours,

F. B. MEEK.

SMITHSONIAN INSTITUTION,
Washington City, D. C., Feb. 7, 1873.

FOSSILS OF THE CINCINNATI GROUP.

RADIATA.

ECHINODERMATA.

*CRINOIDEA.**

GENUS HETEROCRINUS, Hall, 1847.

(Palæont., N. Y., vol. 1, p. 278.)

In first publishing this genus, Prof. Hall illustrated it as having only a single range of body pieces below the radial series, and without anal plates or pinnulæ. Species subsequently described by Mr. Billings, and others by the writer and Mr. Worthen, however, show that it has a well-developed anal series, and that the arms are often, though not always, provided with pinnulæ. Still more recently, Prof. Hall (see his Descriptions New Sp. Crinoidea, p. 4, dated 1866) called attention to the presence, in some species of this genus, of five very minute pieces at the connection of the column with the body; one being placed directly at the lower end of each suture dividing the first range of well developed body-plates. These minute pieces he views as true basals, and the range just above them, that have always been regarded as the basals, he considers sub-radials–thus making the genus have both sub-radial and basal pieces.

I have some doubts, however, in regard to the propriety of this view of these parts, not only became the minute pieces at the head of the column are sometimes entirely wanting, and never so much developed

* It way be proper to mention here, that some recent investigations of the soft parts of *Comatula,* by Prof. Metschnikoff, of St. Petersburg, seem to render it very doubtful whether the *Crinoidea* really belong to the Class *Echinodermata* at all, as generally believed. At any rate, he could find no traces whatever, in *Comatula,* of the water system of the *Ophiurians,* Star-fishes, *Echini* and *Holothurians.* (See Bull. Acad., St. Petersburg, XV., p. 508, Feb'y, 1871; and Am. Naturalist, Vol. VI., May, 1872, p. 305.)

as to form a contiguous range of pieces all around; but also, because they correspond exactly in size and form, and in their vertical range, with five others often seen intercalated between each two of the discs of the column for some distance below the body. In this, as in some other genera, particularly of Silurian age, the column is always equally divided, longitudinally, into five sections, so that each of its discs is really composed of five distinct pieces, which, however, frequently become anchylosed together. The more minute pieces mentioned above are also always placed exactly at the dividing lines between each two of the five larger ones composing each disc of the column, and thus form rows exactly coincident, vertically, with those at the head of the column. Farther down the column, these minute pieces become more and more extended laterally, until finally they connect with each other, and thus themselves form discs—at first thinner than those with which they alternate, but still farther down the column, they become, in part at least, of the same size as the latter. (See fig. 3 *a*, pl. 1.) From these facts, I am inclined to think the very minute pieces at the immediate connection of the column with the body, should rather be viewed as belonging to the column, than as true basals. I have, therefore, in describing the species in which these minute pieces exist, always called them sub-basal pieces, and the well developed range above, basals.

In the paper above quoted, Prof. Hall, in speaking of these minute sub-basals in this genus, also remarks, that, if they were "developed, the structure would be the same as in *Poteriocrinus;* and in the absence of these plates, those which are the sub-radials in that genus, become the basal or lower series." It seems to me, however, that even if these minute pieces in this genus were large enough to assume the character of true basal, the structure of the genus would still be constantly distinct from that of *Poteriocrinites,* in the number and arrangement of its anal pieces. In *Poteriocrinus,* the anal pieces always rest directly down upon the sub-radials, and generally consist of two vertical rows of alternating pieces, the lowest piece being often, as it were, wedged down obliquely, partly under the first radial on the right; while in *Heterocrinus,* there is always but a single row of true anal pieces, the first or lowest one of which, instead of resting down upon the range of pieces that would, according to Prof. Hall's view, correspond to the sub-radial pieces in *Poteriocrinus,* actually rests upon one of the sloping sides of the *second radial* on the right, and partly upon the first radial on the left. This structure seems to be constant in all the species, and imparts so singular an appearance to the anal series, that they have generally been mistaken by Prof. Hall for an arm.

HETEROCRINUS CONSTRICTUS, Hall.

Plate 1, figs. 10 *a*, *b* (and 11 ?).

Heterocrinus constrictus, Hall, —; Illustrations of a paper entitled "Descriptions New Sp. Crinoidea," etc., dated 1866, p1. 1, fig. 3 (without description).

Body short sub-cylindrical, or slightly tapering below, and distinctly constricted just below the arm-bases above. Sub-basal pieces wanting, or only appearing as minute, imperfectly developed divisions of the last joint of the column, without modifying the form of the basals. Basal pieces wider than long, sub-pentagonal in form, the mesial angle above being scarcely perceptible. Radial pieces of unequal size and form; the first one in the left posterior lateral ray about as long as wide, and sub-pentagonal in form (its right superior lateral angle being a little truncated), while it supports above, a shorter quadrangular piece, which bears on its upper edge a still shorter, but wide pentagonal axillary piece, upon which the arms rest; anterior, and right anterior lateral rays, having the same number, form and proportions of pieces; left anterior lateral ray composed of four primary pieces, the first of which is pentagonal, and about as long as wide, the second as wide as the first, but much shorter, and quadrangular in form, the third quadrangular and nearly as long as wide, and the fourth very short, pentagonal, and bearing two arms on its upper sloping sides; right posterior ray composed of five primary, or body pieces, the first one of which is wider than long, and pentagonal in form, the second much shorter than wide, and sub-pentagonal, the third about the size of the first, but quadrangular, the fourth very short, and the fifth wider than long, pentagonal in form, and, like the last piece in each of the other two rays, bearing above, two arms. First anal piece, as usual, resting between the lateral superior sloping sides of the first piece of the left posterior ray, and the second of the right, and connecting on each side with the succeeding pieces of these rays above, while it appears to support one or two other smaller pieces in direct succession above.

Arms ten, stout, rounded on the dorsal side, and simple from their origin on the last radial pieces; composed of short wedge-formed pieces, about every third one of which is thicker than the others, and supports on the upper lateral sloping side of its thicker end, a stout pinnule or small armlet, that does not diverge from the arm, but lies close and parallel to the sides of the latter, when they are folded together; armlets thus arranged alternately on each side of the arms, and apparently

sometimes themselves bearing smaller secondary divisions. Surface nearly smooth, or only finely granular.

Height of body to the top of the last radial pieces, 0.30 inch; breadth at same point, allowing for accidental compression, 0.34 inch; breadth at the point of constriction, 0.29 inch; breadth of base at its connection with the column, 0.21 inch; thickness of arms near their bases, about 0.10 inch.

The foregoing description and measurements, as well as our figures 10 *a*, *b*, of plate 1, were prepared from Prof. Hall's typical specimen belonging to Mr. Dyer's collection. Another specimen belonging to Mr. Dyer, now before me, and represented by fig. 11, of the same plate, has a somewhat different aspect, and was, at one time, believed to be a distinct species, but as it seems to agree exactly in structure, so far as we have the means of comparison, it is most probably only a variety of the same species. Its chief differences consist in the possession of rather decidedly less robust and less rounded arms, and a proportionally narrower body, that tapers less below. In the typical specimen, the column and the upper part of the arms are broken away, so that these parts cannot be compared with those of the specimen mentioned above. In the latter the arms are of moderate length, scarcely tapering, excepting near their free ends, and when folded together, present the appearance of a sub-cylindrical bundle, of about twice the breadth of the body below. Its column is quite stout, being nearly as thick as the body, near which it is round and composed of alternately thicker and thinner pieces. Between the upper one of these and the base, fine, thin, small pieces can be seen, that do not truncate the corners of the basals, and present the appearance of the elements of a thin joint of the column, not yet coalesced so as to form a single segment. Similiar but somewhat larger pieces are also intercalated between the first and second segments of the column below.

In the form and structure of the body, this species is related to *H. juvenis*, and less closely to *H. heterodactylus*, of Hall; but it is very much larger, and more robust than either, and differs in having its column rounded instead of pentagonal. It likewise differs very materially from the former, as well as from the western form that has always been referred to *H. heterodactylus*, in having its arms simple instead of bifurcating.

From *H. simplex*, which has simple arms, it will be readily distinguished by its larger size, more robust habit, proportionally much larger column, and less tapering and peculiarly constricted body. Its

arms are also much stouter, and its pinnulæ, or armlets, proportionally larger.

Locality and position: About 100 feet below the tops of the hills at Cincinnati, Ohio, in the Cincinnati group of the Lower Silurian. Mr. Dyer's collection.

HETEROCRINUS EXILIS, Hall?

Plate 1, fig. 12.

Heterocrinus exilis, Hall, —; "Descriptions New Sp. Crinoidea," etc., p. 6, dated Nov., 1868; and re-issue same (l872), pl. 1, fig. 16.
Heterocrinus exiguus, Meek, 1872; Proceed. Acad. Nat. Sci., Philad., Jan'y, p. 308.

Body small, obconoidal, or tapering from above to the column, near which it becomes pentagonal in consequence of the flattened surface of each of the basal pieces. Sub-basal pieces obsolete, or very minute. Basal pieces (sub-radials of some) of moderate size, about as wide as long, pentagonal, and almost perfectly flat. Left posterior ray bifurcating first on the fifth piece, the first piece being comparatively large and irregularly hexagonal, in consequence of having a short sloping side on its upper right edge for the reception of one side of the first anal piece; the four succeeding pieces much narrower, about as long as wide, and rounded, and more or less constricted in the middle, with expanded upper and lower ends. Right posterior ray bifurcating first on the eighth piece, the first piece being decidedly smaller than that of the left posterior ray, pentagonal in form, and slightly longer than wide; while the second is of the same breadth, but shorter, rounded on the dorsal side, and irregularly pentagonal in form, the fifth angle being formed by a short side on the left above, for the reception of the first anal piece; succeeding pieces, about as long as wide, or slightly longer, rounded and constricted in the middle, and expanded at the ends. Right anterior lateral ray bifurcating first on the sixth piece, the first piece being distinctly larger than the others, apparently a little longer than wide, and sub-pentagonal in form; while those above are smaller, and of the same form as the corresponding pieces of the other rays described. (Other rays unknown.) Arms very long, slender, and bifurcating at least four times, at irregular distances above the first divisions of the rays; pieces of the lower divisions generally longer than wide, rounded and constricted in the middle, and expanded at the ends; while those of the smaller terminal divisions are usually from three to four or five times as long as wide, and scarcely expanded at the ends. Surface smooth. Pinnulæ not seen.

First anal piece small, about as long as wide, and, as usual, resting

between the superior sloping sides of the first radial on the left, and the second on the ridge, and bearing three or more others in direct succession above, that doubtless form a part of the walls of the ventral extension.

Column small, distinctly pentagonal near the base, where it is composed of alternately thin, and slightly thicker pieces.

Length of body to top of the larger radial pieces forming a part of its walls, 0.14 inch; breadth, about 0.12 inch; length of rays and arms above the body, 1 inch; thickness of column near base, about 0.07 inch.

In describing this form in the Proceedings of the Academy (under the names *H. exiguus),* I mentioned that it seemed to be closely allied to *H. exilis,* Hall (which had not at that time been figured), and might possibly belong to that species, but added, that "if Prof. Hall's description [of *H. exilis*] is strictly accurate, however, in several important characters, the form under consideration must be clearly distinct, as he states that the posterior lateral rays of *H. exilis* bifurcate on the *second* piece, and the anterior lateral on the fourth; while in the form here described, one of the posterior lateral rays bifurcates first on the *fifth* piece, and the other on the *eighth,* and in the only one of the lateral rays seen, the first division takes place on the *sixth* or *seventh* piece." I farther remarked, that "he also says that the arms of *H. exilis* bifurcate *once* or *twice;* while in our type, they bifurcate at least four times above the primary division of each ray. Again he describes the body plates of *H. exilis* as having the general curve of the body; but in our type the sub-radial (more properly the basal) plates are flattened so as to impart a pentagonal form to the lower part of the body."

Since this was printed in the Proceedings of the Academy, I have seen a figure of Prof. Hall's species, on a plate accompanying a re-issue of the paper containing his original description. The impressions of this plate illustrating this re-issue seem to have been taken when it was in an unfinished condition, and do not show the arrangement of the parts very clearly; but as nearly as I can make them out, the right posterior lateral ray certainly is not represented as bifurcating on the second piece at all, though, like other species of the genus, it supports an arm-like ray of *anal pieces* on the left superior sloping side of the first or second piece (it looks as if on the first, in the figure), while three other radials are seen in direct succession above the one supporting the anal series (and a fourth is represented in outline in a part of this ray restored) before the first true bifurcation takes place. Again, in the left posterior lateral ray, there are *four* pieces represented in the figure, in direct succession below the first bifurcation; while, including restorations in outline, of portions

of the arms, there are clearly represented at least three bifurcations in some of the rays, instead of one or two, as stated in the description.

Since seeing this figure, I am strongly inclined to believe the form here under consideration is identical with Prof. Hall's species, though in consequence of the discrepancies between his figure and description, and the rather unfinished condition of the former, I am left in doubt on this point.

This form will be at once distinguished from *H. simplex* by its frequently bifurcating arms, and other well marked characters. From the western form that has generally been referred to *H. heterodactylus,* which also has its arms bifurcating several times, it may be distinguished by the very different form of its body, its much more slender arms, with more frequent divisions, and greater length, as well as by its more slender column.

Locality and position: Cincinnati group, at Cincinnati, Ohio, where it occurs at the horizon of about 100 feet below the top of the hills. Mr. Dyer's collection.

HETEROCRINUS SIMPLEX, Hall.

Plate 1, figs. 4 *a, b;* 5 *a, b* (with 6 *a, b,* and 7 *a, b, c?*)

Heterocrinus simplex, Hall, 1847; Palæont. N. Y., vol. 1, p. 280, pl. lxxvi., fig. 2 *a, b,* c, *d;* Hall (1872), pl. 1., figs. 11 and 12, accompanying a re-issue of his paper on New Crinoidea, etc., dated Nov., 1866.

H. Canadensis, Billings, 1859; Canadian Organic Remains, Dec. IV., p. 48, pl. IV., fig. 5 *a*-5 *d.*

Body small, obconic, or tapering regularly from above to the column, as long as wide, or a little longer. Sub-basal pieces undeveloped. Basal pieces of moderate size, about as wide as high, one regularly pentagonal, and four irregularly so. First radial pieces in three of the rays, small and short, being decidedly wider than long, and pentagonal in form; each supporting on its rather broadly truncated upper side a second radial of considerably larger size, generally longer than wide, and quadrangular in form, excepting one on the anal side, which has one of the superior lateral angles truncated so as to present a pentagonal outline; third radials in these rays smaller than the second, wider than long, with a quadrangular form, and each supporting a somewhat larger, pentagonal fourth radial, which is an axillary piece, and bears two arms on its superior sloping sides. First radials in the other two rays comparatively large, as long as wide or longer, one hexagonal and one heptagonal (there being no mesial angle at the base), and each supporting a smaller short, transversely oblong, second radial, above which there is in each of these

rays a slightly larger third radial of pentagonal form, that bears on its superior sloping sides two arms.

First anal piece about as wide as long, pentagonal in form, and resting between the short superior sides of the first piece in the left and the second piece of the right posterior rays; second anal supported on the upper side of the first, quadrangular in form, and surmounted by a third smaller trigonal or sub-pentagonal piece, immediately above which the arms close together so as to hide any succeeding parts connecting these with the ventral prolongation.

Arms above their origin on the third and fourth radials, simple, rather long, somewhat flattened on the dorsal side, and composed of a single series of pieces that are usually about as long as wide, but alternately longer on one side than on the other, and bearing on each inner lateral margin of the arms a row of pinnules.

Surface smooth or only finely granular.

Column round, and small, compared with that of other species of the genus, and with the body tapering downward from the base, near which it is composed of thin discs, and farther down of alternately thicker and thinner discs; perforation small and nearly circular, or sub-pentagonal.

Height to the first bifurcation of the rays (medium sized specimen), 0.21 inch; breadth, 0.17 inch; thickness of column at base, 0.08 inch; length of arms, about 0.70 inch.

The above description is made out from the form generally recognized in the west as *H. simplex*, the original type of which was from Cincinnati, Ohio; and it agrees more nearly with the figures and description of that species given in the Palæontology of New York, than any of the known western forms. Consequently I have little doubt in regard to its being that species, although it differs, as will be seen by the foregoing description, and the accompanying figures and diagram, in some of the details from the illustrations and description given in the New York report. For instance, the enlarged diagram showing the anatomy of *H. simplex*, given in the New York Palæontology, vol. 1, pl. 76, fig. 2d, is drawn as if there were no anal pieces whatever (which are, as already stated, now known to exist in all the species of the genus), nor is any truncation of the upper left angle of the second piece in the right posterior lateral ray, or of the right of the left, represented there, for the reception of the first anal piece. The arm-pieces are also represented in that diagram as being decidedly wider than long, and each of equal length at each end; while in our specimens they are as long as wide (excepting in a variety to be mentioned farther on, differing in other respects), and more or less wedge-

shaped, or longer an one side than the other, in all the varieties I have seen. The genus is also described in the New York report as having the arms “not tentaculated." Our specimens of this, and some other species, show that the arms are provided with pinnulæ, or so-called tentacula.

Among the specimens before me from Cincinnati, that I am inclined to refer to this species, there are individuals showing some rather marked varieties in the details of structure, that may possibly hereafter be found to belong to more than one species. In addition to those presenting the characters given above, there is one agreeing in all other respects (see plate 1, fig. 6 *a*, *b*), that has the last piece of each of the radial series a little constricted an each side, and slightly prominent, or protruding at the mesial superior angle; while its lower arm-piece for several ranges up, are proportionally longer than in the specimen described, and somewhat constricted at each alternate suture between them, so that they are joined together by twos in such a manner that each two pieces (that is, the one above and that below each constriction) present together some approach to an hour-glass form. Another specimen (fig. 5 *a*, *b*, of same plate) agreeing exactly in the form and structure of the body, free rays, and arms, up to the third or fourth arm-pieces, with the usual characters of the species; while above this its arms suddenly diminish materially in size, and present the appearance of a new growth of arms that had been broken away during the life of the animal. This may be a normal form or condition of the arms, but I am disposed to view it as the result of some accident, and a subsequent restoration of lost parts, such as not unfrequently occurs in the lower types of animals.

Another individual (fig. 7 *a*, *b*, *c*, of pl. 1), much larger and more robust than the usual size and appearance of the species, but agreeing in all other respects, has the arm-pieces proportionally decidedly shorter than in the smaller average sized specimens, particularly above the middle of the arms, where even at the longer end, the length of these pieces is less than half the breadth. They are all distinctly cuneiform, but they do not have the individual shorter and longer ends regularly alternating an opposite sides of the arms, there being generally two pieces lying together with the longer ends on one side, and then two with them on the other side, the upper one of each pair supporting a pinnule at its longer end, thus giving an alternating arrangement of the pinnules, of one to every third piece along the opposite inner sides of the arms. This is, I believe, the usual arrangement in the smaller individuals; but in those, as already stated, the arm-pieces are proportionally longer and less distinctly wedge-shaped, which causes the pinnules to be less closely arranged.

This large individual agrees almost exactly in size, form and general

appearance with *H. Canadensis*, of Billings (Decade IV, Canadian Org. Remains, p. 48, pl. iv, fig. 5 *a*-5 *d*, which is regarded by some as a variety of *H. simplex*), excepting in its decidedly shorter and cuneiform arm-pieces, there being 12 of these pieces at a point a little above the middle of the arms, in a length of 0.25 inch; while only 5 or 6 pieces can be counted in the same space in Mr. Billings' figures.

This large individual, I suspect, may belong to a distinct species from the others, but I prefer to place it, for the present, as a variety of the same, because in this genus the arm-pieces seem to be subject to more or less variation.

Lorality and position: Cincinnati group of the Lower Silurian, Cincinnati, Ohio. Mr. Dyer's and Dr. C. A. Miller's collections. Those in Dr. Miller's collection came from the lower part of the series. The large specimen was sent by Mr. S. A. Miller to the Smithsonian Institution, from a position in the same series, 380 feet above low water mark of the Ohio at Cincinnati; though I am informed by Mr. Miller that the same occurs lower in the series there.

HETEROCRINUS JUVENIS, Hall.

Plate 1, figs 3 *a, b, c.*

Heterocrinus juvenis, Hall, —; Descriptions of New Species of Palæozoic Crinoids, etc., p. 4, dated Nov., 1866; and (1872) illustrations of a re-issue of same, pl. 1, figs. 9 and 10.

Body very small, less than once and a half as long as wide, with breadth nearly the same above and below, being slightly constricted above at the point where the rays become free; somewhat pentalobate, as seen from below, in consequence of each radial series being convex, and the vertical sutures between them a little excavated. Sub-basal pieces minute or only appearing, externally, as sub-trigonal points at the lower ends of the sutures between the basal pieces, which are comparatively rather large, a little wider than high, with a general pentagonal outline, their lower lateral angles being minutely truncated. First radials in the anterior ray a little longer than wide, and supporting another shorter piece above, that tapers upward and seems to be included as a part of the walls of the body; and upon this rest, in direct succession, three other pieces, that are wider than long, and appear to be free, the third one being axillary, and supporting two arms. Anterior lateral rays with first piece a little wider than long, and supporting in direct succession two other shorter pieces, apparently belonging to the body; while above these there are three still shorter, apparently free pieces,

the last one of which is axillary, and supports two arms. First radial of the left posterior ray, usually a little longer than wide, irregularly hexagonal, or sub-heptagonal in form, and supporting a smaller upward tapering piece above, also apparently belonging to the body series; other parts of this ray unknown. Right posterior ray, with first piece about as long as wide, and pentagonal in form, while it supports, above, a slightly smaller pentagonal body piece, the left superior sloping side of which connects with the first anal, while its right slightly sloping upper side, supports a third smaller radial; which is as far as the parts of this ray can be made out in the specimens studied.

First anal piece (see *a*, of fig. 1 *d*, pl. 1) resting as usual on the left sloping side of the second radial of the right posterior ray, and partly upon a short sloping side of the first radial of the left posterior ray, irregularly pentagonal in form, and bearing above, in direct succession, two other smaller pieces that taper rapidly upward. Surface smooth, or obscurely granulated.

Arms ten, rather short and small; above their origin on the last of the primary radial series, rounded and composed of pieces nearly or quite as long as wide, every fourth or fifth one of which gives off (at least on the interradial side) an armlet or branch about half as large as the main arm above; armlets diverging little from the main arms, and composed of pieces that are longer than wide.

Column proportionally very large, or equaling the diameter of the widest part of the body, sub-pentagonal in form, and composed of moderately thin discs, between each two of which are intercalated, for some distance below the body, five small pieces, ranging exactly on lines with, and corresponding in size and form to, the sub-basal pieces at the connection of the body with the column; farther down these intercalated pieces seem to coalesce and form discs like the others.

Length of body, 0.19 inch; breadth, about 0.17 inch; length of body and free rays to first bifurcation or arm bases, 0.30 inch; length of arms, 0.40 inch; breadth of column, about 0.16 inch.

This species is perhaps most nearly allied, in some respects, to the Cincinnati form usually referred to *H. heterodactylus,* but differs materially in the structure of its arms, which are shorter, and do not regularly divide into equal branches, but merely give off a few lateral armlets, so much smaller than the arms themselves as to present somewhat the character of stout pinnules. The form of its body is also different, not tapering downward to the column, which is likewise very much stouter than that of *H. heterodactylus.* The proportionally very large size of its column, and the smallness of its body and arms, give it a very curious

appearance, so unusual, indeed, that at a first glance the body and arms scarcely attract attention at the end of the column.

I am indebted for the use of the specimens of this species figured to J. Kelley O'Neall, Esq., of Lebanon, Ohio.

Locality and position: Upper part of the Cincinnati group, near Lebanon, Ohio..

HETEROCRINUS HETERODACTYLUS, Hall ?

Plate 1, figs. 1 *a*, *b* (and 2 *a*, *b*?).

Heterocrinus heterodactylus Hall, 1847; Palæontol., New York, vol. 1, p. 279, pl. 76, figs. 1 *a*, to 1 *o*.

Body small, nearly as wide as long, tapering a little from above. Sub-basal pieces minute, only appearing as little rudimentary sections of the last joint of the column at the lower ends of the sutures between the next range of plates. Basal pieces, composing nearly one-third the height of the body, a little wider than long, with a general pentagonal outline, but having the two inferior lateral angles sometimes very slightly truncated by the minute sub-basals. First and second radial pieces of the right posterior lateral ray, larger than the basals, both pentagonal, and somewhat round on the dorsal side; the first one slightly longer than wide, and the second wider than long, and supporting on its left superior sloping side, the first anal piece, while on its right it bears, in direct succession, four rather decidedly smaller primary radials, that are narrowed and rounded so as to assume the character and appearance of free arm-pieces; on the last of these, the first bifurcation of this ray takes place, and both divisions can be seen to subdivide two or three times again, at intervals of about five of the pieces, which are slender, rounded, and about two and a half times as long as wide. First radial of the right anterior lateral ray, comparatively rather larger, longer than wide, pentagonal in form, rounded on the outer side, and supporting in direct succession above, four smaller, rounded primary radials, all of which, excepting perhaps sometimes the first, presenting the appearance of arm-pieces; on the last of these the first bifurcation of this ray takes place, and of these divisions, the left one can be seen in the specimen to divide again on the fifth piece, and its right subdivision again on the fifth; all the segments or joints of the arms being long and slender like those of the posterior ray. First and second radials of the left posterior ray, comparatively large, the first pentagonal and the second quadrangular, and supporting in direct succession three decidedly smaller, rounded arm-like pieces, on the last of which there *appears* to be a bifurcation;

and this is as far as the structure can be traced in this ray. (Other rays unknown.)

First anal piece of moderate size, and resting like an arm base on the left sloping side of the second radial of the right posterior ray, while its left side connects with the second, and perhaps touches the third radial of the left posterior ray; second anal smaller than the first, tapering upward, and resting upon the first, with its upper end passing obliquely inward between the arm-like radials farther up, where it doubtless joins others forming the base of the ventral prolongation.

Column comparatively rather large and strong, somewhat distinctly pentagonal near the body, with more or less rounded angles, and composed of alternately thicker and thinner pieces; the latter not forming continuous discs, but consisting each of five minute sections, disconnected from each other, and ranged as minute transverse nodes coincident with the five angles of the column, and with the minute pieces at the connection of the latter with the body, that are described above as sub-basals. Farther down the column gradually becomes nearly cylindrical, and the little intercalated pieces more and more developed, until they coalesce, and form complete discs, scarcely distinguishable from the others.

Length of body, 0.17 inch; breadth, about 0.14 inch; length of arms, including the free primary radials, about 0.50 inch; diameter of column near the base, 0.06 inch.

This is the western form that has always been referred to *H. heterodactylus,* of Hall; but as the original typical specimen of that species did not show whether or not its arms bifurcate above the division on the last primary radial, and there seem to be some slight differences in the details of its structure*, its identity with that species can scarcely be regarded as established beyond doubt. The specimen studied, was found by Dr. C. A. Miller, of Cincinnati, in the lower beds of the Cincinnati group at that city. It is represented by our figures 1 *a*, *b*, of plate 1, and shows only the posterior side of the body and column, and the arms of the same side.

I also have before me another specimen belonging to Mr. Dyer's collection, agreeing in size, form and general appearance with that described above, and yet presenting some rather marked differences in the details of its structure; particularly of the parts above the body. It also shows only the posterior side, with the left anterior lateral ray. In the first

* Its left posterior ray bifurcates on the fifth piece, while Prof Hall's figure, l*d*, shows eight pieces in direct succession in this ray, without any bifurcation, at least that far up.

place, all of its arm-pieces, and free primary radials, are proportionally decidedly shorter, broader, and less rounded; while in its right posterior ray, it has eight pieces below the first bifurcation, instead of only six, the upper five being much shorter than wide. The difference in the length of the arm-pieces, and in the breadth of the arms, give this specimen quite a different appearance, as seen under a magnifier, and it is therefore possible that if we could make a critical comparison of all parts of the two, other corresponding differences might be apparent. If so, and these differences should be thought of sufficient importance to entitle this form to rank as a distinct species or variety, I would propose to designate it by the name *propinquus*, from its close general resemblance to the one I have regarded as *H. heterodactylus*. Our figures 2 *a*, *b*, of plate 1, represent this form.

Locality and position: As already stated, Dr. Miller's specimen of the form first above described, came from the lower part of the Cincinnati group; and the one last above mentioned, was found by Mr. Dyer in the middle part of the same series at Cincinnati, Ohio.

HETEROCRINUS LAXUS, Hall.

Pl. 1, figs. 8, *a, b.*

Heterocrinus laxus, Hall, 1872; Pl. 1, fig. 15, accompanying a re-issue of a paper of his, date 1866, in which this species is not described.

Body small, somewhat higher than wide, obconoidal, but a little excavated between the radial series of piece, so as to present a sub-pentagonal appearance below. Radial pieces five or six to each ray, not differing materially in form or size, excepting that the first piece in the anterior, right anterior lateral, and left posterior rays, are larger than the others, and longer than wide; in the right posterior, and the left anterior lateral ray, three, and in the others two, of these pieces are included as parts of the walls of the body; the others above these being free, rounded, and separated from those below by a constriction. Anal pieces having the usual arrangement of the genus, that is, the first resting between the sloping, superior lateral sides of the first piece of the left posterior ray, and the second of the right, and supporting two or more smaller pieces in direct succession above.

Arms long, slender, rounded, flexuous, composed of pieces about as long as wide, without being distinctly wedge-formed, though about every fourth one is somewhat larger than the others, and gives off a stout armlet nearly half as thick as the main arms; armlets rounded, alternately arranged on each side of the main arms, and composed of joints that

appear to be nearly twice as long as wide. Surface nearly smooth, or somewhat granular.

Height of body, 0.28 inch; breadth, 0.15 inch; breadth of base, 0.10 inch; thickness of arms at their bases, 0.05 inch; length unknown.

The above description, and our figure and diagram, were made out from the original typical specimen, loaned for that purpose by Mr. Dyer. It does not retain the column, but from the pentagonal outline of the base, it is very probable that the column is distinctly pentagonal at its upper end; and it must also be comparatively rather slender.

This species seems to be most nearly related to the form I have referred doubtfully to *H. heterodactylus;* but it differs in having its body proportionally longer, and more angular, its basal and arm-pieces shorter; while the armlets, or lateral divisions of its arms, are given off at shorter intervals, and its arms proportionally stouter.

Locality and position: Cincinnati group of the Lower Silurian; Cincinnati, Ohio. Mr. Dyer's collection.

HETEROCRINUS [IOCRINUS] SUBCRASSUS, M. and W.

Plate 1, figs. 9 *a*, *b*.

Heterocrinus subcrcrassus, Meek and Worthen, 1865; Proceed. Acad. Nat. Sci., Philad., p. 148; Illinois Geological Report, Vol. III., p. 325, pl. 4, fig. 5 *a*, *b*, c, 1868.

Heterocrinus? (Iocrinus) *polyxo*, Hall, —; Descr. New Species *Crinoidea* and other fossils, page 5, dated Nov., 1866; also (1872) in re-issue of same, pl. 1, figs. 1 to 4.

Heterocrinus (Iocrinus) subcrassus, Meek, 1871; Proceed. Acad. Nat. Sci., Philad., p. 310.

Body presenting the form of a short truncated and inverted pentagonal pyramid, with the five sides deeply concave, excepting at the top, where the breadth is nearly double the height; thence tapering abruptly to the stout column below. Sub-basal pieces undeveloped. Basal pieces, of moderate size, about twice as wide as high, pentagonal in form, the superior sloping margins and lower side being comparatively long, and the lateral very short; all deeply concave up the middle of the outer surface, and very prominent on each side. First radial pieces comparatively large and strong, wider than high, pentagonal in form, and truncated nearly their entire breadth above, for the reception of the succeeding pieces; each very profoundly excavated on their external surface, at the inferior lateral angles, so as to leave all the central region standing out in the form of a very prominent vertical ridge, coincident with that formed by the prominent lateral margins of the basals; while a some-

what similar, but less prominent ridge, extends horizontally across the upper margins on each side, so as to connect with each other on each two contiguous plates.

Right posterior ray, with the second piece a little larger than those of the other rays, twice as wide as long, irregularly quadrangular, or sub-pentagonal in form, with the upper two sides sloping so as to give it the appearance of an axillary piece, but the left, shorter sloping side, merely supports the first anal piece; while from the right continue the succeeding true radials, of which there are three short, smaller pieces in direct succession, the third one being axillary and supporting the first free divisions of the arms. Other rays, bifurcating on the third, fourth or fifth of the free radials, which are smaller than the first, scarcely half as long as wide, and rounded on the outer side. Arms rather long, gradually and regularly tapering; bifurcating three to four times or oftener, above the first division of the rays on the last primary radial. Arm-pieces, like the free radials, all projecting at the upper edge, so as to present a kind of upward imbricating, or roughened appearance.

Anal series, consisting of a direct vertical range of pieces, that are very convex and rounded on the outer side, and rise from the left sloping side of the second radial of the right posterior lateral ray, so as to present much the appearance of an arm, or branch of this ray, but connecting on each side with others forming the lower part of the ventral prolongation. Surface smooth.

Column stout, distinctly pentagonal, the angles coinciding with those of the body; composed near the body, of alternately thicker and thinner pieces.

Height of body, 0.18 inch; breadth of same at top, 0.31 inch; thickness of column at its connection with the base, 0.17 inch; length of arms above the first divisions of the rays, about 1.60 inches; thickness of same just above the last primary radial, 0.08 inch.

This species is most nearly related to *H. crassus*, Meek and Worthen, from the same horizon in Illinois; but differs in being smaller, less robust, and particularly in the slenderness and peculiar roughened appearance of its arms. This latter character is produced by the slight projection of the arm and free radial pieces, on their upper margins, beyond the lower margin of each succeeding piece above.

In the right posterior ray not only the first and second radial pieces are included as a part of the walls of the body, but two, if not all three of the smaller succeeding primary radials, seem also to connect laterally with the pieces forming the lower part of the ventral prolongation.

In first describing this species, Mr. Worthen and the writer mentioned the anal series doubtfully, as a branch of one of the rays, though we at the same time explained, in a foot note, in describing the closely allied species, *H. crassus,* that these may be properly anal pieces, and not an arm or division of this ray. In re-describing these forms in the fourth volume of the Illinois Report, however, we distinctly pointed out that these pieces belong to the anal series.

In describing this species under the name *Heterocrinus?* (*Iocrinus*) *polyxo,* Prof. Hall evidently confounds these anal plates with a division of the arms or rays, as he distinctly states that "no anal plates have yet been observed in any of the individuals examined;" while he farther on adds that "the first division of the arms takes place on the second radial plate in one ray." He placed the species doubtfully in *Heterocrinus,* under a sub-genus, *Iocrinus.* The differences in its general physiognomy, and in the number and proportional size and form of the primary radials included as a part of the walls of the body, may render this distinction desirable.

Locality and position: Upper part of the Cincinnati group of the Lower Silurian, at Cincinnati, Ohio. Mr. J. Kelley O'Neall's collection.

GENUS ANOMALOCRINUS, Meek and Worthen, 1868.

(Illinois Geol. Report, Vol. III., p. 327.)

ANOMALOCRINUS INCURVUS, M. and W.

Pl. 2, figs. 6 *a, b,* c, *d, e, f.*

Heterocrinus? (Anomalocrinus) incurvus, Meek and Worthen, 1865; Proceed. Acad N. S., Philad., p. 148, Aug., 1865.

Hybocrinus? (Anomalocrinus) incurvus, Meek and Worthen, 1868; Illinois Geological Report, Vol. III., p. 327, pl. 4, fig. 3 *a, b.*

Ataxocrinus caponifornis, Lyon, 1869; Trans. Am. Philos. Soc., Vol. XIII., p. 464, pl. xxvii., fig. 0, 0 1, 0 2, and 0 3.

Body depressed sub-globose, expanding very rapidly from the base to the summit of the first and second radials, where it is about twice as wide as high. Basal pieces wider than long, and pentagonal in form, with the superior sloping sides and basal margin longer than the lateral.* Three of the rays with the first radial pieces from three to five times as large as the basal pieces, wider than long, and, like the second pieces in

* Between two of those on the anal side, a sixth smaller, probably abnormal, quadrangular piece occurs in the specimen studied.

the other rays, all very strongly incurved above, between the free radials. Two of these pieces present an irregular octagonal general outline on the outer side, and the third larger one in the left posterior ray, a general ten or eleven-sided outline; while in one of the specimens studied, this piece is abnormally split in two, by a vertical suture passing up the middle, over the intercalated abnormal sixth basal piece; and in another specimen, not only this, but the second piece of the next ray to the left is also split in two. First radials in the other two rays, smaller than those of the three rays described, wider than long, pentagonal in form, and each supporting, in direct succession above, a wider second radial of about the same length, that is also included as a part of the walls of the body, and shows a general hexagonal outline; these latter two second radials, and the first three of the other rays, each provided with a comparatively very small, nearly flat, outward sloping facet above, for the reception of the much smaller free radials, which are comparatively very narrow, but generally as wide as long, or a little wider, distinctly rounded or arm-like, and number in direct succession, in the tight posterior ray, four, in the left, one, in the right anterior-lateral, two, in the left, three, and in the anterior ray, two. Surface finely, or more or less coarsely granular, with sutures sometimes slightly furrowed.

Arms distinctly diverging at their origin on the last of the small free primary radials, long, slender, and very irregularly bifurcating several times above; the divisions being often of unequal size, rounded and composed each of a single range of pieces that are as long as wide, or sometimes longer, more or less constricted around the middle, and bear stout pinnules.

Column stout, round, composed of very thin discs or segments, and, near the base, provided with a large pentagonal opening; segments having the appearance, when moistened and examined by a magnifier, of each being composed of numerous little anchylosed spicula of irregular size and form.*

Height of body, on the posterior side, 0.67 inch, and on the anterior, 0.43 inch; greatest breadth, 0.92 inch; thickness of column at its connection with the body, 0.34 inch.

Although the specimen from which the original description of *Alaxocrinus caponifornis* of Lyon was drawn up, was larger than the type of

* A root in Mr. Dyer's collection, probably of this species, consists of a solid expansion near an inch in diameter, with irregular margins. It has a short piece of the column attached, which rises abruptly from the expansion, and is composed of very thin anchylosed segments, showing this appearance of being each made up of numerous little pieces, very clearly seen, when examined under a glass. See pl. B, fig. 6 *d*.

Anomalocrinus incurvus, M. and W., I cannot doubt that the two proposed species are really the same crinoid. The specimens here under consideration agree well in size and other characters with that studied by Mr. Lyon, excepting in the abnormal presence of a sixth basal piece in one, and the division, vertically, of some of the large primary radials. As these characters, however, are not constant in the specimens, of course they cannot be of specific importance. The small intercalated sixth basal piece has, so far as I know, only been seen in the single specimen figured, there being no traces of it in others agreeing in all other respects; while still others, that agree equally well in all other characters, have none of the primary radials divided into two by a vertical suture.

This division of some of the large primary radial pieces composing the body, is a very peculiar feature. These pieces are divided by a central suture, terminating above directly under the sinus for the reception of the first of the small free radials. Sometimes this suture passes directly from the sinus above to the middle of the lower margin of the piece, and in other examples, very obliquely. I have never seen more than two pieces in anyone specimen so divided, and it is probable that a majority of specimens have none of these pieces split in this way; which was the case with Mr. Lyon's typical example, as well as with that studied by Mr. Worthen and the writer.

In first describing the species founded upon the last mentioned specimen, we place it doubtfully as a *Heterocrinus*, but stated that it differed from the typical form of that group, to such an extent, that, if we were sure the characters presented in the specimen were normal, we would be inclined to view it as the type of a new genus. At the same time we proposed to range it, provisionally, under a sub-generic name, *Anomalocrinus*.

In re-describing it in the Illinois Report, we retained the name *Anomalocrinus*, but placed it provisionally as a sub-genus under *Hybocrinus* of Billings. It seems to me now, after examining several fine specimens, to differ too much from both of the above named genera, as well as from all of the other established groups, to be ranged as a sub-genus under any of them. Mr. Lyon made it the type of a distinct genus *Ataxocrinus* in 1869, and I would willingly retain his name, but for the fact that our name *Anomalocrinus* was published in 1865, and again in 1868; consequently the law of priority requires that it should be adopted.

None of the specimens I have yet seen are in a condition to give any clue to the nature of the vault; but that figured by Mr. Lyon shows that it is not elevated or produced, as in *Heterocrinus*, but scarcely rises above the summit of the body; while in the structure and arrangement

of its body-plates, it differs, as stated above, from that genus, though related to it in some points of structure.

Locality and position: Upper part of the Cincinnati group, at Cincinnati, Ohio. For the use of the fine specimen figured, we are under obligations to Dr. C. A. Miller, of Cincinnati. Other good examples were also loaned for study by Mr. Dyer, of the same city.

GENUS POTERIOCRINITES, Miller, 1821.

(Nat. Hist. *Crinoidea,* p. 68.)

SUB-GENUS DENDROCRINUS, Hall, 1852.

POTERIOCRINITES (DENDROCRINUS) CINCINNATIENSIS, Meek.

Plate 3 *bis,* figs. 5 *a, b.*

Poteriocrinites (Dendrocrinus) Cincinnatiensis, Meek, 1872; Proceed. Acad. Nat. Science, Philad., Feb'y, p. 312.

Body of about medium size, obconic or tapering to the column from above, nearly or quite as wide at the top of the first radials as the height to the same. Base forming a rather rapidly expanding cup, nearly twice as wide as high. Basal pieces of moderate size, wider than high, pentagonal in form, and each provided with a minute notch at the middle of the under side, corresponding to a furrow extending up each side of the column, Sub-radial pieces about twice as large as the basals, as wide as long, or slightly wider, all hexagonal, excepting the one on the anal side, which is heptagonal, and a little larger than the others. First radial piece in the ray on the right of the anal series a little smaller than the sub-radials, and pentagonal in form; supporting on its upper truncated edge a rather shorter piece corresponding to the slightly larger first radials in the other rays, and like the latter, rounded on the outer side, with a pentagonal outline, and a somewhat narrowed facet above, for the reception of the first free radials. Succeeding or free radials, distinctly narrower than those forming a part of the walls of the body, rounded on the dorsal side, and, in the two posterior-lateral rays, all shorter than wide; while the fifth one in each of these rays is an axillary piece, supporting two arms. (Other rays unknown.)

First anal piece nearly as large as the sub-radial upon the upper side of which it rests; connecting on the left with the first radial piece, and on the right with the first and second radials; while it supports others above, forming the base of the ventral extension, which is composed of small pieces strengthened by radiating ribs.

Arms of the two posterior rays rounded, composed of pieces slightly

wider than long, and a little projecting at their upper margins; each bifurcating at least twice (and perhaps oftener) at unequal distances above their origin on the last primary radials.

Column of only moderate size, for an inch or so below the base, where it is very distinctly pentagonal, the angles being a little rounded, with a rather deep furrow between, on each side; composed of short pieces, which near the base seem to alternate with much thinner ones.

Length of body to the top of first radials, 0.25 inch; breadth of same, 0.23 inch; thickness of column at its junction with the body, 0.07 inch breadth of free rays below the first bifurcation, 0.06 inch.

So far as the specimens afford the means of making a comparison, this species would seem to be nearly related to *Poteriocrinus gracilis* of Hall, described in the first volume of the Palæontology of New York, p. 84. His diagram and figure, however, do not show whether that species has two of the primary radials of the right posterior ray included as a part of the walls of the body, as in *Dendrocrinus,* or whether it has more properly the structure of *Homocrinus.* He represents the first anal piece, however, proportionally much smaller than it is in our crinoid, while to the right of, and partly beneath, the anal piece, he shows in his diagram a small piece, that *seems* to occupy the position and relations to other parts, of the sub-anal in true typical *Poteriocrinites.** His specimen had only a segment or two of the column attached, but an end view of it in his diagram represents it as being *round,* while in the form under consideration it is very distinctly pentagonal. As he does not *say* that it differs in the form of the column from his *P. alternatus* (which has a decidedly round column) in pointing out the distinctions between the two, I also infer that it is round in both. In addition to this, *Poteriocrinites gracilis* of Hall is stated by him to be found only at the base of the Trenton limestone; while our crinoid is only known to occur in the middle or upper part of the Cincinnati group. From these facts, and the usual

* Prof. Hall also ranges it under *Poteriocrinus,* in his corrected list of the New York fossils, published in 1859, after he had proposed the genera *Homocrinus* and *Dendrocrinus,* and included this form in the former group in 1852; from which we may infer that his type has more recently been found to possess the structure of typical *Poteriocrinites.* In that case, it would, of course, differ *specifically* from our crinoid: but if either a *Poteriocrinites* proper, or a *Dendrocrinus* (if we view the latter as only a sub-genus of *Poteriocrinites,* as Prof. Hall has since done in describing other species), then the name *P. gracilis* could not stand for the New York fossil, because Prof. McCoy had used that specific name for a species of this genus from the Carboniferous rocks, in 1844. For this reason, D'Orbigny proposed the name *P. sub-gracilis* for the New York species, which will have to be retained if it belongs to any mere section of that genus.

very restricted vertical range of the species of *Crinoidea*, I infer that our Cincinnati form is specifically distinct from the New York species.

Locality and position: Cincinnati, Ohio, in the upper part of the Cincinnati group, of the Lower Silurian. Mr. C. B. Dyer's collection.

POTERIOCRINUS (DENDROCRINUS) POLYDACTYLUS, Shumard (sp).

Plate 3 *bis*, fig. 9.

Homocrinus polydactylus, Shumard, 1867; Trans. Acad., St. Louis, vol. 1, p. 78, pl. 1, fig. 6.

An examination of good specimens of this species shows that it has the structure of the body seen in *Dendrocrinus*, and that it is related to *D. Jewettii*, of Billings, more nearly than to any of the other species known to the writer. Our fig. 9 of plate 3 bis, represents the posterior side of a good specimen of this species.

This is a rather common species in the upper part of the Cincinnati group at Richmond, Indiana.

POTERIOCRINITES (DENDROCRINUS) POSTICUS, Hall.

Plate 3 *bis*, figs. 4 *a*, *b*, c.

Poteriocrinus posticus, Hall, 1872; Plate 1, figs. 5 and 6, illustrating second edition of a paper bearing date of Oct., 1871, in which the species is not described.

Body small, obconic, wider above than the height to the top of the first radials, from which point it tapers rather abruptly to the column below; basal pieces pentagonal, forming about one-fourth the height to the top of the first radials, and all a little wider than high; sub-radials two to three times as large as the basals, about as wide as long, all hexagonal, excepting one on the anal side, which is heptagonal, and somewhat larger than the others; first radials smaller than the sub-radials, with which they regularly alternate, and having a pentagonal general form, but sometimes with the superior lateral angles a little truncated, each, excepting in the right posterior ray, supporting, in direct succession, five other rather small radials, which are rounded so as to present an arm-like appearance, the last one bearing the first divisions of each ray; right posterior ray having six of these pieces above the first, the second piece being, as usual in the group, larger than those above, and corresponding to the first piece in the other rays, in being included as a part

of the walls of the body: one or two of the pieces farther up in this ray, as well as some of those of the other rays, are likewise included as parts of the walls of the ventral extension.

First anal piece nearly or quite as large as the largest sub-radial upon which it rests, hexagonal in form, and connecting on the left with the first radial of that ray, and on the right with the first and second radial of the right posterior ray; while it supports, in direct succession, two or three rows of small pieces above, that compose the posterior basal part of the ventral extension, and in part connect with the radial series on each side. A few small pieces are also seen between the other rays, and connecting with some of the lower radials on each side, so as to present the appearance of interradials, but they more properly belong to the ventral part.

Ventral extension long, apparently cylindrical, and, as usual, composed of about eight vertical rows of alternating hexagonal pieces, with a small ridge extending up the middle of each row, and numerous smaller transverse ridges between.

Arms rounded, and, as in other species of the group, composed each of a single series of pieces nearly as long as wide; bifurcating once or oftener, above their origin on the last free radial pieces, the divisions being usually somewhat unequal in size.

Column unknown; surface nearly smooth, or finely granular.

Height of body to the top of the first radial pieces, 0.18 inch; breadth at the top of same, 0.24 inch; breadth of base at its connection with the column, 0.09 inch.

The specimens of this species from which the above description, and our figures on plate 3 *bis,* were prepared, are those upon which the species was originally founded. They do not retain any part of the column, but from the rounded character of the base, it is probable that the column is round.

It appears to be related to the last, but has decidedly shorter basal pieces, which show no traces of the indentations below, corresponding to the concave sides of the sharply pentagonal column, so characteristic of that species; while its arms are stouter, and composed of pieces that are not a little projecting at their upper and lower margins, as in that species. It seems to be even more nearly related to *P. gracilis,* Hall (not McCoy), than the last is, but has much shorter basal pieces, and a direct comparison of good specimens would doubtless show other well defined differences. It certainly presents one peculiarity, not yet *known* to occur in any other species of the group, unless it may be in the first of the

following species. That is, in having some of the primary radial pieces, above those forming the body, included as a part of the walls of the ventral extension. From that species, however, it differs so widely in nearly all other respects as to render a comparison unnecessary.

Locality and position: Cincinnati group of the Lower Silurian, at Cincinnati, Ohio. Mr. Dyer's collection.

POTERIOCRINITES (DENDROCRINUS) DYERI, Meek.

Plate 3 *bis*, figs. 3 *a*, *b*.

Poteriocrinites (Dendrocrinus) Dyeri, Meek, 1872; Proceed. Acad. Nat. Sci., Philad., Feb'y, p. 314.

Body small, obconic, or tapering regularly to the column from above.

Basal pieces longer than wide, the greatest breadth being across between the superior lateral angles; all pentagonal. Sub-radial pieces a little larger than the basals, longer than wide, and, excepting the one on the anal side (which is largest and heptagonal), all hexagonal. First radials of about the size of the sub-radials, but proportionally broader, being a little wider than long, with a general pentagonal outline, though all excepting the one on the right of the anal series, have the superior lateral angles a little truncated; while the second piece in that ray, which, as is usual in the group, corresponds to the first in the other rays, also has these angles truncated. Succeeding radials in all the rays much narrower, about as long as wide, or slightly longer, and numbering from five to six or seven pieces below the first bifurcation. Arms remarkably long and slender, laterally compressed, more or less angular on the dorsal side, and giving off alternately on opposite sides, at distant intervals above the first bifurcation of each ray, from three to four or more scarcely diverging divisions, that are slightly more slender than the main arms, from which they spring, and sometimes themselves bifurcating once or twice, and composed of pieces about as long as wide.

First anal pieces nearly as large as one of the smaller sub-radials, resting on the superior truncated edge of the largest heptagonal sub-radial, between the first radial on the left, and the first and second on the right; while it supports others above, that form the base of the ventral extension. Interradial spaces with the lowest piece of the ventral part resting between the truncated superior-lateral angles of the first primary radials, so as to appear like minute interradials. Surface without costæ or sculpturing of any kind.

Ventral extension very long, or nearly or quite equaling the length of

the arms, and as wide as the body below; composed of the usual small hexagonal plates, apparently without costæ, and separated by punctured sutures. Column slender, slightly tapering downward just below the base, near which it is more or less pentagonal, and composed of short alternately thicker, and exceedingly thin, segments. Farther down, it becomes nearly or quite cylindrical, and composed of more uniform, very short pieces, with a very small, nearly or quite round perforation.

Length of body from the lower end of base to the top of first primary radials, 0.24 inch; breadth of do., at top, 0.16 inch; length of rays from top of body to first bifurcation, 0.20 inch; length of arms above this bifurcation, 2.30 inches; diameter of column, 0.04 to 0.05 inch.

This delicate little species seems to agree exactly in structure, as well as in physiognomy, with the genus *Dendrocrinus*, excepting that it *appears* to have the small pieces forming the lower part of its ventral extension above the first anal piece, and those seen in the interradial spaces above the large first radials that form a part of the walls of the body, connecting laterally with the succeeding smaller radials nearly up to the first bifurcation. This arrangement, if it really exists, would make these smaller primary radials above the body proper, as it were, a part of the walls of the ventral extension, so that the rays would only become free near the first bifurcation. The specimens seen are not quite in a condition to remove all doubts on this point, but in some conditions these little pieces between the rays give that part of the fossil somewhat the appearance of a *Glyptocrinus*. The presence of well developed sub-radials, and a long ventral extension of the body, exclude it, however, at once, from that genus (to say nothing of other differences), as well as from *Mariacrinus*, from which latter it also differs materially in the structure of its arms, and in other important characters.

In general appearance, it seems to resemble most nearly *Dendrocrinus acutidactylus*, and *D. gregarius* of Billings. It differs from the first, however, in having a more slender body, with proportionally longer arms, much less diverging at the bifurcations, as well as in having the two branches at each division unequal. From the latter species, it also differs in the nature of its arms, as well as in having its column composed of very short pieces, not presenting a bead-like appearance.

Locality and position: Cincinnati group of the Lower Silurian, at Cincinnati, Ohio, where it occurs at the horizon of 100 feet below the tops of the hills. The Survey is under obligations to Mr. C. B. Dyer, of Cincinnati, for the use of the only known specimens of this species.

POTERIOCRINITES (DENDROCRINUS) CADUCEUS, Hall.

Plate 3 *bis.*, fig. 1 *a, b,* c, *d.*

Poteriocrinus (Dendrocrinus) caduceus, Hall, —; Descrip. New Sp. Crinoidea, etc., p. 3, dated Nov., 1866; also (1872) illustrations of new issue of same, pl. 1, figs. 7 and 8.

Body obconic being a little higher than the breadth at the top of the first radial pieces, which are more or less prominent and rounded on the outer side above, owing to the excavation of the interradial spaces; tapering regularly from above to the rather small column. Base wider than high, and forming nearly one-third the height of the body; basal pieces longer than wide, pentagonal, with the superior sloping sides each about equaling the length of the lower side, and shorter than the lateral margins. Sub-radial pieces three or four times as large as the basals, longer than wide, and all hexagonal, excepting one on the anal side, which is heptagonal. First radials somewhat shorter than the sub-radials, but of near the same breadth, pentagonal in form, and all (excepting that of the right posterior ray) more or less deeply excavated above for the articulation of the first of the succeeding free radials; first and second pieces of the right posterior ray smaller than the first in the other rays, a little wider than long, the upper one, which corresponds to the first piece in each of the other rays, being quadrangular, with the upper side wider, and generally merely truncated above for the reception of the first of the smaller fine radial.

Free radial pieces decidedly smaller than those included as a part of the body, being much narrower than the latter, and scarcely more than half as long as wide; all rounded on the dorsal side. First bifurcations of the rays at somewhat variable distances above the body; generally on the sixth free piece, but sometimes farther up, or on the seventh, or even on the eleventh, in the left posterior ray.

Arms bifurcating several times above the first division on the last free primary radials, the divisions being sometimes unequal in size, and becoming much attenuated, the smaller divisions being composed of proportionally longer joints.

First anal piece shorter than the sub-radial on which it rests, but of about the same breadth, hexagonal in form, and supporting a direct series of hexagonal pieces above, that connect with others on each side, forming the lower part of the ventral prolongation.

Surface of body nearly smooth, excepting broad, very obscure ridges, radiating from the central regions to the sides of each plate, to meet

others on the adjacent plates; thus leaving a vertically elongated, rhombic, shallow excavation between, and partly upon, the lateral margins of each two contiguous sub-radials, across each of which excavations three smaller, very faintly defined ridges or costæ may be seen passing horizontally near the edges of these plates. Similar, but proportionally smaller excavations (without the transverse ridges), are also seen between the basal pieces; and a trigonal one at the meeting of the mesial superior angle of each sub-radial and the inferior lateral angles of the first radials.

Column comparatively small, sub-pentagonal or nearly round; and near the base composed of alternately thicker and thinner segments, that show indications of division into five parts by longitudinal sutures.

Length of body to top of radials, 0.35 inch; breadth at same point, 0.34 inch; length of arms from the first divisions of the rays to the extreme ends of some of their smallest sub-divisions, sometimes 2.40 inches or more.

Of this fine species, I have for study nine examples of the body, with more or less of the arms and column attached to each, all from the same locality and position as the original typical specimen. These are generally in a good state of preservation, and, taken together, give a fine opportunity to work out nearly the entire structure. They show that its arms each bifurcate several times, the divisions (above the first bifurcation) being generally unequal, the smaller one becoming very attenuated, but usually, like the larger, bifurcating two or three times. Prof. Hall describes the arm-pieces as having their "upper lateral margins somewhat projecting for the attachment of tentacula." The specimens under consideration show this slight projection of the superior lateral margins of the arm-pieces; but I have been unable to see any traces of tentacula (pinnulæ) in connection or association with any of them, though detached pieces of the very attenuated sub-divisions of the arms themselves, as seen lying in the matrix, might be readily mistaken for such. His statement that the arms or rays bifurcate first on the sixth piece above the first radial plate, although agreeing with the general structure of our specimens, is not strictly correct with regard to all of the rays of all the specimens, the left posterior lateral ray in one case showing, as stated in the description, seven of these pieces, and another eleven, below the first division.

None of the specimens examined show the ventral prolongation, but it is doubtless much produced as in other species of the group.

Locality and position: Upper part of Cincinnati group, of the Lower Silurian, near Lebanon, Ohio. For the use of the specimens from which our description and figures were made out, I am under obligations to J. Kelley O'Neall, Esq., of Lebanon, Ohio.

POTERIOCRINITES (DENDROCRINUS) CASEI, Meek.

Plate 3 *bis.*, fig. 2 *a, b, c.*

A Pentacrinite, Christy, 1848; Letters on Geology, plate II. (without a description or specific name.)

Dendrocrinus Casei, Meek, 1871; Am. Jour. Sci. and Arts, Vol. II. (3d ser.), p. 295; issued Sept. 29th, for October, 1871.

Column very distinctly pentagonal, the angles at the connection with the body being continuous, with strong ridges passing up the sutures between the basal pieces and to the middle of the sub-radials. Body having the form of an inverted pentagonal pyramid, a little wider above than its height. Base wider than high, strongly pentagonal, being deeply excavated up the middle of each piece, and very prominent at the lateral sutures; basal pieces wider than high, pentagonal in form, with the mesial angle above salient, and the superior lateral sloping sides much longer than the lateral margins. Sub-radial pieces of moderate size, four hexagonal and one heptagonal, all very convex in the middle, from which point they each send one strongly elevated ridge to each side to meet others on each of the surrounding plates, and one to the mesial angle below to another coming up the sutures between the basals; while on each side of these ridges, excepting sometimes those passing to the first radial pieces above, there is usually a smaller, less elevated parallel ridge; the surface of the body being divided by these ridges into profoundly excavated triangular spaces, in the middle of which the corners of the body-plates meet. First radial pieces, excepting one on the anal side, larger than the sub-radials, about as wide as high, with a general pentagonal outline, the upper side being longest and deeply excavated for the reception of the comparatively narrow free radials; one on the right of the anal series pentagonal, and supporting another radial above, that is included as a part of the walls of the body, and corresponding to the first piece in the other rays; all the first radials in four of the rays, and the second in the other, convex in the middle, and sending a strong ridge to each of the contiguous body-plates below, while six or eight much smaller ridges pass horizontally across from one to another of each two contiguous plates of this range. Succeeding radials free, much narrower and assuming the character of arm-pieces; in the posterior rays the fifth piece above the body being axillary and supporting each two arms, which are long, rounded, and seen in one of the specimens to bifurcate at least twice above, where they become quite slender, and are composed of pieces that are longer than wide; anterior and anterior lateral rays, bifurcating

first on the sixth or seventh piece, which is as far as they can be traced in the specimen studied.

Anal series with the first piece resting directly upon the upper truncated side of the heptagonal posterior sub-radial, hexagonal in form, and bearing in direct succession above a series of hexagonal pieces gradually diminishing in size; while alternating with these similar small hexagonal pieces can be seen on each side of the mesial series, for some distance above the body between the free rays, and connecting with those of the ventral part.

Ventral prolongation of the body more than five times as long as the body itself, and, as seen flattened, of greater breadth than the same; apparently equaling the entire length of the arms; as usual, composed of numerous small hexagonal, alternately interlocking pieces, of equal size, that are strengthened by little, transverse, or slightly oblique costæ, so arranged as to present an ascending zig-zag appearance.

Height of body to the top of the first radials, 0.39 inch; greatest breadth at top of same, 0.32 inch; length of incomplete ventral prolongation, 1.95 inches; breadth of same as flattened near upper end, 0.65 inch; breadth of free rays below the first bifurcation, 0.12 inch.

Although differing considerably in its physiognomy from the typical species on which the genus or sub-genus *Dendrocrinus* was founded, this crinoid agrees well in its fundamental points of structure with the same, and evidently belongs to the same group. In general appearance its body resembles that of *Palæocrinus angulatus* of Billings, but it differs in having the costæ of its body-plates, in part, with each a smaller one on each side; and its column is very much more distinctly pentagonal. Of course it also differs in the generic character of having its ventral portion prolonged so as nearly or quite to equal the length of its arms, instead of scarcely rising above the horizon of the arm-bases, as in *Palæocrinus.**

Since seeing a plaster cast (belonging to Mr. U. P. James, of Cincinnati) of the crinoid figured by Mr. Christy in the paper cited at the head of this description, under the name *Pentacrinites*, I have no doubt that it is the same species here described; Mr. Christy's figure being enlarged and inaccurate in some of the details of structure and ornamentation.

The *Dendrocrinus* group agrees so nearly with *Poteriocrinites* in structure, that it ought probably not to be regarded as more than a sub-genus under the same.

* Now, since the nature of the vault of *Cyathocrinites* is known (see Proceed. Acad. Nat. Sci., Philad., Dec., 1868, pp. 324 and 336), it seems to me that *Palæocrinus* can scarcely be retained as distinct from that genus.

The specific name of the form here described was given in honor of L. B. Case, Esq., of Richmond, Indiana, to whom I am indebted for the use of the first specimen of the species I have seen. I am also under obligations to Mr. C. B. Dyer, of Cincinnati, for the loan of two smaller specimens, one of which (see fig. 3 *c*) shows the anal side, and more of the arms, than the larger one belonging to Mr. Case.

Locality and position: Mr. Case's specimen was found by him at Richmond, Indiana, in the upper part of the Cincinnati group of the Lower Silurian; and those belonging to Mr. Dyer came from the same horizon, between Cincinnati and Oxford, Ohio.

GENUS GLYPTOCRINUS, Hall, 1847.

(Palæontology N. Y., Vol. 1, p.281.)

GLYPTOCRINUS DECADACTYLUS, * Hall.

Plate 2, figs. 5 *a, b.*

Fossil Encrinite, Anthony, 1839; Am. Jour. Sci. and Arts, Vol. XXXV., p. 405, with a wood cut.
Glyptocrinus decadactylus, Hall, 1847; Palæont. N. Y., Vol. 1, p. 281, pl. LXXVII., fig. 1, *a-f;* and pl. LXXVIII., fig. 1, *a-u.*

Body obconoidal, with interradial and axillary areas a little flattened, so as to present a slightly pentagonal outline, as seen from below; somewhat higher than wide, and tapering to the column below. Sub-basal pieces undeveloped. Basal pieces small, pentagonal in form, wider at the top than high. First radial pieces larger than the basals, as wide as long, and heptagonal in form. Second radials a little smaller than the first, and hexagonal or heptagonal in outline; third radials of the same size as the second, heptagonal in outline, and each supporting on its upper sloping sides the secondary radials, of which there are two in direct succession in each division, that are nearly as large as the third primary radials; while on the second of these, another bifurcation takes place, giving origin to two series of brachial pieces, the first two or three of which are included as a part of the walls of the body, so as to present the appearance of tertiary radials, but there are no farther bifurcations, the free arms being directly continued from the last included brachial pieces, thus making four arms to each ray, or twenty to the entire series.

Interradial series, consisting of one piece in the first range, resting between the superior sloping sides of the first primary radials; over each

* It was an unfortunate misnomer to call this species *decadactylus,* as it has 20, instead of only 10 fingers, or arms, as they are now called.

of these, two occur in the second range, three in the third, and two or three in the fourth; while above the latter ten or twelve smaller pieces may usually be counted in each area of adult specimens. Anal area occupied by about the same number of pieces as the interradial, but with a somewhat different arrangement, there being above the first piece three in each range, those of the middle series resting each directly upon the upper truncated side of the next below, all the way up. Axillary areas each occupied by about three small pieces; while each interbrachial area is also occupied by two or more very small pieces.

Arms rising vertically from the last attached brachial pieces; long, slender, simple, rounded on the outer side, and composed each of a single series of very short wedge-formed pieces, each of which supports at its larger end a pinnule; pinnules alternately and very closely arranged along the inner lateral margins of the arms; very slender, and composed of joints three or four times as long as wide.

Surface elegantly ornamented, with radiating costæ, of which those passing up the middle of the primary and secondary radials to the arm-bases, are a little larger and more prominent than the others, so as to form continuous narrow ridges; while the others radiate from the center of each of the body-plates to each of its sides, where they connect with those on the contiguous plates, so as to divide the whole surface into numerous triangular impressed areas.* Vault depressed to the horizon of arm bases, and composed of numerous, very small, generally hexagonal pieces, that are nearly flat, or sometimes rise into little node-like prominences in the middle.

Column of moderate size, and, near the base, round, and composed of alternately thicker and thinner pieces, the former of which are also a little wider, so as to project somewhat beyond the others; perforation distinctly pentagonal.

Height of the body of a very large, fine specimen, 1.30 inches; breadth of same, about 0.95 inch; thickness of arms at their bases, 0.09 inch.

This is one of the most common and beautiful crinoids of the Cincinnati rocks, and can be readily distinguished from all the other known species by the form and structure of its body. In its ornamentation it resembles *G. Dyeri*, but it differs materially from that species, not only in its more elongated obconical form, but in only having two, instead of nine or ten pieces in each division of the rays, between the first bifurcation and the arm-bases, as well as in other details of structure. In gen-

* In well preserved specimens, the costæ sometimes become suddenly attenuated before meeting at the center of the plates.

eral form it is more like *G. O'Nealli*, from which it may be at once distinguished, by its less deeply excavated interradial and interbrachial areas, which are also occupied by larger and much less numerous pieces. It also presents the important difference of having its secondary radials (and even some of the lower brachial pieces) included as a part of the walls of the body, instead of becoming free between the first division and the arm-bases; while the distinct radiating costæ of its body-plates is another strongly marked distinction.

Among all of the numerous fine specimens of this species I have seen from Cincinnati, I have not observed the undulating character of the sutures between the body-plates, represented by figure 1 *e*, pl. 77, of Prof. Hall's illustrations in volume 1 of the New York Palæontology.

Locality and position: Middle and upper part of Cincinnati group of the Lower Silurian, at Cincinnati, Ohio, and the surrounding country. It is also said to occur near the top of this series at Madison, Indiana, and Maysville, Kentucky, and fragments supposed to be of this species, have been found at near the same horizons in New York.

GLYPTOCRINUS DYERI, Meek.

Plate 2, fig. *a, b.*

Glyptocrinus Dyeri, Meek, 1872; Proceed. Acad. Nat. Sci., Philad., Feb'y, p. 314.

Body globular-subturbinate, being wider than high, with sides rounding under to the base. Sub-basal pieces obsolete, or if present, not exposed externally. Basal pieces projecting as a thin rim below, very small, much wider than high, and presenting a trigonal general outline, though the lateral angles are doubtless minutely truncated. First radial pieces of moderate size, heptagonal in form, and wider than long; second and third a little smaller, the second being hexagonal, and the third pentagonal, and supporting on its superior sloping sides the first divisions of the rays. Secondary rays, or supraradial series, each composed of from eight to eleven pieces, that rapidly diminish in size upward to the second bifurcation, or commencement of the arms, just below which a few of the smaller pieces seem to be free and bear pinnulæ on their inner sides; farther down, the second and fourth supraradials of each ray give off alternately on each side small divisions, that do not become free, but are soldered into the interradial walls, though they can be traced to the summit of the body, where they merely give origin to pinnules.

Anal area a little wider than the interradial areas. First anal plate of about the same size as the first radials, hexagonal in form, and supporting, in the next range, three pieces, arranged with the middle one

higher than the others; while above these, three smaller pieces can be seen disposed in the same way in the third range, and three to four or five in the fourth; which is as far up as they can be traced. The middle plates of this series form a direct vertical row, that have a more or less prominent mesial rounded ridge extending all the way up from the middle of the lowest piece, of about the same size as those passing up the primary and secondary radial series; while the other plates on each side, and other parts of the lowest pieces, are ornamented with radiating costæ of smaller size, like those on the interradial pieces.

Interradial areas not excavated below, but becoming moderately concave above; first interradial pieces, of about the size of the second primary radials, hexagonal in form, and supporting two other somewhat smaller pieces in the next range, that bear between their superior, sloping sides a fourth smaller piece; while above these there are two pieces in the next range, that connect with the pieces of the little lateral divisions of the secondary radials, and perhaps with some other small intercalated pieces filling the upper part of the interradial areas.

Axillary areas flat, and each occupied below by a hexagonal or heptagonal piece of about the size of the second piece of each secondary radial; while the space above is occupied by several much smaller pieces.

Arms, four to each ray, rounded on the dorsal side, slender, of moderate length, very gradually tapering, simple, and composed of very short, slightly wedge-formed pieces, each of which bears at its larger inner lateral end a pinnule; pinnules slender, rather closely arranged, deeply furrowed on their inner sides, and apparently composed of rather long joints.

Surface of body-plates all ornamented with distinct radiating costæ starting from the center of each piece, and passing one to each of its sides so as to connect with others on each contiguous piece; of these costæ, those passing up the middle of each of the radial series are a little larger and more prominent than those of the interradial plates, while they bifurcate with the rays, so as to send a division up each of the secondary radial series, toward the upper part of which they become more prominent and rounded, being there of about the size of the free arms. Column unknown.

Height of body, 0.60 inch; breadth about 0.68 inch; length of arms, 1.05 inch; thickness of same, 0.05 inch; number of joints in a space of 0.10 inch near the base, eight.

This very beautiful species reminds one by its sculpturing of the common typical species *G. decadactylus,* from which, however, it may be at once distinguished by its proportionally broader and shorter body, with

sides rounding regularly under to the column, instead of being obconical. It also has proportionally more slender arms, and differs materially in having, in each secondary radial series, from nine to eleven pieces; between the first bifurcation of each ray and the arm-bases, instead of only two. In the form of its body, it agrees more nearly with *G. ornatus* of Billings, but it differs materially from that species in having twenty arms instead of only ten, as well as in less important details.

The specific name was given in honor of C. B. Dyer, Esq., of Cincinnati, Ohio, to whom I am indebted for the use of the very fine specimens figured, and from which the description was also made out.

Locality and position: Cincinnati group of the Lower Silurian; about 100 feet below the tops of the hills, at Cincinnati, Ohio.

GLYPTOCRINUS DYERI, *Var.* SUB-GLOBOSUS, Meek.

Plate 2, fig. 2 *c.*

Glyptocrinus Dyeri, Meek, 1872; Proceed. Acad. Nat. Sci., Philad.

There are in Mr. Dyer's collection some specimens agreeing almost exactly in structure with *Glyptocrinus Dyeri;* but differing in the form of the body, which is less rounded below, while their arms, and the ridges extending up the radial and anal series of plates, are decidedly stouter, and thus impart to these specimens a more robust appearance. They also have a much thicker column. In general appearance, this form stands, as it were, intermediate between *G. Dyeri* and *G. decadactylus.* It differs, however, decidedly from the latter, and agrees with the former, in having ten to twelve secondary radials between the first bifurcation of each ray and the second division, instead of only two, as in *G. decadactylus.*

It is quite possible that this may be a distinct species from *G. Dyeri,* to which it is most nearly allied; but without having more specimens for comparison, I scarcely feel warranted in separating it more than as a variety.

Locality and position: Same as last.

GLYPTOCRINUS NEALLI, Hall.

Plate 2, fig. 3 *a, b,* c.

Glyptocrinus Nealli, Hall, —; Descriptions New Sp. Crinoidea, etc., p. 2, dated Albany, Nov., 1866; also 1872, illustrations new issue, pl. 1, figs. 18 and 19.

Body obconoidal, somewhat wider above than the height, with the interradial and axillary spaces so deeply excavated as to impart a five-

angled appearance below, and a ten-angled outline above the first divisions of the rays. Sub-basal pieces well developed, so as to assume the character of basals, wider than long, and exposing merely a triangular, sometimes slightly protuberant surface, with the lateral angles minutely truncated. Basal pieces proportionally much larger, about as long as wide, and hexagonal in form. First and third radials of equal size, with a general pentagonal outline, about as wide as long, the first being wider below, and the latter above; second radials as long as the others, but narrower, and presenting a general oblong outline.* Secondary radials twelve to about sixteen in each series, four or five of the lower ones being larger, and proportionally longer, than those above (which are very short, free, and scarcely differ from the free arm-pieces); the second or third one having somewhat the character of an axillary piece, and giving off a small lateral division or series of pieces on the outer or interradial and anal sides, that do not become immediately free, but are soldered in with the interradials and anals to the top of the body, where they each merely give origin to a pinnule like those of the arms.

Interradial areas occupied by numerous (70 to more than 100†) small pieces of very irregular size and form, and without any definite arrangement. Anal series less numerous (50 to 60), and still more unequal in size, the middle row being decidedly larger and more prominent than the others, so as to form a ridge up the middle of the anal area; while the other smaller and less prominent ones are crowded in irregularly on each side. Axillary areas each occupied by about fifty to sixty very small, irregularly arranged, unequal pieces. Vault composed of numerous minute pieces, generally of hexagonal form; highest on the anterior side, with a ridge radiating to each arm-base, and a corresponding sulcus between; opening minute, penetrating a small tubercle situated behind the middle, and directed backward.

Arms twenty, long, slender, rounded, gradually tapering, and simple, above their origin on the last, free, secondary radials; composed of very short, slightly wedge-formed pieces, each of which (like those of the smaller free primary radials below) supports a pinnule at its thicker end within. Pinnules long, rather stout, closely arranged, and composed of joints apparently three times as long as wide.

Surface of body smooth, excepting strong ridges that start from the head of the column at the base of the sub-radials, on which they bifurcate

* In one specimen this piece is abnormally wanting in one of the anterior lateral rays.

† The number of all these interradial and axillary pieces here given is greater than stated by Prof. Hall, but the specimens vary much in this respect.

and send a branch to each of the primary radial series, and on these they unite and ascend as five prominent ridges to the last piece of each of these series, where they bifurcate and send a branch up each secondary radial series.

Column more or less distinctly pentagonal, and composed of alternating thin and somewhat thicker pieces.

Height of body to the commencement of the first free primary radials, on the anterior side, 0.77 inch; breadth at same point, about 0.65 inch; thickness or breadth of free primary radials, 0.08 inch; do. of arms at base, 0.06 inch; length of arms unknown; thickness of column at base, 0.13 inch.

This is a very distinct species from all of those previously described. In the general form of its body it does not differ much from *G. decadactylus*, but it differs materially from that species in having its interradial, anal and axillary spaces deeply excavated and occupied by much more numerous, smaller, and non-costated plates. It likewise has a much larger number of secondary radials in each series, and seven or eight of the upper ones in each free, and bearing pinnulæ like the arms, instead of having them all soldered as a part of the walls of the body, up to and above the second bifurcation of the rays.

The remarkable development of the sub-basal pieces of this crinoid, so as to give them the character of basals, and the great number and rudimentary character of the minute interradial pieces, are characters showing a decided approximation toward *Reteocrinus* of Billings, in which the interradial pieces are apparently entirely obsolete.

Locality and position: Upper part of the Cincinnati group, near Lebanon, Ohio. I am under obligations to J. Kelley O'Neall, Esq., of Lebanon, for the use of the fine specimens of this species, from which the figures and description are given.

GLYPTOCRINUS PARVUS, Hall.

Plate 2, fig. 4 *a*, *b*.

Glyptocrinus parvus, Hall, 1872; Illustrations accompanying a re-issue of "Descriptions of New Sp. Crinoidea," etc., pl. 1., fig. 17, without a description.

Body small, obconoidal, with interradial spaces a little flattened. Sub-basal pieces undeveloped, or very small. True basals, comparatively large, with a general pentagonal outline. First radials a little larger than the basal pieces, and heptagonal in form; second and third a little smaller, the

former hexagonal, and the latter apparently pentagonal or hexagonal, and supporting on each of its superior, sloping sides, in direct succession, two rather large secondary radials, the upper of which are each axillary pieces, and bear two arms, that are apparently free from near their bases.

First interradials nearly as large as the first radials, hexagonal in form, and each bearing two pieces in the next range, above which there are two or three smaller pieces in each area. Anal area not exposed in the specimens studied. Axillary spaces apparently occupied by one or two small pieces.

Arms twenty, slender, and near their bases composed of pieces that are nearly twice as long as wide, but which gradually become proportionally shorter and more wedge-formed farther up, so as to be about as long, at their longer ends, as their breadth; the larger ends being alternately on opposite sides, and bearing, along the inner margins, comparatively rather stout pinnules.

Surface of body scarcely costate, but with the primary and secondary radial pieces more prominent than the others, so as to form ridges. Column round at its connection with the base. Vault unknown.

At a first glance this species might be mistaken for a young G. *decadactylus;* but it differs from that species, not only in being much smaller, and in having a proportionally shorter body, but in having its arms apparently free from their origin on the last secondary radials. Its arm-pieces are also proportionally decidedly longer and its pinnules stouter and less closely set; while its body-plates want the distinct radiating costæ of *G. decadactylus.*

The only specimens of this species I have seen are somewhat crushed and distorted by accidental pressure, so that the characters given in the foregoing description may be found not to be *exactly* correct, in all the details, though they seem to be as given.

Locality and position: Cincinnati group of Lower Silurian, at Cincinnati, Ohio. Mr. Dyer's collection.

GLYPTOCRINUS BAERI, Meek.

Plate 2, fig. 1 *a, b.*

Glyptocrinus Baeri, Meek, 1872; Am. Jour. Sci. and Arts, Vol. III., (3d series), p. 260.

Body of about medium size, globose-obconoidal. Sub-basal pieces apparently not developed, or very small. Basal pieces short and pentagonal. First primary radials of comparatively moderate size, presenting a general heptagonal outline; second a little narrower than the first, but of nearly

the same length, with a general quadrangular form; third slightly larger than the second, and pentagonal in general form. Secondary radials consisting of about four pieces in succession on each upper sloping side of each third primary radial; the first two or three of each series only about one-third smaller than the second primary radials, while above these the succeeding pieces soon become much shorter free brachials. Interradial pieces numerous, small, of very unequal size, and without any regularity of arrangement. Anal series unknown, but probably consisting of a mesial series of hexagonal pieces resting one upon another, and many much smaller pieces irregularly arranged between these and the radials on each side. Axillary spaces each occupied by some six or more small pieces.

Arms ten, rather long, simple, widest a little above their bases, and then gradually tapering to their ends; composed of very short pieces, so strongly cuneiform as to appear almost to taper to nothing alternately on opposite sides, while each supports a pinnule at its thicker end. Pinnules very long, moderately stout, nearly in contact, and composed of pieces that are three to four times as long as wide.

Surface of body-plates without costæ or striæ; those of the primary and secondary radial series more prominent than the much smaller pieces filling the interradial and axillary spaces, and thus forming somewhat flattened ridges, more or less interrupted at the sutures, and abruptly beveled at the sides; interradial and axillary areas roughened by a minute projection on each of the little pieces filling the same.

Column of moderate thickness, apparently nearly round, or perhaps sometimes sub-pentagonal near the base, and composed of alternately thicker and thinner pieces, the former of which project a little beyond the others.

The body of the only specimens of this species I have seen are too much distorted by pressure to afford very accurate measurements, but it seems to be about 0.45 inch in height, by a little less in breadth; while its arms measure 0.07 inch in breadth at the widest part, a little above the body, where about eight arm-pieces may be counted in a length of the same space.

This species will be readily distinguished from all of the described forms of the genus resembling it in other respects, by having only ten simple arms, and by the large number and small size of its interradial pieces. In the latter character it resembles *G. Nealli* of Hall, from which, however, it differs very decidedly in almost every respect; but more particularly in having only ten, instead of twenty arms, which are also stouter. Its interradial and axillary spaces likewise differ materially in

not being distinctly excavated, and in having each of the little pieces by which they are filled provided with a little projecting point.

The specific name was given in honor of Dr. O. P. Baer, of Richmond, Indiana, to whom I am indebted for the use of the specimens from which the figures and description have been prepared.

Locality and position: Upper part Cincinnati group of Lower Silurian, at Richmond, Indiana.

CYSTOIDEA.

GENUS LEPOCRINITES, Conrad, 1840.

(Ann. Report Palæontol., N. Y., p. 207.)

LEPOCRINITES MOOREI, Meek.

Plate 3, fig. 4 *a*, *b*, c.

Lepocrinites Moorei, Meek, 1871; Am. Jour. Sci. and Arts, Vol. II., p. 296, 3d series, (issued Sept. 29, for Oct., 1871.)

Body obovate. Base forming nearly one-fourth the height of the body, with its four pieces each about as long as wide, and of nearly equal size; three of these pieces being irregularly pentagonal in form, and one on the anal side hexagonal. Plates of the second range alternating with the basal pieces, excepting one on the anal side, which is longer than the others, cuneate-pentagonal in form, and resting on the upper slightly concave side of the hexagonal basal piece, while its narrow end extends up to the lower margin of the anal opening; succeeding piece on the left of that just described, of equal or slightly greater length, and heptagonal in outline, with one of its short upper sides forming a part of the margin of the anal opening;* the other three pieces of this range are about as long as wide, two hexagonal, and one apparently heptagonal. Plates of the third range, of very unequal size and form, and all alternating with those of the second range, excepting one on the anal side, which rests on the short upper side of the largest heptagonal piece of the second range, forms a part of the margins of the anal opening, and also extends upward so as to compose a part of the upper side or vault of the body; two of the others have an oblong sub-hexagonal form, one a more regular hexagonal

* This opening is often called the ovarian aperture; but this is against all analogy, if we can judge from the known method of reproduction in the existing *Crinoidea.* Differences of opinion also exist in regard to whether it was simply an anal opening, or both anal and oval. The former seems to me to be the most probable.

outline, and the fifth, which is largest, a trapezoidal outline. Fourth range, although in part curved and extending downward so as to form a portion of the lateral walls, also extend upward and forming the top or vault of the body.

Pectinated-rhombs four, comparatively large, and, as usual, each composed of a pair of elongate-subtrigonal openings, protected each by fifteen to twenty little transverse bars. Lower rhomb at the base of the anterior side of the body, with its lower half near the margin of one of the basal pieces, and the other near the contiguous margin of one of the next range of pieces above. Two of the other three rhombs situated on the right side of the body, mainly above the middle, in such a manner that their longer diameters diverge upward at an angle of 45°, a half of each being placed, one near each of the lower sloping margins of a plate that extends up and forms a part of the vault, and the other two halves occupying the upper margins of each of the two contiguous plates of the third range just below. Fourth rhomb on the left side of the body, with its longer diameter ranging horizontally on a line with the anal opening, and so situated that its upper half is at the lower margin of a plate forming a part of the vault, and the other half near the upper margin of the third range just below.

Arms five, recumbent, and very short, so as to be confined mainly to the top of the body, where they occupy very shallow, scarcely perceptible, smooth depressions in the surface of the vault plates; arranged so that one extends backward and downward nearly to the anal opening, another to the two rhombs on the right side, a third to the right margin of the rhomb on the left, and two others diverge forward; each provided with a distinct, slightly flexuous, ambulacral furrow, and composed of about ten alternating pieces, exclusive of an axillary piece between each two of of their inner ends. Pinnulæ unknown.

Anal opening large, round, with beveled margins, and placed about one-third the length of the body below the summit of the posterior side; valvular pieces by which it was protected, unknown, excepting two minute pieces, each provided with a minute central tubercle, seen adhering to its lower margin, that probably belonged to that series, the others having been accidentally removed. Other apertures unknown.

Surface ornamented with small thread-like radiating costæ, one of which, passing from the middle to each side of each plate, is usually slightly larger than the others between.

Column round, at its connection with the base, comparatively large, composed of thin pieces, and provided with a large internal canal, but soon tapering to a smaller size, and composed of thicker segments below.

Height of body, 0.46 inch; breadth, about 0.36 inch; thickness of column at its connection with the body, 0.14 inch; and at a little more than 0.50 inch below, scarcely 0.07 inch.

This species seems to present essentially the characters of the genus *Lepocrinites,* excepting that it has four, instead of three pectinated rhombs, and five instead of four arms. Exactly how much importance should be attached to these differences, I am not fully prepared to decide, without specimens of several allied types at hand for comparison; though I am scarcely inclined to think these characters, even if normal in the only specimen I have seen, of generic importance. Prof. Hall includes under *Lepocrinites,* or *Lepadocrinus,* as he corrects the orthography of the name, *Apiocystites* of Forbes, and his own *Callocystites,* the first of which has four, and the latter five arms; but each of these, as well as the original type, has only three rhombs or pairs of pectinated openings.

Should the change in the orthography of the name of this genus be adopted, of course the name of the species here described would become *Lepadocrinus Moorei.*

The specific name was given in honor of Prof. Joseph Moore, of Richmond, Indiana, to whom I am under obligations for the use of the only specimen of the species yet discovered.

Locality and position: Upper part of the Cincinnati group of the Lower Silurian, at Richmond, Indiana.

GENUS ANOMALOCYSTITES, Hall, 1859.

(Palæntol. N. Y., Vol. III., p. 133.)

ANOMALOCYSTITES (ATELEOCYSTITES?) BALANOIDES, Meek.

Plate 3 *bis,* figs. 6 *a, b,* c.

Anomalocystites (Ateleocystites?) balanoides, Meek, 1872; Am. Jour. Sci. and Arts, Vol. III. (3d series), p. 423.

The only specimens of this fossil that I have seen are in a bad state of preservation, being distorted by pressure, and only consisting of the lower portions of the body, and some of the extremely thin segments of the thickened part of the column connecting with the base of the same. One side of the body was evidently fiat, or a little concave, and the other convex; and the entire outline, as seen on either of its sides, was probably oblong-suboval; while the lateral margins are distinctly carinated, at least toward the lower part of the body.

On the flat or concave side, the middle two pieces are elongate cuneiform, being widest below, and tapering upward, the length of each piece being a little more than twice its greatest breadth below, where they are each truncated obliquely upward and inward, with concave margins, to form a very profound, rounded sinus, for the reception of the large upper end of the column. The marginal pieces, one on each side of those just described, on the contrary (as seen on the flat side), taper downward with an inward curve, and do not quite reach the base of the lateral portions; while they appear to be shorter above than the middle pieces, their upper ends being apparently obliquely truncated (downward and inward) for the reception of an unknown piece above each, belonging to the next range; while they are abruptly deflected along the lateral carinæ, so as to appear as marginal pieces on the convex side of the body also.

On the convex side of the body, the lower range of plates consists of three large pieces, with a comparatively narrow face of the deflected and carinate marginal pieces on each side. The lower edges of the three large mesial plates are also sinuous, for the reception of the end of the column, but less deeply so than the central two on the flat side of the body. The central of these three pieces is the largest, somewhat coffin--shaped, and as long as the middle two pieces of the other side. It tapers from near the middle downward, to a narrow base, and also upward, more or less, from the same point, but the exact form of its upper part cannot be made out from the specimens studied. On each side of this middle piece there is a somewhat shorter piece, wider below, and tapering slightly upward, with its upper end truncated a little obliquely inward and downward, with a slightly concave margin, for the reception of a piece (the form of which is unknown) above each, in the next range, and connecting with each side of the middle plate above its middle. Outside of each of the lateral of these three pieces of the lower range, on this side, the comparatively narrow face of the marginal carinate piece is seen, and apparently extending upward a little farther than the lateral of the three larger pieces. The parts above those described, on both sides, are unknown.

The surface is finely and obscurely granulo-striated, these markings showing a tendency to run longitudinally on the marginal pieces, and transversely (but much interrupted and broken up) on the middle pieces of the flat side. On the convex side, they generally assume more the character of obscure irregular granules, excepting near the lower ends of the two lateral of the three principal pieces, where they become little regularly arranged, rather distinct, raised transverse lines.

The column was evidently comparatively very large at its connection

with the body, and composed of extremely thin pieces, that are not transverse, but (at least near the body) bent or deflected, so as to conform to the sinuous margins of the base of the body. It also seems probable that the habitual posture of the body, with relation to the column, was such that the two were not on a line with each other, but more or less flexed or bent, so that the column connected with the body obliquely, somewhat as in *Eucheirocrinus (Cheirocrinus,* Hall, 1860; not Eichwald, 1856). At least the much deeper sinus for the connection of the column, in the lower range of pieces on the flat side, than on the convex, would favor such a conclusion.

Length of body unknown, but it measures 0.93 inch in breadth, and about 0.40 inch in convexity, near the lower part; breadth of upper end of column, about 0.49 inch.

Although this fossil is evidently very closely allied to the genera *Anomalocystites,* and *Ateleocystites,* I am not entirely sure that it would be found exactly congeneric with either, if we had the means of comparing its entire structure with that of the types of those groups, which are *very* closely related to each other. It certainly differs conspicuously, however, at least in its specific characters, from the typical and only known forms of these groups. In the first place, it is much larger than the type of *Anomalocystites (A. cornutus),* and has the middle two pieces of its lower range of plates on the flat side proportionally longer—that is, longer than the marginal pieces, instead of the reverse. Its base is also more deeply sinuous on this side than in the New York species. On comparing its convex side with that of *A. cornutus,* we observe still more marked differences, the three principal plates of the lower range, in our type, being all decidedly longer than wide, instead of the reverse, and the middle plate considerably longer than that on each side of it; while the carinate marginal pieces, which are quite distinctly seen in this view of our species, are scarcely visible on this side of the New York species. There are doubtless also equally great differences in the structure and arrangement of the parts above on both sides, if we had the means of making comparisons of this part of the body.

In size, our species corresponds more nearly with *A. disparilis,* from the New York Oriskany Sandstone; but from what has already been stated, it will be seen to differ too widely in the form and proportions of its lower range of pieces, to render a comparison necessary.

Compared with *Ateleocystites Huxleyi* of Billings, the typical and only known species of that group (if it is distinct from *Anomalocystites),* our species will be found not only to differ in its much larger size, but also in

having its base greatly more widely and deeply sinuous on the flat side, for the reception of the column; while the central two pieces taper more rapidly upward, and are longer in proportion to the lateral ones. Its lateral pieces, on the contrary, taper more decidedly downward, and differ in having their lower ends curved inward. The convex side of *A. Huxleyi,* and the upper parts of our species being unknown, we have no means of carrying the comparison farther, but enough can be seen to show, beyond doubt, that the two forms are at least clearly distinct specifically.

Whether these several types belong to one, two, or three genera, it must be evident, I think, to anyone accustomed to study these old types of the *Echinodermata,* that in a systematic classification or arrangement of the genera of the *Cystoidea* into families, they will have to stand together in a distinct family *Anomalocystidæ,* occupying a somewhat analogous position in this group to that of the family including *Eucheirocrinus,* of the *Crinoidea.*

Locality and position: Upper part of the hills at Cincinnati, Ohio, in the Cincinnati group of the Lower Silurian. The best specimen I have seen belongs to the collection of C. B. Dyer, Esq., of Cincinnati. I am also under obligations to Prof. O. C. Marsh, of New Haven, for the use of another more crushed specimen of the same, or an allied species. Both of the specimens mentioned were discovered, I am told, by G. W. Harper, Esq., of Cincinnati.

GENUS LICHENOCRINUS, Hall.

Lichenocrinus, Hall, —; Advance Sheets of Regent's Report, p. 9, dated Nov., 1866; Meek, in Am. Jour. Sci. and Arts, Vol. II. (No. 10, 3d series), issued Sept. 29, for Oct., 1871, p. 299; Hall, Advance Sheets Regent's Report, dated Oct., 1871, pp. l and 2, also figs. 1 to 7, plate 3, of illustrations of same, issued at a later date; Meek, Am. Jour. Sci. and Arts, Vol. III. (3d series), p. 15, Jan'y, 1872.

This curious fossil, found in the Cincinnati rocks, and first noticed by Prof. Hall, under the name *Lichenocrinus,* has attracted much attention, and various suggestions have been made to explain its anomalous structure. If really the *body* of a crinoid, it must certainly be one of the most remarkable and interesting types of that protean order of animals. Prof. Hall's generic description of this fossil first published, reads as follows:

"Bodies parasitic on shells and other foreign substances. Form discoid or depressed convex, with a proboscidiform appendage rising from the center. Disc composed of an indefinite number of polygonal plates, and apparently having no distinct mode of arrangement. Proboscis perforate,

and in the known species formed of five ranges of short plates alternating and interlocking at the margins."

After examining a number of specimens of the two known species of this type, during the summer of 1871, belonging to the collections of Mr. Dyer and other gentlemen at Cincinnati, I proposed, in a paper issued a few days before the end of September, in the October number of American Journal of Science and Arts, to extend the description of the genus as follows:

"Discoid or depressed plano-convex bodies, growing firmly attached to shells, corals, trilobites and other marine objects, and entirely destitute of free or recumbent arms or pinnulæ, ambulacral openings or pectinated rhombs. Free or convex side concave in the central region, and composed of numerous small, non-imbricating polygonal plates, without any definite arrangement; mesial depression provided with a long, slender, perforated, flexible, column-like appendage, composed of five longitudinal series of short, alternately interlocking pieces.* Attached side, when separated, presenting no sutures or openings,† but in some conditions showing numerous, distinct, regularly arranged, radiating striæ, corresponding to radiating lamellæ that occupy the whole internal cavity from top to bottom."‡

After this diagnosis, the following remarks and suggestions were added: "Among the more remarkable features of this fossil, may be mentioned its very curious system of radiating lamellæ occupying the whole internal cavity, and giving it, when the plates of the upper side are removed so as to expose these lamellæ in place and attached to the adhering side, almost exactly the appearance of the little fungoid coral *Micrabacia.* The entire absence, so far as known, of free or recumbent arms or pinnulæ, as well as of the most minute ambulacral or other openings, save the minute perforation into the slender, column-like appendage, and the attachment of this appendage to the free side of the firmly adhering disc, are also very anomalous features, if we view the disc as the body of a crinoid."

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* I subsequently ascertained that this alternate arrangement of these pieces is not always continued, well defined, all the way from the disc to the free end of this appendage.

† Since this was written, Mr. James has sent to me a detached specimen, that shows the whole under, or flat side, to be distinctly marked by numerous minute rhombic, suture-like markings. This character, however, seems to me to have been produced by the reticulations of some little coral, upon which the disc had grown, since others attached to smooth surfaces show the under side, when separated, to be smooth.

‡ A very fine specimen in this condition, examined at a later date, shows that these radiating lines on the under side of specimens in this condition really *alternate* with the lamellæ within, as will be noticed farther on.

"On examining one of these fossils, one of the first questions that suggests itself is, what can be the nature of this long, slender appendage, not more than four to eight or ten hundredths of an inch in diameter, and several inches in length? Is it homologous with the so-called proboscis or ventral tube of other crinoids, or with the column of the same? Prof. Hall evidently entertained the former opinion at the time he wrote the diagnosis quoted above, though I was informed at Cincinnati, that after seeing other specimens than those from which his diagnosis was written, he inclined to the opinion that it is a column. That one or the other of these views is correct, would almost necessarily seem to be the case, and yet there would appear to be rather strong objections to both of these conclusions, if we view the disc as the body of a crinoid. In the first place, if a column; why should the body, instead of being, as usual, attached by it, always (when not accidentally detached) be found growing firmly by the whole opposite side to foreign bodies, and this long appendage in all cases be left dangling free, and, if viewed as a column, apparently useless? Again, if a column, connected with the free side of an attached crinoid, how are we to account for the fact that no traces of any other opening than that passing in through this appendage can be seen, even by a careful examination under a magnifier, in any part of the body? In addition to this, it does not connect with the disc by a series of basal pieces, as is usually the case with the connection of the column of a crinoid or cystoid to the body of the same, but on the contrary, the plates of the disc diminish in size inward, and pass by easy gradations into those forming the base of this long appendage."

"On the other hand, if we proceed to view this appendage as a proboscis or ventral tube, connecting with the ventral side of the body, we are met by the objection of its extreme proportional length, slenderness, flexibility, and the fact that it seems to taper off nearly to a point at its free end. In Mr. Dyer's collection there is a piece, apparently of the free end of this organ, about an inch in length, and agreeing exactly in size, form and structure, with that of *L. Dyeri*, that is broken at one end, and tapers to a slightly blunted point at the other end, which is composed of very minute pieces drawn together. In other examples, where three or four inches in length of this appendage can be seen attached to the disc at one end, it tapers off until it becomes exceedingly slender at the free broken end. This character of its termination, especially when viewed in connection with its length, slenderness and other peculiarities, would seem to be a very strong objection to the conclusion that it is a ventral tube or proboscis. Still there might have been a minute opening at the extremity, closed by diminutive pieces, as we often see is the case with the opening of much larger crinoids."

"While examining specimens of this type, several solutions of the mystery of its structure suggested themselves, the first one of which was, that possibly the disc, viewed as the body, might really be only a peculiarly constructed root, or base of attachment of a crinoid, the body of which grew at the free end of the long column-like appendage. This suggestion receives some support from the fact that the disc, although usually growing on the flat surfaces of shells, etc., is sometimes found growing upon the side of the columns of other larger crinoids, as well as on other uneven surfaces, and in such cases it is bent around so as to conform to the curve of this surface of attachment, just as we see in crinoid roots similarly situated; while its whole interior is so filled with radiating lamellæ, as to leave extremely little space for the viscera of an animal, and is, as already stated, apparently hermetically sealed, excepting the minute canal leading up into the long appendage. It is true that the roots of crinoids are generally formed of thickened and anchylosed rings or segments of the column, but Mr. Billings has figured the root of one type *(Cleiocrinns grandis),* apparently composed of an accidentally folded expansion of minute polygonal plates; and it is worthy of note, that the column attached to this root is longitudinally divided by five sutures. It is also true, that there is no example, so far as known to the writer, of any such system of radiating lamellæ being connected with the root of a crinoid; but this objection would doubtless apply with even greater force against the conclusion that this disc is the body of one of these animals."

"On the other hand, among the strong objections to the suggestion that these discs are roots, may be mentioned their very regular, symmetrical form, and the fact that no indications of a body at the free end of the column-like appendage have yet been observed, nor of a detached body with adhering portions of a column agreeing with this; while no free crinoid that might have been attached to this column in its early stages of growth, is known in these rocks. In addition to this, the tapering and pointed extremity of this appendage would seem to render it at least improbable that it had ever supported a body at that end."

"Two other solutions of the difficulty suggest themselves, one of which is, that possibly the specimens, as we now see them, may not be the mature condition of the animal, but only one of the stages of development of some crinoid, which, if known in its adult condition, is supposed to be an entirely distinct type. The other is, that the discs, as we now see them growing fast to other bodies, may be the adult condition of a crinoid that in its earlier stages of growth was supported on its little column, as in other types, being otherwise free, and that at a later period

of its growth, the column became free at it its lower end, and was, for a time, trailed about by the floating body, which finally inverted itself and grew fast to other objects by what was originally its vault. The fact, however, that these discs attain a diameter of at least half an inch, with the elongated appendage four inches or more in length, would, even if known analogies supported such a view, seem to be a very strong objection to the conclusion that these are immature or embryonic forms; while, to say nothing of other strong objections that naturally present themselves against the last mentioned suggestion, the occurrence of these discs of all sizes, from the largest down to others less than a tenth of an inch in diameter, all alike growing fast to other bodies by the side opposite the column-like appendage, seems to demonstrate that this is their mode of growth from the first."

"In view of all that is now known of this curious fossil, it seems to me, without undertaking to express a positive opinion on the subject, that the weight of evidence (supposing that these discs are really the body of a crinoid) favors the conclusion that the long appendage is a ventral tube; but *if the appendage is a column*, then I should incline to the opinion that the disc is a peculiarly organized root, and that the body may be yet unknown, unless as an entirely distinct crinoid."

In some advance sheets of a paper issued after the publication of the remarks quoted above from the Journal of Science, Prof. Hall also noticed the peculiar character of the presence of internal radiating laminæ in this fossil, and makes the same remark, that they give the interior the appearance of a coral. He likewise makes the same suggestion, that possibly the disc may really be the root, instead of the body of the crinoid, and mentions the same objection (its form) to this conclusion. He farther suggests, in the same paper, that the animal may possibly have been capable of attaching itself temporarily by its flat side, and removing at will; and after mentioning the radiating lamellæ, adds, that "we may imagine that the spaces between these lamellæ may have been occupied by slender fleshy tentacula."

On examining the collections sent on by Mr. Dyer, after the publication of the paper already cited from the Journal of Science, including some specimens I had not previously seen, I again called attention, in a note published in the January number of the same Journal, to one of these specimens showing the long column-like appendage tapering off to a remarkable degree of slenderness, and mentioned the bearing this fact seemed to have against the conclusion that this organ properly corresponds to the so-called proboscis or ventral tube, or to the column, of other crinoids. I there also mentioned some

strong objections to the supposition that the animal may have possessed the power of attaching and detaching itself at will to and from other bodies by its flat side. These were the absence of any opening through the basal platform of the under side, and so far as yet known, of any traces of arms or pinnulæ. Consequently, if once detached, it is difficult to understand how the creature could have sought and adjusted itself to a suitable station; or, if accidentally brought into contact with such a surface, how it could have adapted and fastened itself so as exactly to conform to the slightest inequalities, such, for instance, as the striæ of a shell, or the lobes and depressions of the glabella of a trilobite.

If there were any openings in the basal layer or platform of its under side in immediate contact with the surface of attachment, and the body had possessed some degree of flexibility, we might suppose the adhesion could have been effected by suction; but all examinations of numerous specimens have entirely failed to detect the slightest traces of any openings through this thin basal layer or platform; while the rigid nature of the lamellæ within, would seem to preclude the possibility of any degree of flexibility.

One of Mr. Dyer's specimens, however, now before me, would, at a first glance, seem to throw doubts on the conclusion that the disc was not flexible. This individual is seen lying in the matrix in such a manner as to expose the under side, which had, by some means, been separated from the object to which it had been attached; while one of its edges is folded closely upon its exposed under side. A careful examination, however, by the aid of a good magnifier, fails to detect any gaping of the sutures, or disarrangement of the plates of the upper side along the folded edge, though some of these plates can be seen to curve a little, so as to adapt themselves to the curve of the folded margin. It must, therefore, be evident that this folding of the edge of the disc could not have taken place after it had attained its full size, flattened out as usual, but must, have been produced as a deformity during its growth; and probably by some peculiarity of the station to which it was attached, such, for instance, as being situated upon, and near the edge of some thin shell, beyond the margin of which it projected as it increased in size, and then curving under, as it grew, so as to become folded against the under side of the thin bit of shell, which subsequently decomposed.

In this specimen, as in nearly all others showing the under side of the basal platform, this surface is smooth, and shows no traces of radiating striæ, excepting when moistened and examined by the aid of a magnifier, when, owing to its thinness and translucency, these striæ can be seen within. Another specimen that grew on the flat part of the cheek of a

large trilobite, but which had separated from this surface of attachment, shows, in the same way, its under surface, without any opening or striæ, but when moistened and examined with a magnifier, the radiating marks of the inner side can be seen through its thin, translucent substance.

Another specimen that I had seen in Mr. Dyer's collection, but which was not received by me for critical study for some time after all of the others mentioned, presents some features worthy of note here. In this alone, of all the specimens of this fossil I have seen, there is, in the flat or under side, a small central opening, due, as I must believe, to some accident, and radiating from this, numerous, regular, fine raised lines, with little linear furrows of the same size between them. In looking at this specimen alone (which has evidently been accidentally detached from the body upon which it grew), without any knowledge of others, one could scarcely entertain a doubt that this opening, situated so exactly at the center of radiation, must be the mouth, and the minute radiating furrows the ambulacral canals. A careful examination, however, under a magnifier, shows that the little raised lines between the furrows bifurcate regularly, sometimes twice or oftener, so that the furrows, in part, do not reach the central opening, but end abruptly at the points of bifurcation. Again, in numerous other instances, the basal layer of the disc can be seen still firmly attached to the original station, with the plates of the upper side, and the internal lamellæ wholly or in part removed, so as to show clearly the upper or inner side of the base, without the slightest trace of any central or other opening, and marked by numerous raised radiating lines corresponding to, or rather being the remaining parts of, the internal lamellæ. These can be, in part, traced very nearly to the centre, where, instead of an opening, there is often a little elevated point. It is also worthy of note that here, on the inner surface of these basal layers, these little radiating raised lines, left by the breaking away of the lamellæ, within the disc, do not increase by bifurcation, but by the intercalation of shorter ones between the longer; so that if we were to place the specimen mentioned above, showing the central opening and striæ of its under side, upon one of these basal layers (supposing both to belong to the same individual), the elevated striæ of its under side would conform exactly to the depressions or spaces between the raised radiating lines of the basal layer in such a manner that the little furrows would thus all be closed up.

If it were not for this fact, and the absence of any indications, so far as yet known, of any minute openings around the base of the periphery of the discs, at their connection with the bodies upon which they grew, I should be half inclined to suspect that there might be a double basal

layer, sometimes capable of accidental separation, with a central opening to an internal mouth through the upper one, and numerous minute ambulacral canals passing in to this opening *between the two layers.*

The bifurcating striæ on the flat under side of this specimen showing the opening, can hardly be, as I had at one time supposed, the edges of the internal lamellæ exposed by weathering, because their bifurcating character would seem to show that they do not coincide with the lamellæ within, but with the *interstices between them;* while there are no open slits between these striæ, as we would expect, if they were the edges of the lamellæ, but mere furrows.

LICHENOCRINUS DYERI, Hall.

Plate 3, figs. 2 (and 3 *a, b?)*

Lichenocrinus Dyeri, Hall; Advance Sheets of Regents' Report, p. 9, dated Nov., 1866; and (1872) pl. 3, fig. 1-6, accompanying a re-issue of same.

Body depressed-discoidal, nearly circular, or obscurely pentagonal in outline; composed of a great number of very small, slightly convex, nearly or quite smooth pieces, of very unequal size and form, the larger ones often somewhat longer than wide, with their longer diameters directed inward and outward; central depression small; column-like appendage comparatively stout at its basal, or attached end, where it is sub-pentagonal, or nearly round, and composed of about five or six ranges of very short, distinctly and regularly alternating and interlocking pieces; perforation at base pentagonal, and scarcely equaling one-third the diameter of the appendage at that point. Interior unknown.

Diameter of apparently an adult individual, 0.32 inch; convexity about 0.09 inch; thickness of column-like appendage, at its connection with the body, 0.08 inch; length unknown.

Locality and position: Cincinnati group of Lower Silurian, near top of hills at Cincinnati, Ohio. Mr. Dyer's collection. Apparently rare.

LICHENOCRINUS CRATERIFORMIS, Hall.

Plate 3, figs. 1 *a-t.*

Lichenocrinus crateriformis, Hall,; Advance Sheets of Regents' Report, p. 9, dated Nov., 1866; and (1872) fig. 7, pl. 3, of a re-issue of same.

Body discoid, with a sub-pentagonal or nearly circular outline; elevated and rounded near the margin, and broadly and distinctly concave in the middle; composed of alternating ranges of comparatively moderate sized,

generally hexagonal smooth plates as wide as long, around the convex outer part, and of much smaller pieces within the central concavity, that diminish in size inward to the base of the central appendage; internal rays slender, about one hundred, only a few of which quite reach the central point, the others ending at different and somewhat regularly arranged distances in from the periphery. Column-like appendage very long, slender, and tapering very gradually through its whole length, so as to end in an extremely slender mucronate point at the free extremity; more or less distinctly pentagonal, and composed of about five equal ranges of small, regularly and alternately arranged, interlocking pieces; but gradually becoming more rounded, with the pieces nearly or quite opposite, farther from the body: perforation small and pentagonal.

Diameter of the largest specimen seen, 0.35 inch, with a convexity of 0.08 inch. Diameter of another individual with a portion of the column attached, 0.15 inch; height of do., 0.05 inch; thickness of column-like appendage, near body, 0.04 inch; length of same to the broken free end, nearly three inches, with a diameter at same of 0.02 inch.

This seems to be much the more common of the two species; and will be readily distinguished from the last by its larger, less numerous, and more regularly hexagonal body-plates, as well as by its more distinctly pentagonal column, and the larger and deeper central concavity of its body. It is more frequently found growing on the surface of *Orthis testudinaria* than on other bodies, though it grew upon various other objects. One individual, belonging to Dr. H. H. Hill's collection, and represented by our figure 1 *b*, of plate 3, is growing in an almost exactly central position on the glabella of a *Calymene senaria*, and exactly conforming to the little inequalities of this part of the trilobite.

Locality and position: Ranges through most of the thickness of the Cincinnati group at that place, and for fifty or more miles from there in the surrounding country. Mr. Dyer's, Mr. James's, Mr. Shaffer's, Dr. Hill's and Dr. Byrnes's collections.

GENUS HEMICYSTITES, Hall.

(Palæontol. N. Y., Vol. II., 245.)

HEMICYSTITES STELLATUS, Hall.

Plate 3, figs. 8 *a*, *b*.

Agelacrinites (Hemicystites) stellatus, Hall; Descriptions of New Species of Crinoidea, etc., p. 8, dated Albany, Nov., 1866; also (1872) pl. 11, figs. 5 and 6, illustrations of same paper.

Body small, sub-pentagonal or nearly circular in outline, depressed discoidal. Disc composed of numerous small pieces, that are a little

convex, and apparently not distinctly imbricating. Rays extending from the middle, straight toward each of the five, obscurely defined, marginal angles of the disc, comparatively rather stout, slightly widest near the middle, and rather obtuse at the outer ends; each composed of a double series of alternating pieces two or three times as wide as long, and numbering about twelve on each side, in a specimen measuring 0.34 inch in diameter, without any intermediate intercalated smaller pieces; anterior ray abruptly tapering to a point at the middle of the disc, and the two posterior lateral ones more confluent at their inner ends with the two anterior lateral, and more distinctly separated by the deeper posterior interradial space. Opening situated in a little protuberance near the middle of the posterior interradial area.

Breadth of disc of largest specimen seen, 0.34 inch; breadth of arms at widest point, 0.06 inch; number of ray pieces on each side in same space, four to five.

This is the form referred to Prof. Hall's species by the geologists at Cincinnati, and doubtless belongs to the same, though it does not conform exactly to his description, since the sides of the disc do not rise vertically from the base of attachment in the specimens I have seen; while Prof. Hall does not mention the obscurely pentagonal outline of the disc seen in our specimens.*

Several authorities have placed *Hemicystites* of Hall as a synonym of *Agelacrinites,* Vanuxem. In this opinion, however, I cannot concur, as it seems to me that the much smaller size, and perfectly straight, proportionally wider rays of the forms for which the genus *Hemicystites* was proposed, ought to separate it generically from *Agelacrinites.*†

Specifically this form will be readily distinguished from the typical species of the genus *H. parasiticus,* from the Niagara group of the Upper Silurian, by its sub-pentagonal outline, non-imbricating, or at least much

* His figures, however, published since the foregoing remarks were written, show this character quite distinctly.

† Prof. Pictet, in his Traite de Palæont., vol. 4, p. 306, expresses the opinion that this genus and *Agelacrinites* probably ought to be united; and it is no wonder that he should have thought so, because he erroneously figures as an illustration of *Hemicystites,* under the name *H. parasiticus,* a true typical *Agelacrinites,* widely removed from the type of *Hemicystites.* Dujardin and Hupe, in their Hist. Nat. des Zoophytes Echinodermes, p. 84, follow Pictet in this error, and copy his figure of a true *Agelacrinites,* as *Hemicystites parasiticus,* giving the two genera as identical. They also fall into the additional error of citing *A. Hamiltonensis* of Vanuxem from the Middle Silurian, instead of from the Devonian (see note on the genus *Hemicystites,* by Meek and Worthen, Proceed. Acad. Nat. Sci., Philad., Dec., 1868, p. 357.)

less distinctly imbricating disc plates, as well as by its more petaloid rays, that do not taper inward regularly from the outer ends; and particularly by its more numerous and much less deeply interlocking ray pieces.

Locality and position: About 80 feet below the top of the hills at Cincinnati, or, in other. words, above the middle of the Cincinnati group of the Lower Silurian, at Cincinnati, Ohio. Mr. Dyer's collection.

HEMICYSTITES (CYSTASTER) GRANULATUS, Hall.

Plate 3, figs. 9 *a*, *b*.

Hemicystites (Cystaster) granulatus, Hall, 1872; plate 11, figs. 1-4, and explanations of same, accompanying a re-issue of a paper of his dated Nov., 1866, in which this form was not described.

Body small, so much elevated as to present a short sub-cylindrical form, but rounded on the top, which is a little wider than the diameter below; the lower part presenting somewhat the appearance of a broad peduncle. Body and interradial areas covered by numerous very small grain-like pieces, that seem scarcely to present any appearance of an imbricating arrangement. Arms convex, short, and comparatively rather wide, the length being only about three times the breadth, curving from the central region over the rounded top, and extending downward about one-third the entire length of the body, where they terminate in rather blunt ends; composed each of about nine to twelve alternating, slightly oblique pieces on each side. Opening unknown.

Height, 0.30 inch; breadth near the middle (allowing for evident accidental lateral compression), about 0.16 inch; do. at top, 0.17 inch; length of arms, 0.16 inch; breadth of do., 0.05 inch.

I have seen only somewhat distorted specimens of this species, with the surface obscured by adhering shaly matter; consequently it is possible that some of the characters mentioned above may not be entirely natural. The species, however, will be readily distinguished by its remarkably elevated form, and very minute grain-like body pieces. Like the other species, it grows generally upon the surface of the valves of *Strophomena*.

Locality and position: Cincinnati Group of the Lower Silurian, at Cincinnati, Ohio. Mr. Dyer's collection.

GENUS AGELACRINITES, Vanuxem, 1842.

(Report 3d Geol. Dist., N. Y., p. 158.)

AGELACRINITES (LEPIDODISCUS) CINCINNATIENSIS, Roemer.

Plate 3, figs. 6 *a, b.*

Agelacrinus Cincinnatiensis, Roemer, 1851; Verh. Naturh. ver. fur Rhein. und Westph., Vol. VIII., p. 372, t. 2, f. 3 *a, b;* and in Brown's Lethea Geog., Vol. 11., p. 275, t. 4, fig. 6; Hall, Descrip. New Crinoidea, etc., p. 6, dated 1866; and (1872) fig. 7, pl. II., accompanying a re-issue of same.

Body circular, depressed-plano-convex, or concavo-convex, the upper side being depressed-convex, and the lower a little concave, or more or less nearly flat, to conform to the surface of attachment. Disc composed of numerous thin squamiform plates, that imbricate inward from the periphery toward the center, those near the margins being proportionally shorter and wider than the others. Arms slender, depressed so as to be nearly or quite even with the surface of the disc; four sinistral and one dextral, composed of the usual double row of interlocking pieces, and (in large specimens) a series of much smaller intercalated supplementary pieces along the middle. So-called ovarian aperture situated near the middle of the largest interbrachial space surrounded by the dextral, and one of the sinistral rays, closed by about nine cuneiform pieces, with apparently nearly as many intercalated smaller ones, the whole, when closed together, forming a depressed circular prominence. Surface of plates nearly smooth.

Diameter of a rather large specimen, 0.77 inch; convexity, 0.15 inch; breadth of arms at their inner ends, 0.08 inch; breadth of the so-called ovarian aperture, 0.12 inch.

This is perhaps the most common, and the finest species of the genus, found in the Silurian rocks of the West. It is usually found growing upon the ventral valve of *Strophomena alternata;* but it sometimes grew on other objects.

I have before me a specimen, a little more than an inch in diameter, apparently of this species, belonging to L. B. Case, Esq., of Richmond, Indiana (found by him at that place), that seems to have grown on one of the valves of an *Ambonychia.* The shell had separated in such a manner as to take with it the under side of the *Agelacrinites,* and leave its upper side in the matrix so situated as to expose its inner surface. The inner side of each arm or ray is here seen to be composed of a single

series of quadrangular pieces that are not imbricating; while the disc plates near the outer margin show, on their inner surfaces, little parallel ridges, directed inward, and apparently fitting into corresponding furrows in the lapping edges of the contiguous pieces.

The distinctions between this and the other species of this horizon, will be mentioned in connection with the descriptions of the latter.

Locality and position: Near top of hills, at Cincinnati, Ohio, in the Cincinnati group of the Lower Silurian. The fine specimen figured belongs to the collection of Mr. Dyer. I am also under obligations to Mr. James, of Cincinnati, for the loan of a smaller individual of the same.

AGELACRINITES PILEUS, Hall.

Plate 3, fig. 5.

Agelacrinites pileus, Hall; Descrip. New Crinoidea, etc., p. 7, dated Nov., 1866; also (1872) figs. 8 to 10, pl. II., accompanying a re-issue of the same.

Body circular, concavo or plano-convex, the upper side being very strongly convex, and the lower plane or concave to conform to the surface of attachment, which is usually the ventral valve of a large *Strophomena.* Disc composed of inward imbricating squamiform plates. Arms rather stout, very prominent, slightly wider near the middle than at their inner ends, and rather blunt at their outer extremities; all strongly curved in such a manner that four are sinistral, and one dextral; composed of stout sub-pentagonal pieces, that have their slightly longer diameters transverse to the arms, along the middle of which their inner ends alternately interlock, without any supplementary intermediate pieces between the two ranges. So-called ovarian opening situated a little outside of the middle of the largest interradial area surrounded by the dextral and one of the sinistral arms; pieces by which it is closed forming a distinct prominence, composed of about eight or ten trigonal and pointed pieces. Surface of body-plates smooth.

Diameter of body, 0.70 inch; convexity, 0.21 inch; breadth of arms at their ends, 0.06 inch; do. near middle, 0.08 inch; breadth of aperture, 0.12 inch.

This species will be readily distinguished from the last, by its more convex body, stouter and decidedly more prominent arms, which are more obtuse at their outer ends, and composed of thicker pieces, proportionally longer in the direction at right angles to the arms, without any supplementary pieces between. Its interradial areas are also distinctly

concave, instead of nearly flat, as in the last, and composed of a smaller number of pieces.

The specimen from which our figure and the foregoing description were prepared, appears not to agree exactly in form with the original of *A. pileus,* which is described as being "globose or globular-bell-shaped, and attached by the smaller extremity, which is composed of small squamiform plates." On the contrary, it differs but little *in form* from *A. Cincinnatiensis,* being only more convex. But as it is also stated in the same connection, that *A. pileus* "in specimens flattened from above, might readily be mistaken for *A. Cincinnatiensis,*" it is probable that the individual here under consideration is an accidentally depressed example. It, however, does not present the slightest appearance of having been so flattened.

Since the above was written, I have seen a fine specimen of this species belonging to the collection of Mr. James Foster, of Cincinnati, Ohio, that was borrowed for my use by Mr. U. P. James. It is almost hemispherical, and shows very minute pieces around the lower margin of the disc. Above and between these and the ends of the rays, there are several ranges of much larger and wider pieces, which also exceed in size those between the vans, on the top of the disc or body.

Locality and position: Above the middle of the Cincinnati group of the Lower Silurian, at Cincinnati, Ohio. The figured specimen belongs to Mr. Dyer's collection.

AGELACRINITES VORTICELLATA, Hall.

Plate 3, figs. 7 *a, b.*

Agelacrinus vorticellata, Hall; Advance Sheets of Regents' Report, dated Dec., 1866, p. 7; and (1872) re-issue of same, pl. II., figs. 11, 12 and 13.

Body circular, depressed-convex above, and flattened or concave below, to conform to the surface of attachment. Disc composed of very small pieces. Arms comparatively very large, stout, prominent, and all strongly curved sinistrally, so close together as to leave very little of the disc exposed; composed of stout pieces a little thickened at each end, two or three times as long as their diameter in the direction of the length of the arms, along the summits of which their inner ends alternately interlock, without any intermediate supplementary smaller pieces between the inner ends of the two rows.

Greatest diameter, about 0.58 inch; breadth of arms, about 0.10 inch.

This species will be readily distinguished from the others yet known,

by its very large, thick, prominent arms, all curved sinistrally; their large size and strong curvature bringing them so close together as nearly to hide the disc. The only specimen I have seen does not show the so-called ovarian aperture, but it is said by Prof. Hall to be minute, and situated near the base of the posterior lateral rays.

Locality and position: Same as last. The figured specimen belongs to the collection of Mr. Dyer.

ASTEROIDEA.

GENUS PALÆASTER, Hall.

(Palæontol. N. Y., Vol. II., p. 247.)

PALÆASTER? DYERI, Meek.

Plate 4, figs. 2 *a-f.*

Palæaster? Dyeri, Meek, 1872; Am. Jour. Sci. and Arts, Vol. III. (3d series), p. 257.

Among the specimens loaned to me for study and description by Mr. Dyer, there is a very imperfect example of one of the largest known species of Silurian Star-fishes. When entire, it could scarcely have measured less than five inches in diameter, across from end to end of the rays on opposite sides; and it presents a breadth of disc (as flattened by pressure) of about two inches. Its state of preservation is, unfortunately, such as not to admit of systematic description, but I think enough of its character can be given to enable the student to identify it, by the additional aid of figures.

The dorsal side of both disc and rays is composed of numerous small pieces, with the pores between them apparently so large that these pieces only seem to touch at three to four salient points of each, so as to form a kind of reticulated structure; while they each bear a little central tubercle, with a minute pit in its top for the articulation of small, short spines, generally about 0.07 to 0.09 inch in length, and about 0.02 to 0.03 inch in thickness.

In one of the axilla between two of the rays the so-called madriporiform body can be seen near the margin of the disc. It is nearly flat, of an obtusely sub-trilobate form, with a breadth or transverse diameter of 0.30 inch, and a diameter at right angles to the same of 0.24 inch. Its lobed edge is directed inward toward the middle of the disc, and its middle lobe is largest, and shows the little divisions between the slits or furrows, diverging and bifurcating inward like the nervation in the pin-

nules of some kind of ferns; while in the smaller lateral lobes these markings diverge outward.

The ventral side is also much obscured by the adhering matrix, and numerous detached and confusedly mingled spines. A row of comparatively small, tumid, nearly square marginal pieces, however, can be seen in places, on each side of the ambulacral furrows, and alternating with a row of similar but slightly smaller adambulacral pieces, the number of pieces in each side of these series being about the same. The marginal pieces seem each to connect with the adjacent range of dorsal pieces, at places in the rays, by a little central salient point only, while those of both series are roughened by numerous comparatively coarse granules, and each piece (especially of the marginal row) also shows a small central pit for the articulation of a spine. These spines are larger than those connected with the dorsal pieces being generally about 0.22 inch in length, and 0.05 inch in thickness; they are smooth, straight, rounded, slightly thickened at the attached end, and tapering at the free end to a slightly blunted point.

The specimen is too much crushed and obscured to show the under side of the body, consequently nothing is known in regard to the nature of the ambulacral or oval pieces. Near the margin of the disc, however, between the inner ends of two of the rays, a few pieces can be seen within the marginal row that certainly seem not to belong to the adambulacral series. These may possibly be disc pieces. They are nearly or quite as large as the marginal pieces, and do not appear to form more than one, or possibly two ranges, while they seem to be confined to the axillary angles, there being no evidence that they extended outward along the rays.

The condition of the only known specimen of this species is such as to leave some doubts in regard to its generic characters, and for that reason I would have preferred to leave it until better specimens could be found. As Mr. Dyer desired, however, to have it characterized, I have done so as fully as the nature of the specimen would permit. Possibly I should have called it *Petraster Dyeri,* for if the apparent presence of a few disc plates on the ventral side between the marginal pieces and the adambulacral, is not deceptive, it would, in that respect, conform to the structure of that group, and differ from *Palæaster,* as now understood; though I am inclined to think this appearance due to the accidental displacement of the parts at the point where there are some indications of a few disc pieces. In the apparently large size of the pores passing through between the dorsal pieces, it would also seem to differ from the typical forms of *Palæaster*—these openings appearing to be so large that the dorsal pieces

seem only to touch at mere points, as already stated, so as to form a kind of reticulated structure. The nature of the dorsal side of *Petraster* is not, I believe, certainly known, but in *Palæaster,* Hall, the dorsal pieces have always been illustrated as if close-fitting, and in the original description the genus was said to have the pores "penetrating the plates of the upper side," instead of passing in *between* them. As no such character, however, exists in any of the species I have seen in a condition to show the dorsal side, or has been mentioned or illustrated by the same author in any of his subsequently published descriptions or figures of species of this genus, or mentioned in any of his remarks on the group, we may infer that he would not now lay much stress upon that supposed character.

I have thought it barely possible that this form might not be distinct from *Palæaster granulosus* of Hall, but from its greatly larger size (that species being described as of medium size), and the fact that it seems to have about the same number of adambulacral as marginal pieces, instead of nearly twice as many of the former as of the latter, I am led to regard it as a distinct species. It is certainly distinct from the following form that I have referred doubtfully to *P. granulosa.*

Locality and position: About 100 feet below the top of the hills at Cincinnati, in the Cincinnati group of the Lower Silurian. Mr. Dyer's collection.

PALÆASTER GRANULOSUS, Hall?

Plate 4, figs. 3 *a, b,* c.

Palæaster granulosa, Hall; Advance Sheets extracted from Regents' 20th State Cab. N. H. Rep., and dated Dec., 1866, p. 285; also (1867) same p., Regents' 20th Report.

Palæaster granulosus, Hall, 1870; Revised edition same Report, p. 327.

Attaining a large size; rays (as a little depressed by accident) slightly more than twice as long as their breadth at their inner ends, and tapering regularly from the disc to their free ends, which are rather acutely angular; breadth of disc a little less than that of the inner ends of the rays. Marginal pieces convex, nearly or quite as long as wide, numbering on each side, in the whole length of each ray (1.40 inch), thirty-one. Adambulacral pieces, a size smaller, as long as wide, convex, and numbering on each side thirty-nine to forty; like those of the marginal series, each bearing a small spine, the largest of which are each about 0.14 inch in length, and 0.02 inch in thickness. Ambulacral pieces very short, or nearly three times as wide as long, apparently not alternating with the adambulacral pieces, and each provided with a rather sharp ridge across

nearly its entire breadth. Dorsal side of disc and rays composed of small tuberculiform pieces, of which about sixteen rows may be counted at about half way between the inner and outer ends of each ray, along the middle of which those of two or three of the rows are a little larger than the others; each dorsal piece bearing a minute, very short spine. Surface of all the pieces minutely granular, one of the central granules always being somewhat larger than the others for the articulation of a spine. Oral pieces and madreporiform body unknown.

Although this fine Star-fish agrees pretty well in most of its characters with the description of *Palæaster granulosus* of Hall (which has not yet been figured), I am far from being entirely satisfied that it is really the same, as it seems to differ in some important respects. For instance, the rays of *P. granulosus* are described as being "obtusely rounded at the extremities;" while in the form under consideration they are rather acutely rounded, if not angular. Again, instead of having twenty-five of the marginal pieces on each side, in a space of one inch and a quarter from the apex of each ray, and forty-two or forty-three of the adambulacral, it shows in this space *twenty-eight* marginal, and only *thirty-two* adambulacral pieces. The number of the latter being about ten less on each side in the same space—a rather decided difference, showing the inner row to consist of proportionally larger pieces. Its ambulacral ossicula seem to have the same proportional breadth and length as in the type of *P. granulosus,* and also have each a similar ridge across the middle; but these ridges do not show the zig-zag arrangement mentioned in the description of *P. granulosus.* Prof. Hall does not say how many rows of pieces are seen on the dorsal sides of the rays of his species; but he states that it is probably the same species that the Western Academy of Sciences sent out lithographs of, under the name *Asterias primordialis.* One of these lithographs, now before me, represents from eight to ten rows of these dorsal pieces, which is six or eight less than may be counted near the middle of the rays of our specimen.

In noticing this form in the Am. Jour. Sci., Vol. III. (3d series), p. 277, I proposed, in case it should be found distinct from *P. granulosus,* to call it *P. speciosus.* It will be at once distinguished from *P. Dyeri,* not only by its smaller size, but by its differently formed and closer fitting dorsal pieces.

Length of rays, 1.40 inch; breadth of do., 0.62 inch at base; breadth of disc, about 0.80 inch.

Locality and position: Cincinnati group, Cincinnati, Ohio. Mr. Dyer's collection.

PALÆASTER? JAMESII, Dana.

Plate 4, fig. 4.

Fossil *Asterias*, Graham, Anthony and James, 1841; Report to Western Academy of Natural Sciences, published in Am. Jour. Sci. and Arts, Vol 1 (2d series), p. 441.

Asterias Anthonii, Dana, 1863; Manual of Geology (1st edition), p. 221, with figure, but without description.

Palæasterina? Jamesii, Dana, 1863; Am. Jour. Sci. (2d series), Vol. XXXV., p. 295; also, 1864, in Man. Geol. (2d series), p. 221, with figure, but without description.

Palæaster Jamesii, Hall; Advance Sheets extracted from 20th Report Regents, and dated Nov. and Dec., 1866, p. 6; and in 20th Report Regents, 1867, p. 289; also in 2d edition same, 1868, p. 329.

Through the kindness of Mr. U. P. James, of Cincinnati, the discoverer of this fossil, I have now before me the original typical specimen, which I find not in a condition to be fully and systematically characterized, nor perhaps to afford the means of determining, beyond doubt, its generic affinities. It evidently attained a large size, and has a comparatively large disc, with its five rays rather broad at their inner ends, somewhat rapidly tapering, and apparently longer than the diameter of the disc. It evidently lies in the matrix in such a manner as to show the ventral side, but presents the appearance of having the marginal and disc plates of this side removed. The five pairs of oral pieces are seen in place, and proceeding outward from these can be seen a row of adambulacral pieces on each side of each of the rather wide ambulacral furrows. These latter pieces are nearly three times as long as their diameters in the direction of the length of the rays, and quite prominent at their inner ends, where they are articulated together by little processes and corresponding sockets or sinuses; while the outer two-thirds of each is flattened and distinctly more depressed than their inner ends. Outside of, and alternating with, the outer flattened ends of these adambulacral pieces, a row of nearly square, or more or less oblong pieces, may be seen all along the margins of the rays, and connecting at their axilla in such a manner as to leave room for several disc plates between them and the oral and inner adambulacral pieces. The pieces of this outer row have the appearance, or rather position and relations to the other parts, of a marginal series, but owing to the fact that they are much less prominent than the inner ends of the adambulacral pieces, and all flat, or even slightly concave on the under side, it is possible that they and the few disc plates mentioned may belong rather to the dorsal side of the fossil, and thus have their under sides exposed, by the removal of the marginal and disc plates of the ventral side. Even in that case, however, it is

probable that those seen along the edges really show the insides of the outer ends of the marginal pieces, curved upward and over so as to form the margins of the dorsal side. If this latter suggestion is correct, the marginal plates would seem to have been so long on the under side, when entire, as to lap upon and entirely conceal the flattened outer two-thirds of each adambulacral piece, when in place.

At some places within the ambulacral furrows, remains of ambulacral ossicula can be seen deeply interlocking with the inner ends of the adambulacral pieces, but their exact form, and the position and arrangement of the ambulacral pores, cannot be clearly made out in the specimen studied.

The two oral pieces of each of the five pairs are separated by deep sutures, and have an irregular form, being longer than wide, and, like the adambulacral pieces, which they somewhat exceed in size, flattened and depressed at their outer ends, and elevated into crest-like prominences farther in, with a lateral process or thickening on the outer side of each, in which a more or less distinct pit may be seen. At their inner ends they seem to connect with other parts occupying the oral opening, but the exact form and arrangement of these cannot be clearly made out in the specimen examined.

The surface, and the arrangement of the dorsal parts, are unknown; but they were probably armed with short spines, as some remains of little spines are seen in the matrix at the margin of the disc, at one place.

As the extremities of none of the rays can be clearly seen, the exact breadth of the whole fossil, between the ends of opposite rays, cannot be exactly given, but it is evident that the length of one of the rays, measuring from the middle of the disc, must have been a little more than two inches, and consequently that the diameter across from the extremities of opposite rays could not be less than about four inches. The breadth of the disc is 1.20 inches; and that of the rays at their inner ends, 0.70 inch.

In first publishing a figure of this fine star-fish, in the first edition of his Manual of Geology, Prof. Dana proposed for it the name *Palæasterina? Anthonyi,* in honor of John G. Anthony, Esq., formerly of Cincinnati, Ohio. On subsequently learning, however, that the typical, and only known specimen of the species, was discovered by U. P. James, Esq., of the same city, he proposed (in the Journal of Science), in justice to Mr. James, to change the name to *P. Jamesii* which name has been continued, with the same figure, in all the subsequent editions of the Manual. It is still a disputed question, however, among Naturalists, whether

or not the publication of a figure and name, without a diagnosis, really establishes a species. Many high authorities say it does, while others maintain that it does not. All agree, however, that when a species is once established, under a name not previously used for another valid species of the same genus, neither the original author, nor any other, has the authority to change it, excepting possibly in a few peculiar cases differing entirely from this. Consequently, if the rule should finally prevail, that the publication of a name and figure, without a diagnosis, is sufficient to establish a species, we would have to admit that the name *P. Anthonii,* was regularly applied to this fossil; and the inflexible law of priority would compel us to retain it. If, on the contrary, it shall be definitely settled that a diagnosis also is, in all such cases, required, then we will be at liberty to comply with the author's desire, by adopting the later name, *P. Jamesii,* which I have here done provisionally.

In regard to the generic characters of this fossil, it is not easy to decide from the only known specimen. If it really had a few disc plates intercalated between the marginal and oral and inner adambulacral pieces, on the ventral side, as there are some reasons to believe may have been the case, its structure would conform to that of the genus *Petraster* of Billings, and the name should then be *Petraster Jamesii,* or *Anthonyi.* If there are no such intercalated pieces, however, it would seem to fall into the genus *Palæaster.*

Locality and position: Cincinnati group of the Lower Silurian, Cincinnati, Ohio. Mr. U. P. James' collection.

PALÆASTER INCOMPTUS, Meek.

Plate 4, figs. 5 *a, b,*

Palæaster incomptus, Meek, 1872; Am. Jour, Sci. and Arts, Vol. III. (3d series), p. 275.

Small; rays rather short, or only about once and a half as long as their breadth at their inner ends, and rapidly tapering to their outer extremities, which are somewhat obtusely angular. Disc equaling in breadth the length of the rays. Dorsal side of rays composed each of three? rows of pieces,* that are wider than long, about nine in each row, and increase rather rapidly in size inward to the margin of the disc, which is composed of smaller pieces; a few very minute pieces apparently

* In some rays there appear to be four rows, but this is probably due to the exposure of one of the marginal rows of the rays, by oblique pressure.

sometimes occur between the rows on the dorsal side of the rays. Surface of dorsal pieces a little granular, but apparently without spines. Madreporiform piece rather small, a little oval, or almost circular, nearly flat, and marked by fine, irregularly interrupted, radiating striæ. Ventral side unknown.

Greatest breadth across between the extremities of rays on the opposite sides, 0.90 inch; length of rays, about 0.35 inch; breadth of same at their inner ends, near 0.22 inch; length of madreporiform piece, 0.08 inch; breadth of do., 0.07 inch.

This species seems to be related to *P. matutinus*, Hall, but has proportionally shorter and broader rays, that are also less pointed at their extremities. Its dorsal pieces are likewise less close-fitting, and appear to have, at some points, a few very minute intercalated pieces between the rows of the rays; though this latter character is not very clearly visible in the specimen. A more important distinction is the absence, in the species under consideration, of the circle of stellately marked pieces seen on the dorsal side of the disc of *P. matutinus*, which, according to Prof. Hall's figure, published in the 20th Regents' Report, seems not to have the well defined madreporiform piece, readily distinguishable from all of the other dorsal pieces, as seen in the species under consideration. As in that species, this has the two inner marginal pieces that connect with each other at the axils of the rays, rather decidedly larger than any of the others, but of different form, being wider than long, instead of the reverse, or with their longer diameters arranged transversely, and each provided with a kind of mesial protuberance on the inner side.

The only specimen of this species I have seen, is firmly attached by its ventral side to a foliated expansion of coral, so as to conceal that side entirely. It was evidently lying dead at the bottom of the sea, on its back, when the coral commenced growing upon its ventral side, and the coral afterwards not only covered this entire side, but grew some distance beyond even the extremities of its rays. This gives the Star-fish the appearance of growing parasitically upon the coral; but this is manifestly not the case, because it is its ventral, and not its dorsal side, that is attached.

Locality and position: Cincinnati group of the Lower Silurian, at Cincinnati, Ohio. Mr. Dyer's collection.

PALÆASTER SHÆFFERI, Hall.

Pl. E, fig. 1.

Palæaster Shæfferi, Hall, 1868; Twentieth Report Regents, p. 284, pl. 9, fig. 1; also p. 326, pl. 9, fig. 1, new edition of same.

I only know this species from the figure and description cited above, and merely copy the figure to make this report as full and complete as possible on the Cincinnati star-fishes. It seems to be a rather neat species, with somewhat slender, pointed rays. No figure of its dorsal side has been published; but it is described in the Regents' Report as having this side of the rays composed of "three rows of subnodose plates, the outer ranges bearing a strong spine on each plate; the central range apparently destitute of spines." The marginal plates of its under side are a little larger than the adambulacral; and the ambulacral plates are somewhat peculiar, in being apparently nearly or quite as long, in the direction of the length of the rays, as their breadth.

Locality and position: Cincinnati group, Cincinnati, Ohio.

GENUS STENASTER, Billings, 1858.

(Canadian Organic Remains, Decade III., p. 77.)

STENASTER GRANDIS, Meek.

Plate 3 *bis*, figs. 7 *a, b,* c.

Stenaster grandis, Meek, 1872; Am. Jour. Sci. and Arts, vol. 3 (3d series), p. 258.

Attaining a rather large size. Body comparatively small, or only the breadth of the united inner ends of the five rays. Rays long, gradually tapering, slender, and very flexible; widest at their immediate connection with the body, where they are more or less depressed, but becoming terete farther out. Dorsal side of body and arms composed of numerous little pieces, usually of subtrigonal form, that rise into pointed tubercles, or sometimes assume almost the character of short spinules, and are arranged in quincunx, so as to form about eight rows near the middle of the rays, those of the outer two rows being a little larger than the others. Dorsal pores apparently rather large, and passing through between the concave sides of contiguous pieces. Ventral side of body unknown; that of the rays composed of the usual single row of transverse adambulacral pieces on each side of the well defined, deep, and

moderately wide ambulacral furrows. Adambulacral pieces rather more than twice as wide as long, with their longer diameters at right angles to the ambulacral furrows, and each projecting along the middle in the form of a kind of narrow crest, that rounds over from end to end; while they do not connect with each other by perfectly flat sides, but have little projecting processes and sinuses, apparently for the purpose of giving greater flexibility to the rays.

Breadth of body, 0.63 inch; length of rays, 1.90 inch; breadth of same at their connection with the body, 0.36 inch.

Not having seen the under side of the body of this species, I am not quite sure that it is exactly congeneric with Mr. Billings's typical specimens of *Stenaster*. It does not show the peculiar contraction of the inner ends of the rays, seen in his *S. Salteri,* from which it also differs in a marked degree, in the much greater length and slenderness of its rays. In these characters, however, it agrees more nearly with his *S. pulchellis,* though its rays are proportionally longer, and provided with a greater number of rows of dorsal pieces, while it attains a much larger size.

In the length, slenderness, and flexibility of its rays, this fossil presents points of similarity to the *Ophiuroidea;* but it differs entirely in structure from that group, and conforms, in this respect, to the true *Asteroidea*. The apparently articulated character of its adambulacral pieces, is a peculiar feature, that may possibly be found to be accompanied by other points of structure, that may separate it generically from *Stenaster;* but this peculiarity cannot be confounded with the articulated character of the arm-pieces in the *Ophiuroidea*.

There are some appearances of the remains of very short spines being in some way connected with the adambulacral pieces; but on this point, or at least in regard to the exact nature of their connection, I have not been able to decide from the specimen studied.

Adopting the suggestion of Prof. Hall, that *Stenaster* of Billings should be replaced by the name *Urastrella* of McCoy, previously proposed for apparently congeneric forms, the name of the species here described would, if my present views of its affinities be correct, become *Urastrella grandis.*

I am under obligations to Mrs. M. P. Haines, of Richmond, Indiana, for the use of the typical specimen of this fine star-fish. It may not be out of place to mention in this connection, that this lady has, by her own zeal and industry, succeeded in getting together one of the finest and most valuable private collections of fossils and minerals in the West.

Locality and position: Upper part of the Cincinnati group of the Lower Silurian, at Richmond, Indiana. Mrs. Haines' collection.

OPHIUROIDEA.

? GENUS PROTASTER, Forbes, 1849.

(Memoirs Geol. Survey Gr. Brit., Decade 1, part IV., p. 1.)

PROTASTER GRANULIFERUS, Meek.

Plate 3 *bis,* figs. 8 *a, b.*

Protaster? granuliferus, Meek, 1872; Am. Jour. Sci. and Arts., Vol. III. (3d series), p.274.

Disc small, apparently circular; rays rather slender, and of unknown length. Dorsal surface of disc and rays covered by an integument composed of minute grains of calcareous matter. Ventral side of disc not well exposed in the only specimen seen, but apparently provided, in the interradial spaces, with minute spines directed outward. Oval pieces not clearly seen in the specimen. Arm-pieces regularly alternating, but apparently rectangular at their inner ends, and not interlocking along the impressed mesial line, longer transversely than in the direction of the length of the arms; each largely excavated at its outer anterior end, so as to form a large pore, or pore-like depression, and divided transversely by a furrow into two parts, the anterior of which is very short, and the posterior longer, and marked by a minute pit at its inner end; about eight or nine of these pieces in each range of each ray included within the disc. Outer arm or ray pieces (adambulacral of some) smaller than those of the inner ranges, and placed edge upward, with an oblique, outward direction, so as to imbricate outward, or toward the extremities of the arms; each bearing one or more minute, articulating spines.

Breadth of disc, about 0.43 inch; breadth of arms at their inner ends, 0.10 inch.

The only specimen I have seen, that is certainly known to belong to this species, is very imperfect, being merely an incomplete disc, and the inner ends of the rays. It does not conform to the characters of *Protaster,* given in Prof. Forbes' diagnosis, in all respects, since its disc, especially on the upper side, is covered by a shagreen-like integument, composed of a vast number of very minute grains of calcareous matter, instead of distinct imbricating scales. It is, therefore, probable that perfect specimens might show other characters that would warrant the establishment of a new genus, or sub-genus, for such forms, for which group I suggested, provisionally, the name *Alepidaster,* in the Journal of Science cited.

I have intentionally avoided, in the foregoing description, the use of the terms ambulacral and adambulacral pieces, sometimes used in describing the parts composing the rays of *Protaster,* and similar forms, because it seems doubtful whether these terms are properly applicable to such types. I should certainly think that they are not, *if those forms belong to the Ophiuroidea* (in which no ambulacral furrows exist), instead of to the *Asteroidea.* According to Dr. Wright, however (see Brit. Foss. *Echinodermata,* p. 32), *Protaster Miltoni* of Salter has a well developed madreporiform body, and hence would belong to the *Asteroidea.* Yet it is very curious that these types seem to have no proper ambulacral canals; and we have, apparently, no positive evidence that the viscera of the animal were not entirely confined to the disc, as in the *Ophiuroidea.*

Locality and position: Middle part of the Cincinnati group of the Lower Silurian, at Moore's Hill, Indiana. Mr. Dyer's collection.

MOLLUSCA.

POLYZOA.

GENUS PTILODICTYA, Lonsdale, 1839.

(Murchison's Sil. Syst., p. 130.)

PTILODICTYA (STICTOPORA) SHAFFERI, Meek.

Plate 5, figs. 1 *a, b,* c.

Ptilodictya (Stictopora) Shafferi, Meek, 1872. Proceed. Acad. Nat. Sci., Philad., Feb., p. 317.

Polyzoum small and delicate, consisting of slender, compressed divisions that give off on each side, rather closely arranged, regularly alternating, lateral branches of the same breadth as the main stems, from which they diverge at an angle of about forty degrees; lateral branches, in the same way, giving oft on each side, very short, lobe-like, alternating projections; flattened lateral margins of all parts very narrow, sharp, and minutely striated longitudinally, in well preserved specimens; pores apparently without raised margins, more or less oval longitudinally, alternately disposed in longitudinal and oblique rows, so as to present a quincuncial arrangement; the number of longitudinal rows varying from five to about seven in the breadth of a stem or branch; spaces between the pores measuring transversely to the stems and their divisions about equal to the breadth of the pores, but greater, measuring in the direction of the oblique and longitudinal rows, all ornamented, in perfectly preserved specimens, by very minute, more or less waved or flexuous striæ.

Size of entire polyzoum unknown; breadth of stems and branches, 0.05 inch; number of pores in 0.05 inch; measuring in the direction of the oblique rows, about 4 to 6, and in the same space measuring longitudinally from 3 to 4.

This very delicate little species will be readily distinguished from the other known Silurian form by its small size and peculiar plumose mode of growth; and particularly by its very minute striæ between the pores. *Stictopora raripora,* Hall, from the Clinton group of New York, is as delicate a form, but differs materially in its mode of growth, and particularly in its very much less numerous pores.

The specific name is given in honor of Mr. D. H. Shaffer, of Cincinnati, Ohio, to whom I am indebted for the use of a fine specimen of the species, found, I am informed, by T. W. Spurlock, Esq., of Cincinnati. I also have good specimens of this species from Mr. Dyer's collection.

Locality and position: Toward the lower part of the Cincinnati group of the Lower Silurian, at Cincinnati, Ohio.

BRACHIOPODA.

GENUS LEPTÆNA, Dalman, 1828.

(KongI. Vet. Acad., Handl., p. 94.)

LEPTÆNA SERICEA, Sowerby?

Plate 5, figs. 3 *a* to *h.*

Leptæna semiovalis, Conrad, 1838; Ann. Geol. Report N. Y., p. 115 (without figure or description).

Leptæna sericea, J. de C. Sowerby, 1839; Sil. Syst., pl. XIX., figs. 1, 2; de Verneuil, 1845, Geol. Russia, Vol. II., p. 227, pl. XV., figs. 1 *a, b;* McCoy, 1846, Sil. Foss. Ireland, p. 27; Barrande, 1847, Sil. Brach. Bohem, Naturw. Abhandl., Vol. II., p. 71, pl. XXI., fig. 18; Hall, 1847, Palæont. N. Y., Vol. I., p. 110, pl. XXXI. B, figs. 2 *a-h,* and p. 287, pl. LXXIX., figs. 3 *a, b;* Phillips and Salter, 1868, Mem. Geol. Survey, Vol. II., p. 285; McCoy, 1852, British Pal. Foss., p. 237; Salter, 1859, Siluria, 3d ed., p. 210, fig. 6 and pl. V., fig. 14; Eichwald, 1859, Leth. Rossica, Vol. I., p. 870; Salter, 1866, Mem. Geol. Survey, Vol. III., p. 266; Davidson, 1871, Monogr. Brit. Sil. Brach., p. 326, pl. XLVIII., figs. 10-19.

Orthis sericea, Eichwald, 1840; Sil. Syst. in Esthl., p. 157; Portlock, 1843, Geol. Lond., p. 450, pl. XXXII., figs. 23, 24.

Strophomena sericea, Conrad, 1840; Ann. Geol.. Rep. N. Y., p. 201; Emmons, 1842, Geol. Rep., 394, cut 105, fig. 1.

Shell small, transverse, semi-oval, approaching semi-circular, concavo-convex; hinge line equaling, or more frequently a little longer than the breadth of the valves at any point farther forward; lateral extremities

varying from somewhat acutely angular to nearly or quite rectangular, and not properly reflexed; anterior and lateral margins forming together nearly a regular semi-circular curve.

Dorsal valve concave, its deepest concavity being near the middle; beak not distinct from the cardinal margin; area narrow or nearly linear, and ranging at right angles to the plane of the valves. Interior showing cardinal margin to be minutely crenate toward the lateral extremities; cardinal process moderately prominent, and trifid, the middle division being most prominent, with a deep pit at its inner base; brachial? processes short, appressed, and widely divergent; muscular impressions generally obscurely defined, occupying an obcordate area, and separated from each other by two sub-parallel, narrow ridges, that sometimes coalesce near the base of the cardinal process; each impression usually nearly equally divided by a slender linear, straight ridge; anterior and lateral regions more or less roughened by minute, granular, radiating striæ.

Ventral valve moderately convex, being nearly evenly, but gently arched, along the middle from the beak to the front, and thus following so nearly the curve of the other valve as to leave but a very thin visceral cavity within; beak very small, or scarcely, if at all, distinct from the cardinal margin; area twice to three times as high as that of the other valve, inclined backward, or more or less nearly parallel to the plane of the valves; foramen arched over, near the beak, by a small false deltidium, and closed between this and the hinge margin by the prominent cardinal process of the other valve. Interior showing hinge margin to be obscurely marked with minute pits for the reception of the crenulations of that of the other valve; teeth small; muscular impressions long, narrow, separated behind by a short linear mesial ridge, and diverging and extending forward beyond the middle of the valve, with a moderately distinct dental ridge along tile lateral margin of each; anterior and lateral regions granulo-striate.

Surface of both valves marked by numerous very minute, closely arranged radiating striæ, about every fourth, fifth, or sixth one of which is a little larger and more prominent than those between.

Length of a mature specimen, 0.36 inch; breadth, 0.65 inch; convexity, 0.12 inch. Some specimens proportionally a little more convex.

The little shell here described is the western form that has long been referred to *L. sericea* of Sowerby, with which it agrees quite well in its external characters. I have had no opportunity to compare it with British or other foreign specimens of Sowerby's species, but on compari-

son with Mr. Davidson's figures of the interior of that shell, I am led to doubt whether it is really the same species. At any rate, it certainly has a more prominent cardinal process than is represented by Mr. Davidson; while its hinge margin is more or less distinctly crenulated, a character neither illustrated nor mentioned by that author, in *L. sericea*. Again, the muscular impressions of its dorsal valve are proportionally smaller, and not so arched; while those of its ventral valve are narrower and more elongated, as well as less diverging, being in form more like those of *L. transversalis,* but much less diverging. In the crenulation of its hinge it also agrees more nearly with *L. transversalis,* from which, however, it differs entirely in the form of the muscular impressions of its dorsal valve, as well as in its more depressed form. I have likewise been unable to see, even by the aid of good magnifiers, any traces of the minute punctures between its striæ, mentioned by several authors in describing the species above alluded to.

Locality and position: This shell has a wide geographical, as well as a great vertical range, or at least it has been identified at various horizons from the Trenton Limestone to the Clinton group in New York, and it seems to have nearly the same range in the Western States. It is found at nearly all the localities in the West where the Cincinnati or Trenton group occurs. It is common at Cincinnati through all the beds exposed there, and occurs at higher horizons in this series at Oxford, Dayton, and numerous other places in Ohio; as well as at Richmond, Madison, and other places in Indiana. It also occurs in Iowa, Illinois, Wisconsin, Kentucky, Canada, etc. The specimens from which our figures and description were prepared are from Cincinnati, Ohio, and Richmond, Indiana, where it occurs in great numbers, often clustered together as if gregarious in its habits.

The typical *L. sericea* seems to have an equally great yertical and geographical range in the Silurian rocks of the Old World.

NOTE.—At the horizon of 150 feet above low water at Cincinnati, there occurs a very similar, but somewhat larger and proportionally wider shell, with a more straightened anterior margin, and the area of its dorsal valve more inclined forward. This form also often has rather distinct oblique wrinkles along the hinge margin on each side, of which only very faint traces are sometimes seen on the last. I have not seen the interior of its dorsal valve, but a single example of the ventral valve, showing the interior, has the muscular scars undefined, excepting as minutely striated spaces free from the granulations seen on other parts of the interior. Its brachial? processes are longer than in any specimens of the other form I have seen, but as these are very slender and free at the end in each, they may not be entire in the specimens of the other form examined. It was for this form that Mr. James proposed the name *L. rugosa* in his list of the Cincinnati fossils. It may be a distinct species, but with the means at hand for comparison I am left in doubt on this point. Our figures *f, g* and *h,* of plate 5, fig. 3, represent this shell.

GENUS STROPHOMENA, Rafinesque, 1827.

Some differences of opinion exist among Palæontologists and Conchologists in regard to what particular shell should be considered the typical form of this genus. Rafinesque's diagnosis was so brief and unsatisfactory, that it will apply almost equally well to anyone of several genera, as now understood; and as he neither figured nor characterized any of the species, though he mentioned *S. rugosa* and others by name, it is difficult to determine, from his writings, for what particular group of shells he intended the name. Prof. Hall says he saw in Rafinesque's collection, purchased at the sale of his property after his death, by Dr. Poulson, a specimen of the common species *rhomboidalis (=Leptæna depressa* of several authors), accompanied by a label, on which was written, in Rafinesque's well-known hand-writing, the name *Strophomena rugosa;* and he therefore regards that as the type of the genus, though of course he admits that the older name *rhomboidalis* will have to be retained for the *species.* The fact that the name *rugosa* would so naturally suggest itself for this shell, to which it would be very applicable, certainly favors the conclusion that Rafinesque really had it before him when he wrote the name *Strophomena rugosa;* and hence that this form should be regarded as the type of the genus. Indeed, it had been given by several authors as the illustrative, or typical form of the genus, before the labeled specimen alluded to above had been especially noticed in Rafinesque's collection; and it has been so regarded by various others since.

Some, however, regarding the question respecting Rafinesque's type as being involved in doubt, have, in accordance with a very general, and usually good rule in such cases, appealed to the first authors who followed Rafinesque in the use of the name *Strophomena,* as settling the question in regard to the type. Defrance was, I believe, the first author that adopted the genus (in 1824); but, so far as I have been able to find, he only used it as Rafinesque did, that is, he neither figured nor described any of the species, but merely mentioned by name those that Rafinesque had mentioned. In 1825, however, Blainville adopted the genus, with a short diagnosis, and figured an illustrative example (doubtless sent to him from America) under Rafinesque's name *Strophomena rugosa.* But his figure clearly shows that the shell he had in view is a very different form from that found in Rafinesque's collection along with that name, and that it is by no means a rugose species. On the contrary, it is one of those resupinate forms, apparently undistinguishable from the common western species *S. planumbona,* to which species it almost certainly

belongs. Consequently, some authors would view this as the typical form of *Strophomena,* and not the geniculated species like *S. rhomboidalis.* Although at one time somewhat inclined to adopt this conclusion, it seems to me, on farther reflection, that if we use the name *Strophomena* at all as Rafinesque's genus, we ought to consider the only shell found in his collection with this name attached as the typical form of the group, especially as this type has been so generally figured as an illustrative example of the genus by subsequent authors.

If all authorities could agree that forms like *S. rhomboidalis* and *S. planumbona,* etc., belong to the same genus, it would, of course, be a matter of no material consequence which should be regarded as the type of the group. But some high authorities consider them generically distinct, while others would separate them sub-generically. But perhaps a majority, including some who have devoted much time and study to the investigation of the *Brachiopoda,* make no distinction whatever—or, in other words, include the whole under the genus *Strophomena,* without even a sub-generic separation.

At present I am rather inclined to the opinion that the Cincinnati species like *S. planumbona,* and most of the others here described, should be separated generically from the group including *S. rhomboidalis,* and placed under Pander's name *Hemipronites.** As it is still an open question however, in regard to which of these types should retain the older name *Strophomena,* and I have neither the time nor (at hand just now) the necessary collections to enter upon a general study of these and allied groups, I have concluded to view *S. rhomboidalis,* provisionally, as the type of the genus *Strophomena,* and to range the others under Pander's name *Hemipronites,* as a *sub-genus* under the same.

It may be proper, however, to state here, for the information of students not yet familiar with the difficulties of zoological nomenclature, that in case the *S. planumbona* group shall be finally separated *generically* from that including *S. rhomboidalis,* and the former shall take the name *Strophomena,* then the latter *may* have to take Dalman's name *Leptæna,* published in 1828. Unfortunately, in publishing the genus *Leptæna,* Dalman included in it *S. rhomboidalis* (under other specific names), along with species of *Productus,* and other types of *Strophomena* and *Leptæna,* as those genera are now usually understood. But his first species was the *S. rhomboidalis,* and consequently some authors view that as the typical form of *Leptæna.* If this conclusion should be adopted, it unfortunately

* *Streptorhynchus* of King was proposed in 1850 for Permian and Carboniferous forms, often having a very high area, and more or less distorted beak; but apparently agreeing, in all essential characters, with the type of *Hemipronites.*

requires still another important change of nomenclature—that is, that the group including such forms as *Leptæna sericea,* and now almost universally known under the name *Leptæna,* should take Pander's name *Plectambonites,* published in 1830. It seems to me, however, as already intimated, that it will be far better to avoid this perplexing swapping about of old familiar names, by considering *S. rhomboidalis* as the type of the genus *Strophomena* (as the facts stated seem to warrant), and then to place the other forms already referred to under Pander's name *Hemipronites,* either as a sub-genus under *Strophomena,* or as a separate and distinct genus.

STROPHOMENA RHOMBOIDALIS, Wilckens (Sp.).

Plate 5, figs. 6 *a, b,* c, *d, e.*

Conchita rhomboidalis, Wilckens, 1769; Nachricht von seltenen Verst., p. 77, pl. viii., figs. 43 and 44.
Anomites rhomboidalis, Wahlend., 1821; Nov. Acta Upsal, Vol. VIII., p. 65.
Producta depressa, Sowerby, 1823; Min. Conch., Vol. V., p. 86, pl. 459, fig. 3.
Producta rugosa, Hisinger, 1826; Act. R. Acad. Sci. Holm., p. 333; Deshayes, 1836, Lam.
An. Syst., Vol. VII., p. 380.
Leptæna rugosa, and *L. depressa,* Dalman, 1828; Vet. Akad. Handl, pp. 106 and 107, pl. I, figs. 1 and 2; Kloden, 1834; Verst. Brandenb, p. 180; Hisinger, 1837, Leth. Succia, p. 69, pl. xx., figs. 2, 3, and others.
Strophomena rugosa, Brown, 1835; Lethaea Geog., p. 87, pl. ii., fig. 8; Von Buch, 1837, Ueber Detth., p. 70; also, 1840, Mem. Geol. Soc. Fr., Vol. IV., p. 220, pl. xii., fig. 24.
Leptæna depressa, J. de C. Sowerby, 1839; Silur. Syst., pp. 623 and 636, pl. xii., fig. 2, and of many others.
Leptæna tenuistriata, Sowerby, 1839; *ib.,* p. 636, pl. xxii., fig. 2 *a;* also of Hall, Salter, and others.
Strophomena depressa, Vanuxem, 1842; Geol. Report, Third Dist., N. Y., p. 79, fig. 5, and of others.
Orthis depressa, Portlock, 1843; Geol. Lond., p. 450; Quenstedt, 185, Handb., p. 488, pl. 32, fig. 20, and of others.
Leptæna (Leptagonia) depressa, McCoy, 1852; Brit. Pal. Foss., p. 248.
Strophomena rhomboidalis, Lindstrom, 1860; Goth. Brach., p. 371; Haswell, 1865, Sil. Form. Pentland Hill, p. 33, plate iii., fig. 3; Davidson, 1868, Trans. Geol. Soc. Glasgow, Pal. Ser., Vol. I., p. 16, pl. ii., figs. 17, 18; and 1871, Monogr. Brit. Fossil Brach. (Silurian), p. 281, pl. xxxix., figs. 1-21,*
Strophomena gibbosa, James, 1871; Cat. Lower Sil. Fossils, Cincinnati Group, p. 9.

This widely distributed shell is too familiar to geologists and collectors to require a detailed description. It seems desirable, however, that it

* For the long list of other references, see Mr. Davidson's Monographs of British Fossil *Brachiopoda,* from which most of the above have been taken.

should be illustrated and noticed here, in order that students may be apprised of the fact that it is one of the forms they may expect to meet with in the Cincinnati group, as well as in some more recent formations of Ohio. Its most marked characters are the strongly flattened and concentrically wrinkled visceral region of both of its valves, and the abrupt geniculation of the front and lateral margins of the same; the deflection being from below upward. The interior of its dorsal valve also has a very prominent ridge around the anterior and lateral regions bounding the visceral area. The general outline of the shell is usually more or less nearly semi-circular; but specimens have been referred to it by Mr. Davidson, in England, with a nearly transversely oblong outline, some of which also have a strongly trilobate front. The latter forms, however, have not, I believe, been observed in this country.

The specimens before me have the cardinal area narrow in both valves, but wider (higher) in the ventral, which has its inconspicuous beak provided with the usual minute perforation, and its triangular foramen closed, or nearly closed, by the bifid cardinal process of the other valve. The whole surface of both valves is ornamented by fine, even, closely arranged, radiating striæ, that most frequently increase by intercalation on the ventral valve, and by bifurcation on the dorsal; while crossing these, on both valves, well preserved specimens show, under a magnifier, extremely minute, regular, crowded, concentric striæ.

One of the largest Ohio specimens before me, from the upper part of the Cincinnati group, measures 0.84 inch, direct from beak to front, 1.30 inches in breadth, and 0.46 inch in convexity.

Widely different opinions prevail among geologists and palæontologists in regard to the geological range of this species. Mr. Davidson and many other high authorities believe that it ranges from the Lower Silurian into the Carboniferous; while others separate the specimens found at these extremes, and at some intermediate horizons, into several distinct species. Although not intending to express a decided opinion on this point, without having the necessary material at hand for comparison while preparing these remarks, it certainly seems to me that our specimens present no constant appreciable differences from Upper Silurian and Devonian forms generally referred to *S. rhomboidalis*, or *S. depressa*, as it has most generally been called in this country. Compared with Mr. Davidson's figures of British Silurian examples, the internal ridge around the line of deflection of the dorsal valve, in our specimens, differs from most of his figures, in not converging inward as it approaches the hinge, but, on the contrary, either approaches the hinge at right angles to the same, or curves outward. The specimens figured by

Mr. Davidson, however, differ much in this respect, while some of them do not differ materially from ours in this character.

Locality and position: As generally understood, this species has an almost world-wide geographical range, and, as already stated, a great vertical range, especially if the Carboniferous form is to be included as a variety. It occurs at various localities in the Trenton Limestone in New York and some of the neighboring States; also in the Clinton and Niagara groups, Lower Helderberg rocks, Schoharie grit and Corniferous limestone. In Ohio, it ranges from the lower part of the Cincinnati group, apparently into the Waverly group. I have no specimens from the Waverly group at hand at the moment of writing, for comparison, but speaking from memory, I can scarcely doubt the identity of specimens seen from that horizon. Among the localities where it has been found in the Cincinnati group, in Ohio, may be mentioned Cincinnati (50 feet above low water of the Ohio), and higher in the group in Butler and some of the adjoining counties. It also occurs at the same horizon at Madison, in Indiana, and in Kentucky, etc. A long list of other American and foreign localities might also be added, if desirable.

SUB GENUS HEMIPRONITES, Pander.

(*Resupinate species.*)

STROPHOMENA NUTANS, James.

Plate 6, fig. 1 *a* to *f*.

Strophomena nutans, James, 1871; Cat. Lower Sil. Fossils, Cincinnati Group, p. 9. Compo *S. camerata* and *S. deltoidea,* Conrad; Palæont. N. Y., Vol. I., p. 31 A, figs. 2 and 3.

Shell under medium size, sub-trigonal, strongly concavo-convex, comparatively thick and strong; hinge about equaling the breadth of the valves; lateral margins usually somewhat straightened behind, where they meet the extremities of the hinge nearly at right angles, while anteriorly they converge to the middle of the front, which is prominent, and very narrowly rounded, or almost angular in outline.

Dorsal valve remarkably convex in the central or anterior central region, from which it rounds down abruptly to the lateral and anterior margins, and slopes strongly posteriorly, the anterior lateral slopes being usually somewhat compressed, so as to impart to the middle of the anterior region a degree of prominence, somewhat like a mesial ridge, near the margin; whole umbonal region flattened; area narrow, or sub-linear, and directed nearly backward; beak not distinct from the edge of the area. Interior with the bifid cardinal process short; sockets deep, sub-trigonal, and very oblique; socket-ridges rather prominent, thin, and continued obliquely forward and outward, with an inward

curve, so as to form the lateral margins of the muscular impressions, which are well defined, rather deep, strongly striated, and separated by a short, mesial ridge coming from the base of the cardinal process; while near the middle of the anterior edge of each, there is sometimes a little oblique prominence; central region, in front of the muscular impressions, sometimes showing four obscure parallel ridges running directly forward, and separated from each other by three shallow, narrow furrows, in the middle of each of which there is a raised line; traces of other smaller and more obscure ridges sometimes extend forward and laterally on each side of those described, while the whole internal surface is usually minutely granular.

Ventral valve nearly flat, with a backward slope in the umbonal region, and distinctly concave farther forward, in the anterior central region; while the anterior and lateral margins are abruptly curved downward parallel to those of the other valve; beak scarcely distinct from the margin of the area, which is of moderate height, flat, and extends the entire length of the hinge, with usually but little taper toward the lateral extremities; foramen rather broad trigonal, and covered above by the convex pseudo-deltidium, which is broadly and deeply sinuous on its inner edge, for the reception of the cardinal process, and a kind of pseudo-deltidium of the other valve, formed by the continuation of the socket plates. Interior with the anterior and lateral margins, geniculated so as to form a marginal ridge that is deeply and somewhat regularly furrowed across, while the ovarian spaces within this marginal ridge are more or less flattened, and sometimes granulated; hinge teeth moderately prominent, transversely sub-trigonal, and striated on their anterior and posterior faces; while from their inner bases the prominent dental ridges extend forward and curve together, so as to form a strongly elevated margin to the deep, sub-circular cavity for the reception of the muscular impressions; muscular cavity scarcely reaching the middle of the valve, usually with its rim slightly notched (not emarginated) at the middle of the front; while within its bottom it is provided with a slender mesial ridge, with the narrow adductor muscular scars on each side of it, and on the outside of these, most of the remaining space seems to be occupied by the striated scars of the divaricator muscles, there being only a very small notch-like impression close to the hinge tooth on each side, apparently left by the ventral adjustor muscles.

Surface of both valves ornamented by very fine, closely arranged, simple radiating striæ, that increase by intercalation, and are either nearly equal, or sometimes have every third, fourth or fifth one slightly larger than those between; while on well preserved specimens, very minute,

crowded, concentric striæ may be seen, by the aid of a strong magnifier, crossing the much larger radiating striæ.

Length of a mature specimen, 0.80 inch; breadth, 0.93 inch; convexity, 0.50 inch.

This species resembles some varieties of *S. deltoidea* and *S. camerata,* Conrad: but it seems to present too strongly marked external and internal differences to be referred to either. In convexity it appears to agree more nearly with the latter, but it shows no traces of the concentric ridges occupying the umbonal region of that form, and differs materially in its prominent sub-angular front, which imparts a nearly triangular form to the valves, instead of having the front broadly rounded. In this prominent sub-angular character of the middle of its front, it agrees more nearly with some varieties of *S. deltoidea,* but it is a greatly more convex shell, and, as already stated, shows no traces of the concentric ridges on its flattened umbonal region, generally so well marked on that. shell; while the details of its internal characters also seem to differ, those of its dorsal valve being very similar to what we see in *S. filitexta*, from which the shell differs widely in nearly all other respects.

The strong concavo-convex, sub-trigonal general form, and the thickened internal ridge and geniculation of its ventral valve are marked features in this species.

Locality and position: Upper part of the Cincinnati group, in Butler, Warren and Clinton counties, Ohio. Mr. James's collection.

STROPHOMENA PLANUMBONA, Hall.

Pl. 6, fig. 3 *a* to *h.*

? *Strophomena rugosa*, Blainville, 1825; Malacol., p. 513, pl. LIII., figs. 2 and 2 *a* (not of other authors).

Leptæna planumbona, Hall, 1847; Palæont. N. Y., Vol. 1, p.112, pl. 31 B, fig. 4 *a, b,* c, *d, e.*

Strophomena planumbona, Hall, 1859; Regents' 12th State Cab. Report, p. 70; Geol. Report, Wisconsin (1862), p. 54, fig. 7.

Shell rather small, or scarcely attaining a medium size, concavo-convex, semi-oval, or more than semicircular in outline; hinge line generally a little longer than the breadth of the valves at any point farther forward; lateral extremities, in most examples, somewhat less than rectangular, or sometimes rather acute, more or less compressed and deflected; lateral margins a little contracted posteriorly, and rounding to the front, which forms a regular semicircular curve.

Dorsal valve flat in the umbonal region, and rather strongly and

evenly convex in the central and anterior regions, from which it rounds off abruptly to the front and lateral margins; beak very small, or not distinct from the edge of the narrow or sublinear area, which is inclined nearly directly backward, but not incurved. Interior showing the cardinal process to be small, depressed, divided to its base into two diverging tooth-like parts, a little flattened on their posterior faces, and directed very obliquely forward and outward; socket ridges short and oblique; mesial ridge low, extending but a little distance forward; while the space between it and the socket ridge, on each side, is occupied by a moderately distinct muscular scar.

Ventral valve broadly and rather deeply concave in the central and anterior regions, and slightly convex at the beak, which is very small, abruptly pointed, scarcely projecting beyond the edge of the area, and usually minutely perforated; area moderately high, extending the whole length of the hinge, generally but little sloping laterally, flattened and inclined more or less backward; foramen closed by a prominent, rounded pseudo-deltidium, that is transversely striated, and rather broadly sinuous on its inner edge, for the reception of the cardinal process of the other valve. Interior showing hinge teeth to be well developed, trigonal, and striated on their posterior sides; while from their inner bases the dental laminæ extend forward so as nearly to encircle the usual saucer-shaped depression for the muscular scars, which is sometimes divided by a small, linear mesial ridge; cardinal margin prominent and sharp within, on each side of the hinge teeth; anterior and lateral regions more or less thickened within, and roughened by the crossing of the vascular markings, which are scarcely visible on any part within this zone.

Surface of both valves ornamented by numerous fine, closely crowded, radiating striæ, that are often alternately a little larger and smaller, or on some parts, with several of the smaller ones between each two of the larger; the smaller being always shorter than the larger, or ending at various distances between the free margins and the beaks, without coalescing with those between which they are intercalated. Striæ and furrows minutely crenulated by extremely small, very regular, closely arranged, concentric lines, in visible without the aid of a magnifier; a few sub-imbricating marks of growth are likewise sometimes seen near the free margins.

Length of a medium sized specimen, 0.73 inch; breadth, 0.98 inch; convexity, 0.24 inch; number of striæ in the space of 0.10 inch near the middle of the front margin, from 5 to 8; the greater number being where smaller ones are intercalated between the larger.

This is the shell that has always been identified by Western geologists with *S. planumbona* of Hall, and it agrees well with his description of that species; though it differs materially from his figures 4 *a* and 4 *b*, cited above, in presenting scarcely any traces of the strong, rounded, concentric folds shown on the same. As no traces, however, of these folds are represented on his profile, figure 4 *e*, of the same plate, which would certainly show them in relief if they exist as represented by the other figures, and nothing is said in the description about concentric ridges or folds (which would be an unaccountable omission if the shell really presents such a character), while no shell agreeing with these figures in these respects is known to collectors from the localities mentioned in the West, we may reasonably infer that it is due to an error in the figures that they are made to represent such strong concentric ridges. If this is not so, the shell here represented would agree much more nearly with *S. deflecta* of Conrad, as illustrated on the same plate of the New York Palæontology, to which it certainly seems to be very closely related.

In size, and some other respects, this shell resembles the last, but it differs materially in being much more compressed, and in not presenting the peculiar trigonal form imparted to that shell by the prominent, sub-angular middle of its anterior margin. There are also well defined internal differences between the two shells.

Locality and position: Upper part Cincinnati group, in Clinton and Preble counties, Ohio, and Richmond and neighboring parts of Indiana. Prof. Hall also mentions Madison, Indiana; Maysville, Kentucky; and Cincinnati, Ohio. It does not occur at Cincinnati, however, but seems to be confined to a higher horizon.

STROPHOMENA PLICATA, James.

Pl. 6, fig. 4 *a* to *h.*

Strophomena plicata, James, 1871; Cat. Lower Sil. Fossils, Cincinnati Group, p. 9.

Compare *Lept. subtenta* (Conr. MS.), Hall, 1847; Palæont. N. Y., Vol. I., p. 115, pl. XXXI. B, fig. 9 *a*, *b;* and *Lept. planumbona,* Hall, 1847, Ib., p. 114, pl. XXXI. B, fig. 7 *a*, *b,* c, *d.*

This form agrees so nearly with that last described, that a formal detailed description would be, with the exception of a few characters, almost an exact repetition of the same words. It will, therefore, be sufficient to point out the few characters in which it differs. In the first place, it attains a somewhat larger size, and a rather more robust appearance; while its lateral extremities are often more acutely angular, and marked by a few wrinkles directed very obliquely outward and backward. It is worthy of note, however, that some of the specimens from the original locality, agreeing in all other respects, do not show these wrinkles, while

others are less extended on the hinge line. The largest specimens also seem to have the striæ slightly more distinct than in the last, and rather more sharply crenated, though they are still variable in this character. In all internal characters the two forms appear to agree quite closely.

From this close agreement, I have doubts whether this form should be considered as more than a variety of the form usually referred to *S. planumbona.* In most of its characters it would also seem to be closely allied to *S. subtenta* of Conrad, as illustrated in the New York Palæontology, from which it only appears to differ externally, in the more acutely angular and produced character of its lateral extremities, as seen in its more typical examples. Otherwise, it agrees exactly in form and surface markings, even to the oblique wrinkles on its lateral extremities.

In this oblique direction of these wrinkles, it agrees much better with the figure first published under the name *S. subtenta,* than any of the specimens yet sent to me from the West with that name attached; all of which latter have the wrinkles ranging at right angles to the hinge margin. It is worthy of note, however, in this connection, that the published figure alluded to, under Mr. Conrad's name, was from Oxford, Ohio; while Mr. Conrad's original type, which has not yet been published, came from the Trenton rocks of New York. Consequently, it is possible that the shell figured in the New York Report may be an individual of the form here under consideration, with its lateral extremities less than usually extended, or worn or broken away, and yet differing specifically from Mr. Conrad's New York type.

It will also be noticed that this shell closely resembles certain forms of *S. filitexta,* both in its external and internal characters; large individuals, with the oblique wrinkles obsolete, or nearly so, being very similar to medium sized specimens of that species. From these facts it seems not very improbable that a thorough comparison of more extensive collections of these shells may bring to light good and sufficient reasons for uniting this form with one of those mentioned. For the present, however, I prefer to keep it separate, provisionally, under Mr. James's name, *S. plicata.*

Locality and position: Upper part of the Cincinnati group, near the base of the hills at Richmond, Indiana, where it is very abundant, and found in a beautiful state of preservation. It also occurs at other localities of that region, at the same horizon, in Ohio and Indiana.

STROPHOMENA PLANO-CONVEXA, Hall.

Pl. 2, fig. 2 *a* to *h.*

Strophomena plano-convexa, Hall, 1847; Palæont. N. Y., Vol. I., p. 114, pl. XXXI. B, fig, 7 *a, b, c, d.*

This is another form so near *S. planumbona,* as to be readily characterized by pointing out the characters in which it differs. In the first place,

it is rather constantly, though not always, wider in proportion to length, sometimes attains a rather larger size, and always differs in having the ventral valve nearly flat, or but slightly concave, instead of being distinctly so; while its dorsal valve is usually, but not always, a little less convex. The area of its ventral valve is likewise, in most examples, proportionally rather lower, and more tapering to the lateral extremities. Its surface striæ are perceptibly coarser than in *planumbona,* or any of the other allied species of this horizon, and seem not to be nearly so distinctly crenated, particularly as the form described under the name *plicata;* while they more frequently increase in number by bifurcation than in *plicata* or *planumbona,* instead of by intercalation, and the smaller ones sooner attain the size of the others, so that the whole present a more uniform size. The perforation of its beak is more constant, and rather larger than in any of the others mentioned. It can be readily distinguished from all the other forms by the above mentioned external characters; while internally it seems always to want the thickened and roughened zone around the anterior and later margins, seen in *S. nutans, S. planumbona, S. plicata,* and the other allied resupinate forms of this region.

Locality and position: Cincinnati group, at a horizon of about 300 feet above the Ohio, at Cincinnati. It also occurs at about the same horizon at many places in Indiana, Kentucky, Wisconsin, etc. Mr. James's, Mr. Shaffer's, Mr. Dyer's, Mr. Miller's, and other collections at Cincinnati.

STROPHOMENA FILITEXTA, Hall.

Pl. 6, fig. 5 *a, b,* c, *d.*

Leptæna filitexta, Hall, 1847; Palæont. N. Y., Vol. I., p. 111, pl. XXXI. B, figs. 3, *a, b, c,d,e,j.*

Strophomena filitexta, Hall, 1859; Regents' 12th Ann. State Cab. Report, p. 70.

? *Strophomena neglecta,* James, 1871; Cat. Lower Sil. Fossils of Cincinnati Group, p .9.

Shell attaining a moderately large size, semi-oval, the length being always less than the breadth; hinge line generally greater than the breadth at any point farther forward; lateral extremities usually somewhat acutely angular, and deflected; lateral margins a little sinuous posteriorly, and rounding to the semicircular front.

Dorsal valve flat in the umbonal region, and evenly convex in the anterior central and lateral portions, and curving downward around the front and lateral margins; area narrow, or nearly linear, and directed obliquely backward and upward; beak not distinct from the margin of the area.

Ventral valve nearly flat, or slightly convex in the umbonal region, and broadly and deeply concave in all the central and anterior central parts,

but curving upward around the front and lateral margins nearly parallel to the free margins of the other valve; cardinal area of moderate height, extending the whole length of the hinge, but sloping rather distinctly from the beaks laterally, flat and directed nearly at right angles to that of the other valve; beak very small, and only projecting slightly beyond the margin of the area; foramen closed by the usual convex pseudodeltidium, which is deeply sinuous on its inner margin, for the reception of the cardinal process of the other valve. Interior with cardinal edge but slightly prominent; hinge teeth sub-trigonal, oblique, and but moderately developed; dental ridges prominent, strong, and encircling a rather large, deep, saucer-shaped cavity, one-third to one-half the length of the valve, and marked within by an obscure central ridge, and on each side of this by rather strong radiating furrows; anterior and lateral margins a little thickened within, and divided by the crossing, apparently, of the vascular markings, into short, obscure ridges; entire internal surface sometimes showing, under a magnifier, a very minute, obscurely granular appearance.

Surface of both valves ornamented by numerous fine, sub-equal, crowded, and rounded, radiating striæ, that increase by intercalation, there being usually slightly larger ones at regular intervals, with three or four smaller ones between, on all the central regions of the valves, only the former of which extend nearly or quite to the beaks; before reaching the anterior and lateral margins, all of the smaller, excepting the shortest, increase nearly or quite to the size of the largest; crossing the whole, there may be seen, by the aid of a magnifier, numerous much finer, closely crowded, concentric striæ, and sometimes a few obscure, distant, stronger marks of growth.

Length of a mature specimen, 1.35 inches; breadth, 1.82 inches; convexity, about 0.36 inch.

I am not entirely sure that any of the specimens examined, showing the interior of the dorsal valve, belong to this species; those *believed* to belong to it, yet examined, having the exterior either firmly imbedded in the matrix, or incrusted over by a growth of corals. These have the cardinal process, as in other allied forms, short and divided into two low diverging parts, directed obliquely forward and outward, and flattened or a little concave on their posterior sides; while the socket ridges on each side are very short and oblique. In the bottom of the valve three low, nearly parallel ridges start forward, from near the base of the cardinal process, the middle one of which is shortest, while the lateral extend to, or a little beyond, the middle of the valve. Two others also originate

behind the middle, between these three, and extend forward parallel to each other, farther than any of the others. Between these four longer ridges, three very slender, much smaller raised lines, may also sometimes be seen, while a large area of the central region of the valve, including the ridges mentioned, and a considerable space on each side of them, is occupied by small, but distinct granulations, that show a tendency to arrange themselves into radiating lines.

This species seems to be quite different, and readily distinguished, from any of those mentioned before it, not only by its larger size, but by its internal characters. I am left in some doubt, however, whether the form called *S. neglecta,* in Mr. James's list, is the same species as the *filitexta,* not having seen specimens showing its internal characters. Most of Mr. James's type specimens of that shell show little or no difference of form from those here referred to *S. filitexta.* One of them, however, is much more elongated on the hinge line, and evidently had more acutely angular lateral extremities. They all, likewise, have nearly the same sized striæ; but the striæ are much more distinctly crenated by the crossing of their more sharply defined, and rather more distant concentric microscopic lines. Unless these shells may present some internal differences, however, I should think them probably not specifically distinct from the other western shells usually referred to *S. filitexta.*

Locality and position: The typical specimens of this species were from the Trenton Limestone of New York. But Prof. Hall mentions seeing it from the same horizon in Ohio; though the localities from which it was obtained in the latter State doubtless belong to the Cincinnati group, which he at that time referred to the horizon of the Trenton. The specimens here under consideration came from the upper part of the Cincinnati group, in Clinton county, Ohio.

STROPHOMENA SULCATA, de Verneuil.*

Plate 5, figs. 4 *a, b,* c, *d, e.*

Leptæna sulcata, de Verneuil, 1848; Bull. Geol. Soc. Fr., Vol. V., p. 350.

? *Strophomena sinuata,* Emmons, 1855; Am. Geol., Vol. I., p. 199, fig. 61 (not James, 1871).
Strophomena sulcata, James, 1871; Cat. Fossils Cincinnati Group, p. 9.

Shell small, more than semicircular in outline, moderately convex, sub-equivalve, the dorsal valve being more convex at the middle of the front, and the ventral in the umbonal region; hinge line equaling the greatest breadth, lateral margins intersecting the hinge nearly at right angles, and rounding to the front, which is regularly rounded, or sometimes faintly sinuous in the middle. Dorsal valve flat at the umbo, and

* This and the first of the following species are peculiar in form, and perhaps belong to a different section from any of the others here described.

raised into a rounded, more or less prominent mesial elevation at the front; beak scarcely distinct from the cardinal margin, which is provided with a very narrow area. Ventral valve a little convex at the umbo, and impressed, or bent so as to form a shallow mesial sinus at the front, that rarely extends back to the middle, provided with a well-defined, rather high area, that is flat and a little inclined back over the hinge; foramen closed by a triangular, convex, pseudo-deltidium; beak not projecting or incurved, but inclined backward with the area, and perforated by a minute, circular aperture at the apex. Surface of both valves ornamented by rather fine, more or less bifurcating, radiating striæ, crossed by rather distinct marks, and finer striæ of growth.

Length of a large specimen, 0.63 inch; breadth, 0.84 inch; convexity, 0.20 inch.

Although this is a common shell, specimens showing the interior are very rarely found, the valves nearly always being united. A single separate dorsal valve in Mr. James's collection, however, shows the hinge, and a little of the interior. In this the cardinal process is seen to be short, and deeply bifid, with very diverging socket ridges on each side, and a small central ridge extending forward from its base. The sockets for the teeth of the other valve are well defined, and rather wide apart. The specimen is not in a condition to show the scars of the interior. None of the specimens I have yet seen show the hinge or interior of the ventral valve.

This is a well marked species, readily distinguished from all the other known forms in our rocks, excepting the next, which it nearly resembles.

I am in some doubt whether it was this, or the following type, that was figured and described by Dr. Emmons, under the name *S. sinuata,* in his American Geology. His figure certainly agrees better with this than with the next, especially in convexity, as shown by his profile view; While his other figure shows the stronger concentric markings and finer striæ of this form. On the other hand, he gives Cincinnati as the locality of his type, at which place the *sulcata* does not occur; while the *sinuata* of James does occur at, or near, that city. The *S. sulcata,* however, being a common species, and in the cabinets of all of the Cincinnati geologists, it is quite possible that Dr. Emmons might have received it from some person living there, and supposed that it was found at that locality.

Locality and position: Butler, Warren, Clinton and Preble counties, Ohio; also at Richmond and other localities in Indiana, always in the upper part of the Cincinnati group. It is not found at Cincinnati, the highest beds there being, apparently, below its proper horizon. I am under obligations to Mr. James and Mr. Shaffer for the specimens studied, and for a knowledge of its geological horizon.

STROPHOMENA SINUATA, James.

Plate 5, figs. 5 *a, b,* c, *d, e, f.*

Strophomena sinuata, James, 1871; Catalogue Fossils Cincinnati Group, p. 9 (not of Emmons, 1855?).

Shell semicircular, or forming rather more than a semicircle, moderately convex, with valves nearly equal, the dorsal being most convex in the central and anterior regions, and the ventral near the umbo; hinge nearly or quite equaling the greatest breadth; lateral margins forming more or less nearly right angles with the hinge line, or sometimes rounding a little to the same, and rounding regularly to the front, which forms a semicircular curve, with rarely a slight sinuosity at the middle.

Dorsal valve flat at the beak, which is not distinct from the cardinal margin, usually a little raised in the middle at the front, so as to form a low, broad, undefined mesial prominence; cardinal area narrow and inclined backward; interior with a low, small, deeply bipartite cardinal process, from which diverge three small ridges, the two lateral of which extend obliquely outward to form the margins of the rather well defined sockets for the reception of the teeth of the other valve, while the third ridge is central, and extends a short distance forward; muscular scars not visible in any specimen examined.

Ventral valve moderately convex at the umbo, which is not very prominent or arched, and has a minute perforation at the apex; front with usually a broad, shallow, undefined depression; lateral regions more or less nearly flat; cardinal area well developed, tapering to the lateral extremities, flat, and inclined more or less obliquely backward; foramen closed by a prominent, triangular deltidium; interior showing small, somewhat saucer-shaped cavity, formed by the low, sharp dental laminæ, extending forward from the inner side of the rather well-developed oblique cardinal teeth, and curving a little toward each other, without meeting at their inner ends; muscular scars not visible in any specimens examined.

Surface of both valves ornamented with rather coarse radiating striæ, most of which bifurcate once or oftener, while occasionally a shorter one is intercalated between two longer; crossing the whole, occasional small marks of growth, and finer, but obscure, concentric striæ may be seen by the aid of a lens, on well preserved specimens.

Length of a rather large specimen, 0.65 inch; breadth, 0.88 inch; convexity, 0.30 inch.

This form is so nearly like the last, in nearly all its known characters, that I would more decidedly question the propriety of separating them, if it were not for the fact that they occur, as I am informed by Mr. James and the other geologists of Cincinnati, at horizons separated by about 300 feet of strata, in which neither form is found. About the only essential differences between them are the following: In the first place, *S. sulcata* has the sinus in the front of its ventral valve nearly always deeper (sometimes decidedly so), and the corresponding elevation of the other valve more prominent, while its striæ are almost always a shade finer than in the form under consideration. It is also generally a little less compressed, particularly around the free margins, which usually show stronger sub-imbricating marks of growth.

These differences, although not striking, are readily perceptible in almost all the varieties of each, so much so, indeed, that the two shells are never confounded by collectors. Still, the analogous *S. antiquata* of Sowerby, as illustrated by Mr. Davidson, might apparently be readily separated on more strongly marked characters, into several species.

Locality and position: Near Cincinnati, Ohio, in the Cincinnati group, 350 feet above low water of the Ohio.

(Non-resupinate species.)

STROPHOMENA ALTERNATA (Conr.), Emmons.

Plate 7, figs. 1 *a* to *g.*

Leptæna alternata, Conrad, 1838; Ann. Geol. Rep. N. Y., p. 115 (without figure or description); ?de Verneuil, 1845, Geol. Russia and Ural Mts., part Palæont., p. 225, pl. 14, figs. 6 *a, b;* Hall, 1847, Palæont. N. Y., Vol. 1, p. 102 and 286. pl. XXXI., figs. 1 *a-n,* XXXI. A, figs. 1 *a-h,* and pl. 79, figs. 2 *a* to *l.*

Strophomena alternata, Conrad, 1839; Ann. Geol. Report, N. Y., p. 63; also *Ib.,* 1840, p. 201, and 1841, p. 37 (all without fig. or description); Emmons, 1842, Geol. Rep. N. Y., 2d Dist., p. 195, fig. 3; Hall, 1859, Regents' 12th Ann. State Cab. Nat. Hist. Report. p. 70.

Strophomena nasuta, Conrad, 1842; Jour. Acad. Nat. Sci., Philad., Vol. VIII., p. 260; Emmons, 1845, Geol. Report, p. 403, fig. 3.

Leptæna alternistriata, Hall, 1847; Palæont. N. Y., Vol. I., p. 109, pl. XXXI. B, fig. 1 *a, b, c.*

Strophomena alternistriata, Hall, 1859; Regents' 12th Ann. State Cab. Nat. Hist. Report, p. 70.

Shell attaining a large size, semi-oval, the breadth being nearly always greater than the length, but varying from about equal to the latter to the proportions of near nine to seven; hinge line as long as the breadth of

the valves at any point farther forward, or somewhat longer; lateral extremities rectangular, or a little more or less than rectangular, sometimes compressed and moderately deflected; lateral margins straight, a little convex, or slightly sinuous posteriorly, and rounding forward to the front, which is semicircular in outline, or sometimes so prominent and narrowly rounded in the middle as to impart a sub-trigonal form to the general outline of the valves.

Dorsal valve flattened in the umbonal and cardinal regions; and gently, or more or less strongly concave in the central and anterior portions, and curved upward around the anterior and lateral margins; beak small, but projecting slightly beyond the edge of the area, which is very narrow, or sub-linear, and directed nearly backward. Interior with cardinal process strong, directed obliquely forward, with its two divisions distinctly diverging, and flattened and longitudinally striated on their posterior faces; sockets for the reception of the teeth of the other valve rather well defined; socket ridges very small, and uniting behind the cardinal process to form a kind of false deltidium; muscular scars comparatively small, but deeply impressed near the cardinal process on each side of a small, short, mesial ridge, and nearly surrounded by a low obtuse ridge formed by the thickening of the adjacent internal surface of the valve; anterior and lateral margins more or less thickened and geniculated within (especially in adult shells), the thickened zone being transversely furrowed, and sometimes granular, while outside of it the immediate edge of the valve is suddenly flattened, and minutely striated and granulated.

Ventral valve a little convex at the umbo, but generally much compressed over the whole visceral region, in the adult (which includes the whole surface of the young and half-grown shell), but becoming more convex (sometimes strongly so) anteriorly, or anterio-centrally and laterally, and thence more or less curved up to the anterior and lateral margins; area of moderate height, flat, and directed obliquely backward nearly at right angles to that of the other valve; beak very small, scarcely distinct from the margin of the area, and minutely perforated; foramen broadly triangular, and arched over above by the pseudo-deltidium, which is very deeply sinuous on its inner edge, the sinus being nearly or quite closed by the dental process and pseudo-deltidium of the other valve.

Interior with cardinal margin somewhat carinate within; hinge teeth moderately prominent, remote, and widely divergent; dental ridges obscure, and extending obliquely outward and forward, but not produced or curving to surround a saucer-shaped cavity for the muscular scars;

scars of adductor muscles narrow, long and closely approximated, or almost in contact; those of cardinal muscles on each side very large, fan--shaped, but shallow, separated sometimes by a small ridge in advance of the adductor scars, and marked by radiating furrows and ridges; while the anterior and lateral regions are usually marked by striæ and scattering granules.

Surface of both valves ornamented by numerous radiating striæ, that increase in number, on the ventral valve, mainly by intercalation, and are usually arranged with one to six or eight smaller and shorter ones between each two larger and more prominent ones, the largest one of which often occupies the mesial line; while on the dorsal valve they more frequently increase by division, and are generally of more uniform small size. On well preserved specimens all the radiating lines are crossed by numerous very minute, regular, closely arranged concentric striæ, that are invisible without the aid of a magnifier; a few moderately distinct, sub-imbricating marks are also often seen near the free margins of adult shells.

Length of a rather large specimen (of medium convexity), 1.52 inches; breadth, 1.84 inches; convexity, 0.36 inch.

This shell varies considerably in convexity, and in the nature of its striæ, as well as in outline, etc.; and these differences have been sometimes considered to indicate several distinct species. It seems to me, however, that there are so many gradations connecting these different forms, that they can scarcely be regarded as more than varieties. Though, after all, it is to a considerable extent a matter of fancy whether such differences as characterize at least some of these, should be considered specific, or as only distinguishing varieties. The following differences of form and other characters may be observed among the specimens here included under this species:

1. *S. alternata*, proper.—Viewing Dr. Emmons' figure (the first ever published of the species) as representing the typical form, it may be briefly characterized as semi-oval, and rather depressed, with nearly rectangular lateral extremities, a regularly rounded front, and alternately larger and smaller surface striæ.
2. *Var. nasuta*, Con.—Sub-trigonal in outline, usually smaller and more gibbous than the typical form, with a more or less prominent obtuse, undefined mesial ridge, and generally a larger mesial striæ, on the ventral valve, the ridge being continued to the middle of the front, to which it usually imparts a narrowly rounded or subangular outline; ventral valve often becoming very convex, and the dorsal very concave in the anterior central and anterior lateral regions, from which they are both strongly curved upward to the anterior and anterior lateral margins. (See pl. 7, figs. 2 *a* to *c*.)

3. *Var. alternistriata,* Hall.—Differing very little from the typical form. Was separated mainly upon its supposed greater proportional breadth, and the more uniform size of the striæ of its dorsal valve. This uniform character of the striæ of the dorsal valve, however, is by no means confined to this variety of form; while even among the specimens figured by Prof. Hall as true *alternata,* some are more extended laterally than the typical specimen of *alternistriata*.
4. *Var. loxorhytis,* Meek.—Attains a large size, moderately convex antero-centrally, or rather depressed; much extended on the hinge line, with lateral extremities acutely angular, flattened, and scarcely deflected; area very narrow; both valves marked near the cardinal margin, toward the lateral extremities, by six to eight distinct, very oblique wrinkles on each side.
5. *Var. fracta,* Meek.—Very thin and fragile, smaller than the typical form, much compressed, decidedly semi-oval, the length equaling, or slightly exceeding, the breadth; lateral extremities rectangular, and not deflected; lateral margins generally straight or a little convex in outline behind, and rounding forward to the regularly rounded front; surface as in the typical form, excepting that there are usually more strongly marked imbricating laminæ of growth around near the free margins; interior of dorsal valve with muscular scars removed proportionally farther forward from the cardinal process than in the typical and other varieties. (See pl. 7, figs. 3 *a* to *e*.)

Of these five varieties, the last two seem to be the most marked. I have not seen any specimens that I could be sure belonged to the variety *loxorhytis,* showing the interior; but its much extended and obliquely wrinkled lateral extremities give it a peculiar appearance. The last variety (*fracta*) occurs in great numbers together, and is always very thin, distinctly compressed, and very narrow in proportion to its length. Although smaller than most of the other varieties, its strongly marked laminæ of growth near the free margins, and the uniformity of size observed among the specimens, seem to indicate that it is not a young shell; and the difference in the position of its muscular scars, mentioned above, seems to be constant. My attention was called to this latter form by S. A. Miller, Esq., of Cincinnati, who noticed it in some remarks before the Cincinnati Society of Natural History, during the winter of 1872, without proposing a name for it.

Locality and position: Strophomena alternata has an extensive vertical and horizontal range in the Lower Silurian rocks of this country, being found in the Trenton limestone of New York, Wisconsin, Tennessee and other States, as well as in Canada. It also occurs in the Cincinnati group, in Ohio, Indiana, Kentucky, Tennessee, New York, Canada, etc. In Ohio, none of its varieties occur much below the horizon of the tops of the hills at Cincinnati; but they nearly all, excepting perhaps the varieties *fracta, nasuta* and *loxorhytis,* range through most of the beds of the group above that horizon in Ohio. It has also been identified in Russia.

GENUS ORTHIS, Dalman, 1828.

(Kongl. Vet. Acad., Handl., p. 96.)

(*Resupinate species*.)

ORTHIS RETRORSA, Salter?

Plate 11, figs. 7 *a, b,* c, *d, e.*

Orthis retrorsa, Salter, 1858; Mem. Geol. Survey Great Britain, Vol. 2, p. 373, pl. 27, figs. 3 and 4; Billings, 1862, New Species Lower Silurian Fossils, p. 136, figs. 112 and 113, and Palæoz. Fossils, Vol. (1865) 1, same p. and figures.

Orthis Kennicotti, McChesney; Descrip. New Sp. Fossils from the Palæozoic Rocks of the Western States, p. 78, dated 1861.

Orthis Carleyi, Hall, 1861; Regents' 13th State Cab. N. Hist. Report, p. 120, with wood-cut.

Orthis porcata, Davidson (pars), 1871; Monogr. Brit. Foss. Brach. (Silurian), p. 250, (McCoy? 1843).

Shell attaining a medium size, varying from transversely sub-oval to truncato-sub-oval, or sub-quadrate, the length being about four-fifths its breadth; hinge line shorter than the greatest breadth of the valves, or about equaling their length, with its lateral extremities abruptly rounded, or very obtusely sub-angular; lateral margins more or less convex in outline, and rounding to the front, which is either regularly rounded, or somewhat straightened along the middle; valves decidedly unequal, or concavo-convex.

Dorsal valve evenly, and sometimes rather distinctly convex, the most prominent part being near, or a little behind the middle, with the anterior and lateral slopes, particularly the anterior, more gradual than the posterior; umbonal convexity projecting a little beyond the hinge; beak incurved; area of moderate height, but with its sharp margins sloping off to nothing near the extremities of the hinge, more or less strongly incurved, so as sometimes to stand at right angles to the plane of the valves; foramen broad-triangular. Interior unknown.

Ventral valve convex at the point of the beak, and thence sloping toward the lateral and anterior margins; the anterior central, and sometimes the lateral regions, being more or less concave; beak obtuse, or abruptly pointed, and strongly inclined forward; cardinal area broad--triangular, well defined, flat, and so distinctly inclined forward as to place the apex of the beak some distance in front of the hinge margin; foramen narrow-triangular, being often a little higher than wide, and extending to the apex of the beak.

Interior with muscular cavity rather deep, distinctly quadrangular,

scarcely reaching the middle of the valve, and sharply defined by a raised margin, which is perfectly straight and uninterrupted across the front;* while its lateral margins are each waved a little outward along the middle, to make room, as it were, for the scars of the ventral adjustor muscles, which are moderately distinct from those of the longer triangular divaricators; scars of the adductor muscles well defined, and occupying a narrow sub-cordate depression, which tapers gradually forward to an acute extremity between the anterior ends of the divaricator scars. Hinge teeth apparently rather small and weak. Vascular markings consisting of two principal trunks, starting from the anterior lateral angles of the muscular cavity, and each immediately dividing so as to send one main branch obliquely outward and backward, with more or less sub-divisions; and another forward with an inward curve, and also giving off more or less sub-divisions on the anterior lateral side.

Surface ornamented by rather coarse, rounded, radiating striæ, some of which, on the ventral valve, are entirely simple, and others bifurcate once or twice; while on the dorsal, they increase in number by the intercalation of shorter ones between the longer; there being, on a moderate-sized adult shell, about three series of the intercalated ones, the longest of which nearly reach the beak, and soon become as large as the largest, and between these there are a few very short, small ones, near the free margins, and a few others of intermediate length and thickness. A few rather distinct imbricating marks of growth are usually seen near the free margins of adult specimens; while under a magnifier, minute, concentric lines may be seen crossing the striæ and interspaces, and on protected parts of the surface a strong magnifier also shows very minute asperities, regularly arranged, and having the appearance of minute, hollow spine-bases, that sometimes leave minute pits when entirely worn off.

Breadth of a moderately large specimen, 1.17 inches; length, 0.95 inch; convexity, 0.47 inch.

This is a very well marked species, that may be distinguished at a glance, by its external characters alone, from all of our other large Lower Silurian forms, particularly by the peculiar character of having the flat, broadly triangular area of the ventral valve so strongly inclined forward

* Since this was written I have received from Mr. Dyer another specimen of this valve, of larger size, showing the anterior side of the muscular cavity to be deeply emarginate in the middle (see fig. 7 *d*, of plate 11); thus showing that this species either varies considerably in this character, or that there are two species confounded under the one name in the West.

as to place the beak of this valve some distance in front of the hinge line. It is with considerable doubt that I have adopted the conclusion, rather generally maintained, that this form is the same as that described by Mr. Salter, though it may be so. It certainly resembles his figure quite closely; but if the shell described by him is only a variety of *O. porcata,* as is believed by the best English authorities, the fact that we do not find the American form shading into any shell agreeing with *O. porcata,* would seem to indicate that it is either distinct from *O. retrorsa,* or that the latter can scarcely be a mere variety of *O. porcata.* We have shells here, such as *O. sinuata* and *O. occidentalis,* that represent *O. porcata,* but the form under consideration is clearly and constantly distinct from these.

Locality and position: At or above the middle of the Cincinnati group of the Lower Silurian. In Southern Ohio, Prof. Orton informs me that the vertical range of this shell is restricted to a thin bed of only a foot or so in thickness. He found it, however, at Madison, Indiana, at a higher horizon in the same series. Mr. Billings refers to *O. retrorsa,* a smaller shell, found in the same series near Ottawa, Bellville, etc., in Canada. Several authors give Cincinnati as the locality from which they obtained this species.

ORTHIS SUBQUADRATA, Hall.

Plate 9, figs. 2 *b* to *g.*

Orthis subquadrata, Hall; Palæont. N. Y., Vol. I., p. 126, pl. XXXII. A, figs. 1 *a-o;* and in Wisconsin Report, 1862, p. 54, figs. 1 and 2.

Shell attaining about a medium size, rather distinctly resupinate, somewhat wider than long, subquadrate in general outline; moderately convex; cardinal margin shorter than the breadth of the valves, and rounding abruptly at the extremities into the lateral margins, which round and converge forward; front a little sinuous or straightened at the middle.

Dorsal valve more convex than the other, its most prominent part being near the middle; mesial sinus small, and rather shallow, sometimes continued back nearly to the umbo, or in other instances scarcely more than reaching the middle; beak very short, or little distinct from the edge of the area, and more or less arched; area narrow, directed obliquely backward and downward. Interior with scars of the adductor muscles moderately distinct, the posterior pair being situated close back under the brachial processes, one on each side of a well defined rounded ridge, that becomes suddenly smaller between the anterior pair; cardinal process rhombic sub-conical, moderately prominent, and having its posterior side marked by deeply impressed divaricating striæ; sockets well

defined; brachial processes rather strong, and directed obliquely forward and laterally; internal surface, excepting the radiately striated front and lateral margins, nearly smooth.

Ventral valve, a little convex at the umbo, and flat, or slightly concave, between the umbo and the front and lateral margins, but sometimes having a low, very obscure mesial elevation toward the front; beak small, and very short, or scarcely equaling that of the other valve, arched at the apex, but not strongly incurved; area about twice as high as that of the other valve, well defined, tapering rather rapidly toward the lateral extremities, arched with the beak, and directed backward and downward at decidedly less than a right angle to that of the other valve; foramen broad-triangular, and partly occupied by the cardinal process of the other valve. Interior with muscular scars occupying a rather deep, bilobate impression extending nearly or quite to the middle of the valve, and usually defined by a low ridge most distinct on each side; scars of adductor muscles small, separated by a mere trace of a raised line; those of the divaricator muscles of moderate size, longitudinally striated, and having their narrowed posterior ends extending backward nearly to a small, triangular, transversely striated space occupying the interior of the beak; those of the ventral adjustor muscles smaller and shorter than the divaricators, and situated nearly under the hinge teeth, which are moderately prominent, sub-trigonal and oblique; vascular markings with their lateral divisions curving up backward and sending off several branches, while the other divisions extend forward and bifurcate so as to occupy the anterior region; anterior and lateral margins crenate within by very short striæ.

Surface of both valves ornamented by moderately stout, radiating striæ, the posterior lateral of which curve so strongly outward that a few of them run out on the cardinal edge before reaching the lateral margins; striæ of ventral valve nearly always increasing by bifurcation (some of them dividing two or three times); while those on the dorsal valve generally increase by the intercalation of shorter ones between the longer. A few distant, sub-imbricating marks of growth are sometimes seen toward the front and lateral margins; while on perfectly preserved specimens, the radiating striæ may sometimes be seen to be roughened by minute elevated concentric lines, that are more or less interrupted in crossing some of the striæ.

Length of a rather large, well-developed specimen, 0.96 inch; breadth, 1.30 inches; convexity, 0.43 inch.

This is a very well-marked species, readily distinguished from all of

its associates by its transversely subquadrate form, the strongly curved direction of its posterior lateral striæ, its nearly equal beaks, rather narrow area, and rounded posterior angles. It also presents well marked internal differences from the other species of its size in the group.

Locality and position: Upper part of the Cincinnati group, at Oxford and various localities in Ohio; Richmond and Madison, Indiana; Maysville, Kentucky, etc. Prof. Hall cites Cincinnati, Ohio, as one of its localities, but it does not occur there, the beds exposed there being below its horizon in the series in this State. I am indebted to Mr. James, Mr. Shaffer, and Mr. Miller, of Cincinnati, for fine specimens of this species.

ORTHIS OCCIDENTALIS, Hall.

Plate 9, figs. 3 *a* to *h.*

Orthis occidentalis, Hall, 1847; Palæont. N. Y., Vol. I., p. 127, pl. XXXII. A, figs. 2 *a-m;* and pl. XXXII. B, figs. 1 *a-i.*
?Orthis sinuata, Hall; *Ib.,* p. 128, pl. XXXII. B, figs. 2 *a-s.*
?Orthis subjugata, Hall; *lb.,* p. 129, pl. XXXII. C, figs. 1 *a-m.*

Shell attaining a moderately large size, wider than long, varying from transversely subquadrate to semi-oval, becoming quite gibbous with age; hinge line exceeding, about equaling, or sometimes a little less, than the breadth of the valves at any part farther forward; lateral extremities moderately compressed, varying from rather acutely to more or less obtusely angular; lateral margins often a little sinuous behind, but sometimes straight or convex in outline, but rounding to the front, which is nearly always a little sinuous, and sometimes rather decidedly so, in the middle.

Dorsal valve more convex than the other, especially in the large adult examples, its greatest convexity being generally a little behind the middle, on each side of a shallow, undefined mesial sinus, generally extending from the front to the umbonal region, but sometimes nearly or quite obsolete, or only represented by a slight flattening along the middle; swell of the umbo comparatively prominent, and often projecting backward farther than the beak of the other valve; beak rather strongly incurved; area of moderate height in the middle, but sloping to the lateral extremities, sharp along the margin, and more or less strongly incurved; foramen broad-triangular, and not closed by the cardinal process. Interior with scars of the adductor muscles situated on each side of a low mesial ridge, which is narrower between the anterior than the posterior pair, which latter are placed far back under the brachial processes, and rather strongly striated, but without well defined margins; anterior

pair somewhat trigonal, and usually each separated from the posterior by an obscure transverse ridge, but without well defined anterior margins; cardinal process merely presenting the appearance of a compressed or sharp ridge, much lower than the surface of the cardinal area; sockets distinct; brachial processes directed forward and more or less laterally, usually sharp on their inner under edges; vascular scars unknown.

Ventral valve most convex at or near the apex of the beak, from near which it slopes more rapidly to the front and lateral margins than to the anterior lateral, the anterior region being impressed so as to form a broad, more or less deep, undefined mesial sinus, that dies out before reaching the umbo; beak rather elevated, but not projecting backward, abruptly pointed, very nearly straight, or sometimes slightly arched at the point; cardinal area rather high at the beak, but sloping to the lateral extremities, flat or slightly arched, and usually standing nearly at right angles to the plane of the valve; foramen generally higher than its breadth at the hinge line, and extending to the apex of the beak. Interior showing the cardinal margin to be prominent and sharp, and the hinge teeth well developed; cavity for the reception of the muscular scars deep, nearly or quite reaching the middle of the valve, obcordate in form, and bounded by a prominent ridge continued forward from the bases of the hinge teeth, and curved a little backward at the central point of the front, where they meet; impressions of the divaricator muscles (cardinal, of some) deep; while those of the adjustors are so small, and pushed so far aside, as to occupy the sides of the dental plates, and thus to be out of sight in a direct view; those left by the adductors are narrow, elongated, and situated on each side of a mesial ridge that is divided along the middle by so wide and distinct a furrow as to appear almost like two linear ridges; transversely striated cavity within the beak very small, and broad-triangular; free margin crenate within, while the surface between this and the deeply impressed muscular cavity is usually smooth, or sometimes very minutely and obscurely corrugated; vascular markings unknown.

Surface of both valves ornamented by distinct, rather prominent radiating striæ, which, on the dorsal valve, nearly always increase by intercalation, and curved gradually outward, on the posterior lateral regions; while on the ventral valve they generally increase by bifurcation, and are nearly straight on all parts. A few distant, imbricating marks of growth are also usually seen around the free margins of adult examples; while well-preserved specimens show minute, but not crowded, prominent, concentric lines crossing the much larger radiating striæ, and the furrows between them.

Length of a mature, rather gibbous specimen, 1 inch; breadth, 1.24 inches; convexity, 0.80 inch. Some examples are proportionally decidedly broader, and others a little less so.

This species differs so clearly from the last, both in form and the details of its internal characters, that it seems to me unnecessary to enter upon a comparison of the two shells. On the other hand, however, it seems to be so connected by intermediate forms with *O. sinuata* of Hall, that I am inclined to believe them only varieties of the same species, although the typical forms of the two proposed species occur at somewhat different horizons; the *O. sinuata* being found at the horizon of about 350 feet above the river at Cincinnati, and the *O. occidentalis* at higher horizons in some of the counties farther northward and eastward in the same group of rocks. The Cincinnati shells (see 4 *a-f*) attain a somewhat larger size, and are not so produced on the hinge line as *some examples* of *O. occidentalis*; while they often have a more or less defined, mesial, rounded ridge (fig. 4 *a* and *d*) on the anterior slope of the dorsal valve, where we *usually* see a sinus in the *O. occidentalis.* This ridge, however, often fades away, and is sometimes (indeed frequently) entirely wanting in the Cincinnati specimens, and we find among them all gradations in this character, so that those with the ridge and those without it, merge gradually into each other. Again, at the localities where the typical forms of *O. occidentalis* occur, we find all gradations between those that have the mesial sinus of the dorsal valve well defined, to others in which no traces of it can be seen; so that it would be exceedingly difficult to separate the varieties of *O. occidentalis* from some forms of *O. sinuata.*

It is worthy of note, however, that although these variations do occur among the specimens from both horizons, I have seen no examples from the localities and position where typical specimens of *O. occidentalis* occur, with the mesial ridge on the dorsal valve seen on typical specimens of *O. sinuata,* nor any from the localities where *O. sinuata* occurs, with the mesial sinus sometimes seen on the same valve of *O. occidentalis.* The Cincinnati specimens of *O. sinuata,* before me, also *generally* have the beak and area of the ventral valve a little more inclined or curved backward than in authentic examples of *O. occidentalis,* but not *always.* Some of them, also, have rather finer striæ, but again they vary in this character also. There may possibly be two species among these shells from the two horizons; but with those I have yet had for study it seems scarcely possible to separate them. It is easy enough to pick out a number of typical examples of each, but when we undertake to separate a collection of specimens from the two horizons, we meet with many that cannot be

separated from either variety, and yet might apparently, with equal propriety, be referred to either or both.

In regard to *O. subjugata,* Hall, I would remark that there appears to be no reason to separate it from *O. sinuata,* whatever may be thought of the propriety of including the latter as a variety of *O. occidentalis.*

Several European authors have expressed the opinion that all of these proposed species are really only varieties of *O. porcata,* McCoy. In this opinion, however, I cannot concur. Mr. Davidson's beautiful figures of that shell show it not only to differ in being generally proportionally longer, with a shorter hinge, but those of the interior of the ventral valve show the cavity for the reception of the muscular scars to have an entirely different form, being much more deeply emarginated in front, with the two divisions more angular than in the American shell; while that species has its adjustor muscular scars quite distinctly visible in a direct view, instead of being crowded laterally out of sight, as in the shells under consideration. There are also differences in the striæ that have been pointed out by Mr. Davidson.

Locality and position: The specimens of *O. occidentalis* that I have studied were, in part, presented by Mr. James to the Smithsonian Institution, and in part collected by Mr. Case and myself. Those collected by Mr. James came from the upper part of the Cincinnati group, in Butler county, Ohio; and those collected by Mr. Case and myself were found at the same horizon at Richmond, Indiana. It also occurs at Oxford, Ohio, and Madison, Indiana, as well as at Savannah, Illinois, and in Iowa, Wisconsin, and at other localities in these States, at the same horizon. Prof. Hall mentions Cincinnati as one of the localities, but I have not seen the typical form from there; though the variety, or species *O. sinuata,* occurs near the tops of the hills at that city, as already stated.

ORTHIS INSCULPTA, Hall.

Plate 9, figs. 1 *a* to *h.*

Orthis insculpta, Hall, 1847; Palæont. N. Y., Vol. I., p. 125, pl. XXXII., figs. 12 *a, b,* c.

Shell generally rather under medium size, wider than long, subquadrate, or transversely truncate-sub-oval; hinge line nearly always a little less than the greatest breadth of the valves, and meeting the lateral margins at an angle of usually more than ninety degrees; lateral margins generally moderately convex in outline, at or near the middle, and rounding regularly to the front, which is nearly always a little sinuous in the middle; valves moderately and nearly equally convex.

Dorsal valve with its greatest convexity usually a little behind the middle, on each side of a narrow, but moderately deep mesial sinus, that

extends from the beak to the front; posterior lateral regions distinctly compressed; beak but little prominent, and more or less incurved; area moderately developed, narrowing rather rapidly to the lateral extremities, directed backward, and more or less strongly arched; foramen broad-triangular, and partly occupied by the cardinal process, which usually projects slightly beyond the surface of the area, and is laterally compressed. Interior showing the brachial processes to be rather prominent and diverging; and the sockets for the reception of the teeth of the other valve distinct; scars of the adductor muscles (occlusors of some) situated on each side of a strong, prominent mesial ridge, behind the middle of the valve, those of the posterior pair being very narrow antero-posteriorly, and placed back directly under the brachial processes, nearly out of sight in a direct view; while the anterior pair are larger, oval in form, and extend forward nearly to the middle of the valve; vascular markings consisting of two principal lateral trunks that extend outward and forward from the anterior adductor scars, but immediately bifurcate, sending each a main division backward and outward, and another forward, each with subordinate branches; while between these principal trunks there are two pairs of smaller ones, and traces of a few other still smaller, all directed forward.

Ventral valve about as convex as the other, but having its most gibbous part farther back, near the umbo, from which point its surface slopes off regularly to the front and lateral margins, without any distinct mesial elevation or depression; beak moderately prominent, or projecting backward more or less beyond that of the other valve, and somewhat arched, but not properly incurved; area two or three times as high as that of the other valve near the beak, and sloping off rather rapidly to the lateral extremities, directed obliquely backward and downward, and a little arched with the beak; foramen usually higher than wide. Interior showing hinge teeth to be prominent and sub-trigonal; cavity for the reception of the muscular impressions scarcely extending forward to the middle of the valve, tapering a little toward the front, where it is more or less emarginate in the middle, moderately well defined by a rather obscure marginal ridge, and divided within, longitudinally, by a low, double ridge, that usually extends forward beyond the muscular cavity, where it suddenly contracts to a very narrow, obscure single ridge, that again expands, or bifurcates farther forward; scars of the divaricator and adjustor muscles not very distinctly separated, and those of the adductors not clearly seen in the specimens examined; ovarian areas comparatively rather large, and each occupied by a number of raised, linear, rather distant, and sometimes bifurcate ridges or lines that radiate forward and laterally.

Surface of both valves ornamented by distinct radiating striæ, that increase both by division and intercalation, and are crossed by much smaller, regular, distinctly defined, imbricating concentric marks, that are more prominent between, than upon the radiating striæ, and present a zig-zag appearance, by being deflected backward on the striæ, and forward in the depression between them; a few much stronger imbricating marks of growth are also usually seen near the free margins of adult specimens.

Length of a mature specimen not quite of the largest size, 0.60 inch; breadth, 0.78 inch; convexity, 0.35 inch.

This is a well marked species, that will be distinguished at a glance from any of the foregoing by its smaller size, more nearly equally convex valves, and particularly by its distinct, regular, imbricating markings, which give an ornate scalloped appearance to the furrows between the radiating striæ. It also presents well defined internal differences. The presence of a mesial sinus, extending to the beak, on its dorsal valve, and the absence of any corresponding fold on the other, are constant characters in this species.

I have no authentic specimens of *O. bellarugosa,* Conrad, at hand for comparison, but, judging from the figures and description of the same given in the New York Palæontology, as well as from Mr. Conrad's original description, his species would seem to be very closely related, in its external characters, to this; the chief difference being its smaller size.

Locality and position: Upper part of the Cincinnati group, at Oxford, Lebanon, and various localities in Butler, Warren, and Clinton counties. Prof. Hall also cites it from Cincinnati, Ohio; but the collectors there say it is not found at that locality, nor anywhere in that State, below the upper part of the Cincinnati group; though Prof. Hall also cites it from the Trenton in New York. I am under obligations for the use of an excellent series of specimens of this species, sent on to the Smithsonian Institution by Mr. James and Mr. Shaffer, of Cincinnati, and for a few from Mr. J. Kelley O'Neall, of Lebanon, Ohio.

ORTHIS BOREALIS, Billings.

Plate 8, figs. 4 *a* to *f.*

Orthis borealis, Billings, 1859; Canadian Naturalist, Vol. IV., p. 436, figs. 14 *a, b,* c; and (1863) Geology of Canada, Report of Progress, p. 129, figs. 56 *a, b,* c; and *Ib.,* p. 167, figs. 168 *a., b,* c.

Orthis Frankfortensis, James, 1871; Cat. Lower Silurian Fossils, Cincinnati Group, p. 10.

Shell rather under medium size, transversely oval-subquadrate, or truncato sub-oval, the length and breadth varying, with relation to each other, from as 9 to 11, to 11 to 12; both valves convex; hinge line shorter

than the greatest breadth of the valves (which is usually a little in advance of the middle), meeting the lateral margins at more or less obtuse angles; lateral margins rounding to the front, which is rather broadly rounded, or possibly sometimes faintly sinuous at the middle.

Dorsal valve sometimes slightly more convex than the other, its most prominent part being near, or a little behind the middle, usually sloping rather more distinctly to the lateral margins than toward the front, where there is generally a broad, very low, undefined prominence, or mesial elevation; beak moderately prominent and arched, but not strongly incurved; area about half the height of that of the other valve, directed backward and more or less arched. Interior unknown.

Ventral valve most convex near the umbo, and sloping sometimes rather abruptly toward the posterior lateral angles, while the anterior central region is depressed so as to form a broad, very shallow mesial sinus, sometimes extending backward nearly or quite to the middle; beak more prominent than that of the other valve, rather abruptly pointed, inclined backward and moderately arched; area broad-triangular, well defined, and tapering to the lateral extremities of the hinge, inclined and a little arched backward with the beak; foramen rather narrow, or slightly higher than its breadth at the hinge. Interior unknown.

Surface of both valves ornamented by distinct, rather prominent, radiating ribs, about forty of which may be counted on each valve of a medium-sized specimen; the furrows between the ribs equaling the breadth of the ribs themselves; larger individuals sometimes having a few of the ribs bifurcating once, and an occasional smaller one intercalated between two of the larger, so as to increase the whole number at the free margins to about fifty. Concentric striæ nearly or quite obsolete; but, in old specimens, one or more sub-imbricating marks of growth may sometimes be seen near the free margins.

Breadth of largest specimen seen, 0.74 inch; length, 0.64 inch; convexity, 0.33 inch. Breadth of a smaller specimen, 0.56 inch; length, 0.47 inch; convexity, 0.26 inch.

It is possible that a comparison of a good series of specimens of this shell and the Canadian species, showing internal as well as external characters, might bring to light some differences that would warrant their separation but with the means of comparison now accessible, I am led to think that they belong to the same species. Compared with Mr. Billings's figures of *O. borealis,* the western specimens before me differ only in having the anterior margin rounded, instead of straight or slightly sinuous in the

middle; while one of them has a few of the ribs bifurcating, and a few smaller ones, at intervals near the margins, intercalated between the others. One of them also has its hinge line proportionally shorter than represented in his figures. Mr. B., however, distinctly states that his species is somewhat variable in these characters, some having, like ours, an indistinct mesial fold on the dorsal valve, and these are rounded, instead of straightened, or slightly sinuous in front; while others have a slight flattening or depression on the middle of this valve, which, together with the mesial sinus of the other, cause the obscurely sinuous character sometimes seen at the middle of the front.

As he states, it closely resembles *O. plicatella,* but is more convex, and has more numerous and smaller costæ. It is also less transverse, and has generally a shorter hinge line, while the mesial sinus of its ventral valve, and the fold of the other, are more decidedly marked.

Through the politeness of Mr. Billings, I have, since writing the foregoing, had an opportunity to compare our specimens with Canadian examples of his species, and have been unable to find any satisfactory external specific differences.

Locality and position: Frankfort, Kentucky, in the horizon of the Trenton limestone, and in the lower part of the Cincinnati group, at Cincinnati, Ohio. Mr. U. P. James's collection. The larger specimen figured is from the former locality and position, and the other from the latter. In Canada, *O. borealis* is cited from the Chazy and Trenton limestones.

ORTHIS BELLULA, James.

Plate 8, figs. 5 *a* to *f.*

Orthis bellula, James, 1871; Cat. Lower Sil. Fossils, Cincinnati Group, p. 10 (without figure or description).

Shell very small, longitudinally semi-oval, or transversely sub-oval, moderately gibbous, sub-equivalve; breadth always greater than the length; hinge line a little less than the greatest breadth of the valves; posterior lateral extremities abruptly rounded, or sub-angular; lateral margins rounding to the front, which is broadly semi-elliptic in outline, or sometimes a little straightened, or even very faintly sinuous at the middle. Interior unknown.

Dorsal valve less convex than the other, with usually a very slight, scarcely perceptible mesial depression near the umbo, that rarely, if ever, extends forward to the middle; beak small, projecting slightly

beyond the edge of the area, and merely a little arched; area of comparatively moderate height, flat, or somewhat arched, and inclined more or less obliquely backward and upward; foramen forming a nearly equilateral triangle.

Ventral valve most convex near the umbo, and perhaps always showing a very shallow, broad, undefined mesial sinuosity at the front; beak moderately prominent, pointed, inclined backward and a little arched, but not incurved; area comparatively rather high, or from twice to three times the height of that of the other valve, well defined, a little arched, and inclined obliquely backward and downward; foramen narrow-triangular, and extending to the point of the beak.

Surface of both valves ornamented by very fine radiating striæ, most of which bifurcate two or three times between the beaks and free mar· gins; the lateral ones being moderately arched.

Length of a medium-sized specimen, 0.23 inch; breadth, 0.28 inch; convexity, 0.13 inch.

This little shell, notwithstanding its small size, has the appearance of having attained its mature growth; while it seems to differ too much in various respects to be the young of any of the other known forms found in the same association. It seems to be most nearly allied to *O. perveta* of Conrad, from the horizon of the Trenton group, in Wisconsin; and possibly it may be a dwarfed variety of the same. I am led to think this can scarcely be the case, however, not only because it is much smaller, but from the fact that its cardinal extremities are more rounded, and the area of its dorsal valve decidedly lower in proportion to that of the other valve, than is represented by the figure of Conrad's species given in the first volume of the New York Palæontology.

That species is also described by Prof. Hall as having the ventral valve (dorsal, as it was then called), "with a broad elevation in front;" while in the shell under consideration there is, on the contrary, a broad, very faint concavity, or undefined mesial sinus there. Again, both Mr. Conrad and Prof. Hall describe the striæ; of *O. perveta* as "bifurcating on the umbo," and say nothing indicating that they bifurcate again farther forward; while they generally bifurcate twice or three times on the little shell under consideration.

Locality and position: About 300 feet above low-water mark, at Cincinnati, Ohio, in the Cincinnati group of the Lower Silurian. The description is made out from the type specimens belonging to Mr. James, and others sent to the Smithsonian Institution by Mr. Miller, of Cincinnati, Ohio.

ORTHIS (?) ELLA, Hall.

Plate 8, figs. 9 *a, b,* c, *d.*

Orthisella, Hall, 1861; Regents' 13th Ann. State Cab. Report, p. 121; also 15th do. (1862), pl. 2, figs. 6-8; and in illustrations of a paper on some fossils from Cincinnati, dated Oct., 1871, issued in advance of Regents' 24th Report, pl. 3, fig. 21.

Trematospira? ella, Hall, 1862; Explanations of pl. 2, Regents' 15th Report.

Shell small, varying from sub-orbicular to transversely (or rarely longitudinally) sub-oval; rather convex, the valves being nearly equally so; hinge line extremely short, or only about one-third the breadth of the valves, and not imparting any angularity to the posterior lateral margins, which slope at various angles from the beak; lateral margins generally more narrowly rounded than the front, but sometimes the reverse. Internal characters unknown.

Dorsal valve rather evenly convex, but generally very faintly raised at the middle of the front, while its greatest convexity is usually a little behind, the middle; beak closely incurved, so as to hide the very small area (if any exists).

Ventral valve most convex at or behind the middle, and slightly impressed, so as to show indications of a very shallow sinus at the front margin; beak projecting moderately beyond that of the other valve, rather pointed, directed backward and arched, but not incurved; area exceedingly small, scarcely more than twice as wide as high, rather well but not sharply defined, and arched and directed backward with the beak; foramen comparatively large, about as wide at the hinge line as its height, triangular, but narrowed above and extending quite to the apex of the beak, where it terminates in a minute opening.

Surface ornamented by from about twenty-three to fifty or more simple radiating plications on each valve, equaling the size of the furrows between. Marks of growth obsolete.

Length of a rather broad specimen, 0.32 inch; breadth, 0.36 inch; convexity, 0.20 inch.

As remarked by Prof. Hall, this little shell is almost certainly not an *Orthis,* its hinge line being shorter, and its area much smaller, than is common in that genus; while it presents the appearance of having a tendency to form a minute, round perforation at the apex of the beak of the dorsal valve. It might be referred to *Retzia,* or *Trematospira,* if it were not for its rather distinct, though small, cardinal area, and open triangular fissure. Its internal characters would possibly show it to belong to an undescribed genus, if they could be determined.

It seems to be a rather rare species, and might be confounded, by a careless observer, with some of the other small brachiopods of the Cincinnati beds; though its extremely contracted cardinal area, and other characters, will enable anyone accustomed to examine such fossils to identify it readily, on a careful examination. It is a very variable little shell, both in form and in the number and size of its costæ.

Locality and position: Cincinnati group of the Lower Silurian, at an elevation of about 300 feet above low-water mark of the Ohio. Mr. U. P. James's collection.

(Non-resupinate species.)

ORTHIS FISSICOSTA,* Hall.

Plate 8, figs. 6 *a* to *h.*

Orthis fissicosta, Hall, 1847; Palæont. N. Y., Vol. I., p. 121, pl. XXXII., figs. 7 *a, b.*

Comp. *O. dichotoma,* Hall; *Ib.,* p. 125, pl. XXXII., figs. 13 *a, b.*

Shell small, or under medium size, only moderately convex, semi-oval, or approaching semicircular in outline, the length being two-thirds to four-fifths the breadth; hinge line very nearly or quite equaling the greatest breadth of the valves; posterior lateral extremities rectangular; lateral margins rounding to the front, which is broadly rounded, or sometimes slightly straightened along the middle.

Dorsal valve somewhat less convex than the other, its most prominent part being at or a little behind the middle; beak projecting but slightly beyond the margin of the area, and a little arched; area about one-fourth as high as that of the other valve near the triangular foramen, but narrowing to nothing at the lateral extremities of the hinge, directed backward nearly on the plane of the valves, and nearly or quite flat. Interior showing the plications of the outer surface strongly defined, owing to the thinness of the shell, but without any defined muscular scars, so far as known; cardinal process small, laterally compressed, and not filling the foramen; sockets obscure; brachial processes little developed, or so thin as to be usually broken; each supported by a very thin, short lamina, immediately under the area.

Ventral valve with its greatest convexity near the umbo, thence sloping forward and laterally—sometimes with a broad, very shallow, scarcely perceptible upward wave of the middle part of the front; beak abruptly pointed, inclined backward beyond the hinge, but not much incurved; area moderately high at the beak, and sloping, with nearly or quite

* This species and *O. plicatella,* as well as two or three of the immediately preceding species, stand rather intermediate between the resupinate and non-resupinate forms.

straight, sharp margins to the lateral extremities of the hinge, moderately arched, and rather strongly inclined backward; foramen narrow, and extending to the apex of the beak. Interior having plications strongly impressed through, as in the other valve; muscular cavity small, shallow, not reaching the middle of the valve, rounded in front and narrowing to the beak, so as to present an oval-sub-trigonal outline, margined on each side by very low linear dental ridges, that do not continue around the front; hinge teeth apparently nearly obsolete.

Surface of both valves ornamented with strong, elevated, rather straight, radiating striæ, which usually, in part, become bifid or trifid; while on other parts they increase in number by the intercalation of a smaller one between two of the larger. On well-preserved specimens, very minute crowded concentric striæ are also usually visible by the aid of a magnifier, mainly in the furrows between the striæ.

Length of a rather large specimen, 0.57 inch; breadth, 0.73 inch; convexity, 0.26 inch.

I am not sure that I have had authentic examples of *O. dichotoma,* Hall, for comparison; but judging from the figures and description of that shell, as well as from specimens that have been identified with it by others, there would seem to be very little to distinguish it from the species under consideration. *O. plicatella,* Hall, is also another similar form, that, although strongly distinct when we compare its typical variety, shades into this by so many intermediate gradations, that it is not always easy to distinguish certain varieties of the two types.

Prof. Hall's typical figured specimen of the form under consideration has the beak and area of the ventral valve more arched than in any examples of *O. plicatella,* or *O. dichotoma,* I have seen; but among the numerous examples before me from Cincinnati, agreeing in all other respects with his type of *O. fissicosta,* scarcely any of them have the beak so much arched as represented in his figure, though some of them approach it in this respect also. His specimen, however, is evidently, as he states, distorted by pressure, and this may have, in part, caused this difference.

Prof. Hall compares it with *O. calligramma,* Dalman, and *O. actoniæ,* Sowerby, but it seems to me too obviously distinct from both of these forms (of which I have good European examples at hand for comparison) to require any remarks on their distinguishing characters.

Locality and position: Cincinnati group of the Lower Silurian, at the horizon of about 300 feet above low-water mark of the Ohio, at Cincinnati. I am under obligations for the use of good specimens of this species sent to the Smithsonian Institution by Mr. James, Mr. Miller, and Mr. Shaffer, of Cincinnati.

ORTHIS PLICATELLA, Hall.

Plate 8, figs. 7 *a* to *h.*

Orthis plicatella, Hall, 1847; Palæont. N. Y., Vol. I., p. 122, pl. XXXII., figs. 9 *a, b,* c, *d, e, f, g.*

This form, as already indicated, is so closely connected with the last, through a series of intermediate varieties, that a formal description is unnecessary. Looking at the typical varieties of each, although they agree in form and general appearance quite nearly, they may be distinguished at a glance by the nearly or quite simple, larger, and less numerous plications of the form under consideration. In separating a large collection of the two forms, however, we soon meet with specimens with the larger and less numerous plications of *O. plicatella,* that have a few of these plications, at the immediate margin, beginning to show faint, but unmistakable, indications of a tendency to divide, and the interspaces to develop an occasional intermediate smaller plication. In other individuals we find these divisions of the plications and the intercalated ones becoming more frequent, and extending farther inward from the margins, until we pass through an almost uninterrupted series, to forms presenting nearly all of the characters of *O. fissicosta.*

A single specimen of the form under consideration, now before me, shows the hinge and interior of its dorsal valve. In this the muscles have left no visible scars whatever, and the brachial processes are small, the sockets obscure, and the cardinal process compressed laterally so as not to fill the foramen, above the margins of which it does not project. It also shows no vascular markings. Consequently, it will be seen that at least in the dorsal valve there are no known internal differences between this shell and *O. fissicosta.* I have not, however, had an opportunity to compare the internal characters of its ventral valve with those of *O. fissicosta,* and do not feel prepared to say that they are merely varieties of the same species.

From the same locality and position, Mr. S. A. Miller, of Cincinnati, sent to me two specimens (see pl. 8, figs. 8 *a* to *e*) having the same form, coarse costæ, and general appearance of *O. plicatella,* but differing in attaining a larger size, and in having the area of the ventral valve *decidedly* lower, and the beak of the same more incurved than in any well-characterized specimens of that form I have seen. It also differs in having the costæ much more widely separated by deeper furrows, and each giving off a smaller lateral division from near the middle of the valves; the main ones, however, continuing larger and more prominent to the free margins thus forming bundles of three ribs, with a wide, deep depression between.

The largest specimen of this form I have seen, measures as follows: Breadth, 1.04 inch; length, 0.70 inch; convexity, 0.40 inch.

I strongly suspect that this should be separated specifically from *O. plicatella*, but these forms vary to such an extent that I feel some reluctance in proposing to separate it as a distinct species, without knowing anything about its internal characters.

In the American Journal of Science and Arts, Vol. IV., 3d series, p. 281, I proposed for this type, in case it should be found to be constant in the characters mentioned, the name *O. triplicatella*, which may be retained if desirable.

Locality and position: Same as last. The specimens studied were sent to the Smithsonian Institution by the same gentlemen that sent those of the last.

ORTHIS EMACERATA, Hall.

Plate 8, figs. 1 *a* to *d*, and figs. 2 *a* to *g*.

Orthis emacerata, Hall, 1860; Regents' 13th State Cab. Report, p. 121; and 15th do. (1862), pl. 2, figs. 1 and 2.

Compare *O. testudinaria*, Dalman, 1827; Kongl. Vetensk. Acad., Handl., p. 115, pl. II., figs. 4 *a, b,* c, *d, e*.

Shell small, plano-convex, rather depressed, transversely truncato-sub-oval, the length being about five-sixths its breadth; hinge line perhaps always a little shorter than the greatest breadth of the valves; lateral margins generally rounding to the hinge, most prominent at or a little behind the middle, and rounding to the front, which is usually somewhat straightened, or very faintly sinuous, at the middle; or presents a regular semicircular outline.

Dorsal valve nearly flat, or slightly convex on each side of a shallow mesial sinus, that commences very narrow at the beak, and usually widens rather rapidly to the front; beak very small, scarcely projecting beyond the edge of the area, and not incurved; area low at the middle, and narrowing off to nothing at the lateral extremities of the hinge, slightly arched, and directed obliquely backward; foramen very small, and filled by the cardinal process. Interior very shallow, and provided with a slender mesial ridge that extends about half way forward from the hinge, between the muscular impressions, which are not usually well defined; scars of posterior pair of adductor muscles smaller, and usually deeper, than the anterior, and situated close back under the brachial processes; those of the anterior pair three or four times the size of the posterior, sub-oval in form, and extending to near the middle of the valve; cardinal process very small and trifid; brachial processes comparatively rather stout and prominent; internal surface having the radiat-

ing striæ of the exterior rather distinctly impressed through, as it were, in consequence of the thinness of the shell, and finely granular, the granules being apparently connected with the punctate structure of the shell.

Ventral valve compressed-convex, the greatest convexity being near, or a little behind the middle, along a more or less prominent, undefined ridge; that sometimes, but not always, imparts a sub-carinate appearance to the central and umbonal regions; beak small, projecting somewhat beyond that of the other valve, abruptly pointed, and rather distinctly arched, but not strongly incurved; area about twice as high as that of the other valve, and with its sharply defined edges sloping to the lateral extremities of the hinge, directed and arched obliquely backward with the beak; foramen having nearly the form of an equilateral triangle, but rather narrowed upward to the apex of the beak, and partly occupied by the cardinal process of the other valve. Interior showing the teeth to be moderately prominent; concavity for the muscular impressions very shallow, small, somewhat bifid anteriorly, and not defined by a very distinct marginal ridge; scars of divaricator muscles apparently narrow, and situated on each side of a shallow mesial depression, which seems to include, far back at its posterior end, those of the very small adductors, merely separated from each other by a hair line; impressions of ventral adjustor muscles apparently wider and shorter than those of the divaricators; striæ and fine granules of the interior as in the other valve.

Surface of both valves ornamented by numerous, distinct radiating striæ, that usually bifurcate about three times between the beak and free margins; posterior lateral striæ so strongly curved that a part of them run out on the hinge line. Numerous very minute, regularly disposed, concentric lines, may also be seen by the aid of a magnifier, most distinctly defined in the furrows between the much larger radiating striæ; while a few distant, sub-imbricating, stronger marks of growth are usually seen in adult shells.

Length of a medium-sized mature specimen, 0.60 inch; breadth, 0.75 inch; convexity, 0.25 inch.

I am in considerable doubt whether it was this or the following form to which Prof. Hall applied the name *O. emacerata*. His remark that his type has finer striæ, and the depression in the middle of its dorsal valve usually deeper, and the mesial elevation of the ventral valve more prominent, than in the form most generally referred to *O. testudinaria,* would seem to indicate that he had the following form in view, and regarded that here under consideration as the *O. testudinaria.* His figure, however, cited above, particularly figure 1, is larger than any example of the following

form I have seen, and agrees decidedly more nearly in outline and general appearance with that here under consideration. I do not believe, however, that there is any specific, or other *constant* difference, between this shell and the western specimens that have long been referred to *O. testudinaria,* Dalman.

I have had no opportunity to compare these shells with authentic examples of Dalman's species, or even with English specimens referred to the same. A careful comparison, however, with Mr. Davidson's figures of English specimens referred to *O. testudinaria,* leads me to doubt whether they can be properly included in the same species with the latter. For instance, the English specimens would seem, according to Mr. Davidson's figures, not only to be proportionally longer, with a more convex dorsal valve, and a more prominent and incurved ventral beak, but also to differ in having their posterior lateral striæ only gently curved, instead of being so strongly arched as to run distinctly out on the hinge line, as we see in all of the specimens of the western form under consideration. Again, there are rather marked and constant differences in the form and proportions of the muscular scars in the shell under consideration, from the same, as represented in Mr. Davidson's figures referred to. For instance, these figures show the posterior pair of adductor scars in the English shell a little larger than those of the anterior pair; while in the form under consideration, the reverse is constantly and decidedly the case. Again, his figure of the interior of the ventral valve shows the cavity for the reception of muscular scars to be narrower, in proportion to length, with the divisions of its anterior end differently formed; while the scars of the adductor muscles in the American shell are placed decidedly farther back than represented in Mr. Davidson’s figure. How far the English specimens may vary in these characters of the muscular impressions, I have no means of knowing, though I have found the American shells quite constant in their internal characters. Mr. Salter's figures, however, given on plate XXVII., Vol. II., part 1, of the Memoirs of the Geological Survey, show that at least some of the English shells referred to *O. testudinaria* have the posterior lateral striæ as strongly curved as in any of our American shells of this type, and also agree quite well with the latter, in at least all external characters.

Locality and position: Cincinnati group, Cincinnati, Ohio, at an elevation of 250 feet above the Ohio; this being the typical form, like Prof. Hall's fig. 1, in the Regents' Report. I also, however, have specimens differing very little, if any, from higher horizons, both at Cincinnati and Butler county, Ohio. A few others, from Cincinnati, agree with the more transverse form represented by Prof. Hall's figure 2; and Prof. Orton has sent to me from Hamilton, Ohio, near the top of the group, a number of specimens agreeing exactly with that figure in outline and fineness of striæ.

ORTHIS EMACERATA, var. MULTISECTA, James.

Plate 8, figs. 3 *a, b,* c, *d.*

Orthis multisecta, James, 1871; Cat. Lower Silurian Fossils, Cincinnati Group, p. 10.

This form, although somewhat variable, differs from the last in being smaller, slightly less transverse, and in having its dorsal valve generally flatter, with usually, but not always, a less defined mesial sinus; and its ventral valve with a less prominent mesial ridge. Its surface striæ are also a shade finer, and the minute concentric lines in the furrows between the striæ more distinct. The granules of its entire internal surface are likewise a little finer and more crowded.

The cavity for the reception of the muscular scars of its ventral valve is also proportionally a little smaller, and sometimes differs from that of the last, in wanting the bilobed character anteriorly, seen in the same part of that shell. There are, again, some slight differences in the form and proportions of the muscular scars of its other valve, but I am not quite sure that these are constant.

The external differences mentioned above give these shells a perceptibly different aspect, when we place, side by side, a tray-full of each; the form under consideration having altogether a more delicate and less robust appearance. It may be specifically distinct from the last, but I am not clearly satisfied that it is more than a variety of the same. It differs from Mr. Davidson's figures of *O. testudinaria* quite as strongly as the last; but it is possible that both may be only varieties of that species.

One of the largest specimens gives the following measurements: Length, 0.50 inch; breadth, 0.58 inch; convexity, 0.20 inch.

Locality and position: Lower division of the Cincinnati group, at Cincinnati, Ohio, where it ranges upward about 200 feet above low-water mark of the Ohio. The specimens studied were sent by Mr. James, Mr. Miller, and Mr. Shaffer, of Cincinnati, to the Smithsonian Institution.

ORTHIS (PLATYSTROPHIA) BIFORATA, Schlotheim (sp.).

Plate 10.

Trebratulites biforatus, Schlotheim, 1820; Petrefact., p. 265.

Terebratula lynx, Eichwald, 1830; Nat. Kizze von Podol., p. 202.

Porambonites dentatus and *brevis,* Pander, 1830; Bietr. Geogn, Russl., p. 96, pl. 11., figs. 4,5.

Spirifer lynx, Von Buch, 1837; Ueber Delth., p. 44; and (1840) Mem. Geol. Soc. Fr., Vol. IV., p, 190; Vern. and Keys. (1845), Geol. Russ., Vol. II., p. 136, pl. III., figs. 3 *a, b,* and 4 *a, b* (as varieties of *S. biforatus);* Hall (1852), Palæont. N. Y., Vol. II., p. 65, pl. 22, figs. 1 *a-e* (as var. *S. biforatus*).

Spirifer biforatus, Eichwald, 1840; Sil. Syst. in Esthel., p. 144; Vern. and Keys., 1845, Geol. Russ., Vol. II., p. 139.

Delthyris brachinota, Hall, 1843; Geol. Report 4th Dist. N. Y., p. 71, fig. 6.

Spirifer Sheppardi, Castlenau, 1843; Terr. Sil. de l'Amer. du Nord, p. 43, pl. XIV., fig. 15.

Spirifer dentatus, Vern. and Keys., 1845; Geol. Russ., Vol. II., p. 138, pl. III., figs. 5 *a, b,* c, *e, f* (as var. of *S. biforata*).

Delthyris biforata, Hall, 1847; Palæont. N. Y., Vol. I., p. 132.

Delthyris lynx, Hall, 1847; *Ib.,* p. 133, pl. XXII. D, figs. 1 *a-k* (as varieties of *D. biforata).*

Orthis biforata, Davidson, 1848; Bull. Geol. Soc. Fr. (2d series), Vol. V., p. 323, pl. III., fig. 25; and (1853) Introduct. to Brach., pl. VIII., figs. 146 and 148; Salter (1859), Siluria (2d series), p. 210, pl. XXXIII., fig. 4; Lindstrom (1860), Gothl. Brach., p. 371; Davidson (1871), Monogr. Brit. Sil. Brach., p. 268, pl. XXXVIII., figs: 11-25; James, 1871, Cat. Cincinnati Fossils, p. 10.

Spirifera biforata, Phillips and Salter, 1848; Mem. Geol. Survey, Vol. II., p. 293; McCoy (1852), Brit. Pal. Fossils, p. 192; Hall (1852), Palæont. N. Y., Vol. II., p. 65.

Platystrophia biforata, King, 1849; Mongr. Permian Fossils, p. 106.

Orthis lynx, Quenstedt, 1851; Handb., p. 486, pl. XXX., figs. 8-11; Schmidt, 1858, Sil. Fom. Ehst., etc., Arch., Vol. II., p. 215.

Spirifera lynx, S. dentata and *S. fissicostata,* McCoy, 1852; Brit. Pal. Foss., p. 192 and 193 (as varieties of *S. biforata).*

The original typical form of this species has, I believe, never been figured, and Schlotheim's description of it is so brief and unsatisfactory, that it would apply equally well to almost any of the various similar forms usually included as varieties or sub-species under his name. M. de Verneuil, however, states that he was informed by M. von Buch, that he had seen the original type in one of the museums at Berlin, and that it only differs from the common var. *lynx,* in having five plications in the mesial sinus, and a greater proportional breadth. Prof. McCoy describes it, from British specimens, supposed by him to be identical, as "having the mesial fold wider, and less elevated, bearing usually from six to nine ribs, at six lines or less from the beak, and five to seven in the sinus; the lateral ribs narrow, simple, and from nine to twelve on each side, at six lines from the beak."

Among the vast number of American specimens of this group that I have seen, none agree with the characters attributed to the variety *biforata* by Prof. McCoy; though we do very rarely meet with an individual that differs in no other respect from the common variety *lynx,* showing four, or even occasionally five, plications in the sinus; but still, in these cases, the additional plications are merely rudimentary, and placed on one or both sides of the usual three well-developed ones, occupying the bottom of the sinus. I can therefore but regard these as only

very slight modifications of the common variety *lynx,* and hence feel at a loss to know whether or not we have any form in this country agreeing *exactly* in all respects with the typical variety *biforata*; especially as we have no means of knowing whether the greater proportional breadth mentioned as characterizing that form, is due to the greater proportional extension of the hinge line and lateral angles only, or to the greater breadth of the entire shell.

I have therefore preferred to give the general synonymy so as to include only the forms that have been usually regarded as belonging to this species, by the highest European authorities; and then proceed separately to notice provisionally, as varieties, the several types known in this country, that are more or less closely connected with Schlotheim's species. Some of these may be entitled to rank as distinct species from the European forms, and I have therefore placed their synonymy separately in connection with the remarks upon each form. In defining each, it is only necessary to describe at length the most common and widely distributed form usually considered the variety *lynx,* and then to point out the character distinguishing each of the others from the same.

The differences of form, nearly equal beaks, areas and fissures in the two valves of these shells, give them a peculiar physiognomy, that seems to warrant their separation from the typical forms of *Orthis,* at least sub-generically.

Var. 1. ORTHIS (PLATYSTROPHIA) LYNX, Von Buch.

Plate 10, figs. 1 *a, b,* c, *d, e.*

Shell attaining a large size, nearly equivalve, wider than long, with a transversely oval-subquadrate outline, or, in old specimens, often becoming so gibbous as to assume a sub-globose form; hinge line usually a little less than the greatest breadth of the valves, but sometimes equaling, or somewhat exceeding, the same; cardinal extremities more or less obtusely angular, nearly rectangular, or sometimes rather acutely so; lateral margins convex, nearly straight, or sometimes rather sinuous behind, and rounding to the front, which is a little sinuous, rounded, or somewhat prominent at the middle; beaks and cardinal areas of the two valves nearly equal, the former incurved and approximate, or, in adult shells, sometimes contiguous.

Dorsal valve generally a little more convex than the other, in some examples rather decidedly so (its greatest convexity being near the mid-

dle), provided with a moderately prominent, rather rounded, mesial fold, that commences at or near the beak, and continues forward, gradually widening and rounding over with the curve of the valve to the front, where it is moderately elevated, with more or less sloping sides; lateral slopes convex; beak projecting beyond the hinge margin, strongly incurved, particularly in old individuals, which sometimes have the gibbous umbo projecting even a little beyond that of the other valve; cardinal area well developed, distinctly defined, nearly as wide as that of the other valve, directed backward, and more or less strongly incurved; foramen broad-triangular, and not closed by the cardinal process. Interior showing cardinal process to be very small, or merely having the character of a low linear ridge in the rostral cavity; posterior pair of muscular impressions corrugated, and decidedly larger, and more widely separated than the others.

Ventral valve with a mesial sinus corresponding to the fold in the other valve, and terminating at the front in a rather short, somewhat rounded projection, that curves more or less upward into a sinuosity of the same size and form in the margin of the dorsal valve; beak usually a little less strongly incurved than that of the other, and very slightly more prominent at its apex; cardinal area about one-fourth to one-third higher, at the middle, than that of the dorsal valve, and narrowing less rapidly toward the lateral extremities; incurved and directed backward, but a little less strongly so than the other; foramen having nearly the form of an equilateral triangle, or sometimes slightly wider than high, or the reverse. Interior with hinge teeth moderately prominent, and trigonal; cavity for the reception of the muscular attachments comparatively small, scarcely reaching the middle of the valve, longer than wide, or elongate-oval, with nearly straight and parallel sides, always well defined by the dental ridges, and, in old specimens, extremely profound, owing to the thickening of the interior of the cardinal region of the valve on each side.

Surface of each valve ornamented by about sixteen to twenty-four strong, more or less angular radiating plications, of which three or four (rarely five) occupy the mesial sinus, and from four to six the mesial fold; plications generally simple, but occasionally some of those in the sinus and on the fold, and, still more rarely, a few of those on the lateral slopes, bifurcating once; lines of growth moderately distinct, particularly near the free margins of adult shells, where they present a distinctly zig-zag appearance in crossing the plications and the furrows between them. Protected portions of the surface of well-preserved specimens also often show, under a strong magnifier, numerous regularly

arranged, minute granules, probably coincident with the punctures of the shell substance.*

Length of a nearly medium-sized adult specimen, 1 inch; breadth, 1.30 inches; convexity, 1 inch. Some examples attain a greater size, by two-thirds, than this, and are proportionally rather more gibbous.

Locality and position: This form has a great vertical as well as horizontal range. In New York, as well as Canada, Wisconsin, Kentucky, etc., it occurs in the Trenton group. In Ohio it is common at the horizon of the tops of the hills in the Cincinnati group, at Cincinnati; and it ranges up through the higher beds of this formation in Ohio, Indiana, Kentucky, and other western States, but it has not, I believe, been found in the equivalent formation in New York; though it occurs there, as well as in Ohio and other western States, as high in the series as the Clinton group. It is likewise found in Russia, England, and other European countries.

Var. 2. ORTHIS (PLATYSTROPHIA) LATICOSTA, James.

Plate 10, figs. 4 *a, b,* c, *d, e, f.*

Orthis lynx, Hall (part), 1847; Palæont. N. Y., Vol. I., pl. 32 D.

Orthis laticosta, James, 1871; Cat. Lower Sil. Foss., Cincinnati Group, p. 10.

This form scarcely attains to more than two-thirds the bulk of the largest specimens of the var. *lynx,* and is always less gibbous, proportionally wider on the hinge line, with more angular posterior lateral extremities, and, even in the largest individuals, it is a much thinner shell. It likewise differs in having its mesial sinus wider and much more profound at the front, and its mesial fold more elevated and angular; while its lateral slopes are decidedly more compressed, those on each side of the sinus being always concave, and the margins of the sinus very prominent and angular, which, together with the prominence of the mesial fold, and the greater length of the hinge line, impart a general angularity of appearance not seen in the var. *lynx.* In the sinus there are nearly always three plications, the lateral two being smaller than the middle one, or sometimes rudimentary; while occasionally one of them is obsolete, leaving the large one, as usual, in the middle, and a smaller one on one side only. The mesial fold has generally four plications (never more), the middle two being usually larger and more prominent than the others, and separated by a decidedly larger and deeper furrow. Its lateral slopes have generally only from five to seven large, simple, angular plications on each side of the fold and sinus; these being decidedly larger than on specimens of the var. *lynx,* of corresponding size.

Internally, the ventral valve of this variety only differs from that of the var. *lynx,* in having the cavity for the muscular scars much less deeply

* These granulations are quite as well, or even better defined, on all of the following forms described as varieties of this.

impressed, owing to the fact that the shell did not thicken within, as in that form, as it advanced in age. The interior of its dorsal valve shows the same rudimentary cardinal process; while its muscular scars (which I have not seen in this valve of the var. *lynx*) are moderately defined, the posterior pair being corrugated, and much larger, as well as more widely separated, than the anterior.

In figuring this variety in the first volume Palæont. New York, Prof. Hall compares it with the var. *dentata* of Pander, mentioning some points of difference. It attains a much larger size, however, than that variety, and differs in having nearly always three plications, instead of only two, in the sinus, which is deeper, and its mesial fold more prominent, thus giving the general aspect of the shell greater angularity of outline.

The specimens for which Mr. James retains the name *O. profundo-sulcata,* in his list, are much smaller than the average size of the form here under consideration; but, with that exception, and their usually rather shorter hinge, and somewhat less compressed lateral slopes, they seem to me to differ very little, if any, from specimens of the same size of the variety under consideration. On the other hand, they only differ from the young of the variety *lynx,* in generally having the mesial sinus deeper, and the fold more prominent, with, perhaps, in most cases one or two plications less on the lateral slopes. I have, therefore, found it very difficult to distinguish this as a variety from young or dwarfed examples of the varieties *lynx* and *laticosta,* though its more prominent fold, etc., bring it nearer the latter. Figs. 2 *a, b, c, d,* of plate 10, show the form and usual size of this variety. It occurs 300 feet above the Ohio, at Cincinnati.

Length of the largest example seen, 0.86 inch; breadth (at hinge line), 1.40 inches; convexity, 0.88 inch.

Locality and position: Cincinnati group of the Lower Silurian, at a horizon of from 250 to 300 feet above low-water mark, at Cincinnati. It is also found at other localities in Ohio, Kentucky, and perhaps in Indiana. The specimens studied were sent to the Smithsonian Institution by Mr. James and Mr. Shaffer, of Cincinnati.

Var. 3. ORTHIS (PLATYSTROPHIA) DENTATA, Pander??

Plate 10, figs. 3 *a, b,* c, *d.*

Orthis dentata, (Pander), James, 1871; Catalogue Cin. Foss., p. 10.

This form is much smaller than the last, and always proportionally narrower in its transverse diameter. Its hinge line generally about equals the greatest breadth of the valves, but may be a little less or a little greater than the breadth. Its lateral slopes are always more abrupt,

and much less compressed than in the last; but, like that variety, its mesial sinus is large, and very profound, with angular margins, and its mesial fold strongly elevated. In old individuals, the valves become often remarkably gibbous, the convexity exceeding the length, and nearly equaling the breadth; being much increased by the prominence of the mesial fold, and the elevation of the plications forming the margins of the sinus. It also differs from the last in generally having but a single strong plication in the sinus, and only two on the mesial fold; though we sometimes see an individual with the commencement of a second smaller plication, occupying one of the slopes of the sinus on one side of the middle one, and very rarely one with a third one on the other side. Where rudimentary plications exist in the sinus, they usually give origin to corresponding partly developed plications on the slopes of the mesial fold of the other valve. All of the plications are simple, and, excepting the rudimentary ones mentioned, quite coarse, prominent and angular; the number on each lateral slope being constantly five or six.

This is the form referred in Mr. James's list to *O. dentata* of Pander. I doubt very much, however, whether it agrees with that variety, which is described by McCoy, from British specimens, as having constantly two plications in the sinus and three on the fold. De Verneuil describes it, from Russian specimens, as having one to two plications in the sinus, and alludes to American specimens he had seen with three in the same. This being a somewhat variable character, I would be less inclined to regard the very general presence of but a single plication in the middle of the sinus of the form under consideration worthy of notice, if it were not for the fact that this shell also presents a very different physiognomy from that figured by De Verneuil in his work on the Russian fossils, already cited; being much more gibbous, with a decidedly more elevated mesial fold, a proportionally shorter transverse diameter, much coarser plications, and greater general angularity of outline. Indeed, I have seen no forms figured in any foreign work agreeing very nearly with either this or the last described variety. It is true, Mr. Davidson figures an example with but a single strong plication in the bottom of the sinus, and six or seven similar ones on each lateral slope; but still its general rounded outline contrasts strongly with the angularity of our shell, and gives it more nearly the aspect of the variety *lynx*.

Length of a medium-sized specimen, 0.58 inch; breadth, 0.68 inch; convexity, 0.60 inch. The largest individual seen measures 0.65 inch in length, with a breadth of 1 inch, and a convexity of 0.83 inch.

Locality and position: Same as last. I am informed that specimens of this variety generally occur clustered together, as if gregarious in their habits. I believe neither

this nor the last described form ranges into the upper part of the Cincinnati group. The specimens studied and figured were sent to the Smithsonian Institution by Mr. James and Mr. Shaffer, of Cincinnati.

Var. 4. ORTHIS (PLATYSTR.) ACUTILIRATA, Con. (sp.).

Plate 10, figs. 5 *a* to *g.*

Delthyris acutilirata, Con., 1842; Jour. Acad. Nat. Sci., Philad., Vol. VIII., p. 260, pl. XIV., fig. 15.

Orthis inflata, O. prolongata,* and *O. annieana,* James, 1871; Cat. Cincinnati Fossils, p.10.

The typical and most common form of this variety or species (*=0. prolongata* of Mr. James's list) is much extended on the hinge line, which usually terminates in acutely angular, or even mucronate lateral extremities, thus causing the breadth to be sometimes twice, or even, in extreme cases, three times the length of the valves. Between these, however, and others having the hinge not more than one-fifth greater than the length, and only about equaling their greatest breadth (*=0. inflata* of Mr. James's list), there is a completely uninterrupted series of intermediate forms. In all of its variations of proportional length and breadth, however, it agrees in having three, or very rarely four, simple, angular plications in the bottom of the sinus, and four, or very rarely five, on the mesial fold, which latter is always rounded, and but comparatively little elevated. All of its plications are simple, while they are smaller and more numerous than those of any of the other varieties found in this country; there being on each side of the mesial fold and sinus from 11 to 18, making the entire number about 26 to 40 on each valve. The specimens with the lateral extremities most extended have the largest number of plications, probably only because there is more space for them. In these, however, only about the same number reach the beaks as on those less dilated, as a number of the outer ones on the lateral extensions of those more produced laterally, run out on the hinge line without reaching the beaks.

This form becomes quite gibbous with age, the gibbosity being generally most obvious (though not always actually greatest) in the specimens least extended on the hinge line, some of those with the most produced lateral extremities having the middle portions of the valves quite as convex as any of the others of the same anterio-posterior dimensions. In these the lateral slopes are very concave, and the anterior lateral margins sinuous and strongly converging toward the front. The mesial

* Not *O. inflata,* Salter.

sinus is well defined, and widens and deepens rather rapidly forward; and, as the mesial fold is proportionally less elevated, the front is often thus caused to be distinctly sinuous in the middle.

Old specimens become quite thickened within, and consequently have the cavity for the muscular attachments in the ventral valve very deep, and similar to that of the var. *lynx*. The surface granulations are usually very beautifully preserved on this variety.

In its much longer hinge line, more produced and acutely angular lateral extremities, more numerous and smaller plications, this form contrasts strongly with the variety *lynx*,* while in these characters and its more depressed and rounded mesial fold, it is even much more strongly distinguished from all of the other known kindred forms of this country.

In its great proportional breadth, and the small size and greater number of its plications, this shell would seem to agree more nearly with the typical European variety *biforata*, than any other we have in this country. Yet it differs in rarely ever having more than three (never more than four) plications in the sinus, instead of five to seven (see McCoy's description of that form). It probably also differs in having its great lateral extension only at and near the hinge line, thus producing acutely angular lateral extremities, as this character is not mentioned in any of the descriptions of that variety I have seen. So far as I have yet observed, no form exactly corresponding to this has been figured from any foreign locality; and it is the most strongly marked type of the group yet known in this country. I am much inclined to think it ought to be separated specifically from all the other forms here noticed under the general name *biforata*, not only on account of the differences mentioned, but because it is confined to one horizon; while all of the others, excepting the var. *lynx*, which has a much greater range, belong to lower horizons.

It is a little remarkable that Mr. Conrad's excellent figure and description of this variety, or species, published in the Journal of the Philad. Academy in 1842, should have been entirely overlooked. This probably arose from the fact that he (erroneously, as I must think) mentioned the Falls of the Ohio as the locality from which his type was obtained. Finding that his figure agrees so exactly with specimens of this shell from Richmond, Indiana, and never having seen any similar shell from the Falls of the Ohio, I wrote to Mr. S. S, Lyon, of Jeffersonville, Indiana, who has long been familiar with the fossils of that locality, asking him if he

* It shades off, however, toward that variety through the individuals least extended on the hinge (*O. inflata*, James), which differ from var, *lynx*, mainly in their more numerous and smaller plications.

had ever found this form at the Falls of the Ohio; and he wrote back that he had never seen such a shell there, or in any of the collections from that locality, and could not believe that it occurs there. I then sent one of the Richmond specimens to Mr. Conrad, and he wrote back that it is, beyond all question, the form figured and described by him under the name *Delthyris acutilirata.*

It is worthy of note that in the same paper in which Mr. C. described this form, he also figured *Rynchonella capax,* from Richmond, Indiana; so that it is evident he had at the same time before him collections from that locality, and it is probable that he was led to cite the Falls of the Ohio, instead of Richmond, by some accidental confusion of labels, or by a slip of the pen.

Length of a moderate-sized, laterally extended specimen, 0.76 inch; breadth, 1.53 inches; convexity, 0.77 inch. Some examples are proportionally more extended on the hinge line, and others much less.

Locality and position: Richmond, Ind., and Clinton, Warren and some of the adjoining counties of Ohio, in the upper part of the Cincinnati group. Not found at Cincinnati or elsewhere so low in the series.

GENUS RHYNCHONELLA, Fischer de Waldh., 1809.

(Mem. Soc. Imp. Mosc. II.)

RHYNCHONELLA DENTATA, Hall.

Plate 11, figs. 3 *a, b,* c, *d.*

Atrypa dentata, Hall, 1847; Palæont. N. Y., Vol. I., p. 148, pl. XXXIII., figs. 14 *a, b,* c.

Rhynchonella dentata, Hall, 1859; Regents' 12th Ann. State Cab. Report, p. 65; James (1872), Cat. Lower Sil. Fossils, Cincinnati Group, p. 11.

Shell rather small, trigonal-sub-globose, generally slightly wider than long, and usually, in adult examples, quite convex; posterior lateral margins nearly straight, or a little convex in outline, and converging to the beaks at nearly a right angle; anterior lateral margins rounded or sub-angular; front usually a little sinuous, as seen in a direct view of either valve.

Dorsal valve more convex than the other, particularly in the anterior central region, where it is often very prominent, being elevated in the form of a distinct mesial ridge that is divided into two plications by a central furrow; lateral slopes rounding off more or less abruptly, and each occupied by from four to five simple, rather angular radiating plications; beak strongly incurved.

Ventral valve (as seen in a side view) somewhat strongly arched from beak to front, or more or less compressed in the central region, and

abruptly curved up at the front and beak; mesial sinus commencing. small near the beak, and widening and deepening (with sloping sides and a single central plication) to the front, where it equals about one-half the entire breadth, and terminates a more or less produced, sub-trigonal marginal projection, curved up nearly at right angles to the plane of the valve, and fitting into a corresponding sinus in the edge of the same; lateral slopes generally quite abrupt from the edges of the mesial sinus, and each occupied by about five simple sub-angular plications; beak incurved, but not so closely upon that of the other as to conceal the small foramen under its apex.

Surface of both valves with the plications continued to the points of the beaks, and imparting to the interlocking anterior margins a sharply zig-zag outline; while on well-preserved specimens, very fine, obscure lines of growth may be seen, by the aid of a magnifier, crossing the plications and furrows between them, parallel to the zig-zag anterior and lateral margins; though these lines are usually nearly or quite obsolete, excepting near the front.

Length of a rather large, well-developed, gibbous specimen, 0.51 inch; breadth of do., 0.55 inch; convexity, 0.67 inch. Some individuals are proportionally more convex, and others less.

The specimens of this shell before me are generally larger, and often more convex, than the typical form (or at least than the figured specimen) of the New York species; but, otherwise, they seem to agree quite well with the figures and description of the same. They are, however, quite as much, or even more, like some varieties of *R. diodonta,* Dalman, as illustrated by Mr. Davidson in his Monograph of the British Silurian *Brachiopoda,* pl. XXI. Yet they generally differ in being straighter or more sinuous in front, and rather more gibbous; while they are decidedly less variable in the number of plications. Among a large number of specimens, I have never seen one with more than a single plication in the mesial sinus, and two on the mesial fold, though there is very rarely a rudimentary plication a little raised on each side of the usual two forming the fold of the dorsal valve; while a large majority of them have only four or five on each lateral slope of each valve; and where we find one or two more, it is only by counting mere rudimentary lateral ones, so slightly developed as scarcely to attract attention.

Locality and position: The New York specimens are referred doubtfully to the Trenton group. Those here under consideration came from Richmond, Indiana, and from some of the adjoining portions of Ohio, where they are rather common in the upper part of the Cincinnati group. I am indebted to Mr. James, of Cincinnati, for some fine specimens of this species.

RHYNCHONELLA CAPAX, Conrad (sp.).

Plate 11, figs. 6 *a* to *f*.

Atrypa capax, Conrad, 1842; Jour. Philad. Acad. Sci., Vol. VIII., p. 264, pl. XIV., fig. 21.
Atrypa increbescens, Hall, 1847; Palæont. N. Y., Vol. I., p.146, pl. XXXIII., fig. 13 *a-y.*
? *Atrypa subtrigonalis,* Hall, 1847; Palæont. N. Y., Vol. I., p. 145, pl. 33, fig. 12.
? *Rhynchonella subtrigonalis,* 1859; Regents' 12th Ann. State Cab. Report, p. 65.
Rhynchonella increbescens, Hall, 1859; Regents' 12th Ann. State Cab. Report, p. 66; and in 13th do. (1861), p. 66; also (1862) Wisconsin Geological Report, p. 55.
Rhynchonella capax, Billings, 1862; Palæozoic Fossils of Canada, Vol. I., p. 142.

Shell attaining about a medium size, varying with age from compressed sub-trigonal to sub-globose, old examples being often more convex than their diameter in any other direction; posterior lateral margins somewhat straightened and converging to the beaks at about a right angle in young shells, but becoming more rounded in the adult; lateral margins rounding to the front, which is more or less distinctly sinuous, or nearly straight in the middle.

Dorsal valve generally a little more convex than the other, most prominent in the middle, and rounding abruptly, or sloping more gently, from the central region in all directions; the more elevated part forming anteriorly a depressed mesial ridge that is nearly flat, and occupied by four plications on top, and rarely continues two-thirds of the way to the strongly incurved beak; while on young or compressed individuals, it is faintly marked even anteriorly; lateral slopes each occupied by four to seven or eight simple angular plications.

Ventral valve with its beak abruptly pointed, and very strongly incurved upon that of the other valve, in adult shells, but less distinctly curved, and showing a small opening under its apex, in young examples; mesial sinus deep and well defined in gibbous specimens, and less so in the young or more compressed forms, never quite reaching the point of the beak, and always having three simple, rather angular plications in the bottom, that extend, like the others, to the apex of the beak, in well-preserved specimens; lateral slopes each occupied by from five to seven simple plications.

Entire surface of both valves marked by numerous very regular, strongly zig-zag, prominent, sublaminar marks of growth, that become nearly or quite obsolete, sometimes, on old examples.

Length of a medium-sized, moderately gibbous individual, 0.75 inch; breadth, 0.81 inch; convexity, 0.66 inch.

This species varies considerably in form, but generally increases regu-

larly in convexity with age, some of the larger individuals becoming extremely gibbous. It varies comparatively little, however, in the number of plications, though the younger individuals usually show the marks of growth more distinctly than the largest and most convex ones. Large examples have the substance of the shell often much thickened within, on each side of the umbonal region of the ventral valve, with a deep angular impression between, for the muscular scars, and a deep, narrowly-rounded, rostral cavity, which makes the beak of this valve very thin, so that its apex is often broken away in such a manner as to appear as if there had been a perforation there. But many well-preserved, adult specimens, show that this is not the case, though there was always a small opening under the immediate apex, in young shells, which became closed, by the close incurving of the beak upon that of the other valve, with age. The hinge teeth of the ventral valve are quite prominent, and between these and the beak there is a concave space on each side of the rostral cavity, that sometimes presents the appearance of a very restricted concave area; but it seems to be the result of the truncation, as it were, of the thickened margin on each side of the rostral cavity, to form a space for the strongly incurved beak of the opposite valve. The cardinal process of the dorsal valve is moderately prominent, and so deeply divided as to present the appearance of two diverging teeth, with a slender, slightly raised ridge or line in the bottom of the division between; while a more or less defined mesial internal ridge extends forward nearly to the middle of the interior surface of the valve, and just outside of these divisions of the cardinal process, a deep pit is seen on each side, for the reception of the teeth of the other valve.

It is a little surprising that Mr. Conrad's name, *capax*, was not retained for this shell, when there is not the slightest reason to doubt that his name was proposed for a gibbous example of the same species. He gives Richmond, Indiana, as the locality, at which place it is well known to occur in great numbers, while no other similar form has been found there. I have now before me numerous specimens collected at Richmond, by Mr. Case and myself, some of the larger, more gibbous examples of which, that have lost their marks of growth, agree exactly with Mr. Conrad's figure.

Locality and position: Upper part of the Cincinnati group, at Oxford and other localities in Ohio; Richmond, Madison, and elsewhere in Indiana; Maysville and Frankfort, Kentucky, as well as at many other localities of the West. It also occurs at the same horizon, and in the Trenton limestone, in New York. Prof. Hall gives Cincinnati as one of its localities, in the first volume Palæont. N. Y., but it does not occur there, nor within twenty miles of that city, I am informed by Prof. Orton.

GENUS ZYGOSPIRA, Hall, 1862.*

(Regents' 15th Ann. State Cab. N. H. Report, p. 154.)

ZYGOSPIRA MODESTA, Say (sp.).

Plate 11, figs. 4 *a, b,* c, *d.*

Producta modesta, Say; MS.
Atrypa modesta, Hall, 1847; Palæont. N. Y., Vol. I., p. 141, pl. XXXIII., fig. 15.
Genus? related to *Leptocostia?* Hall, 1859; Regents' 12th Ann. State Cab. Report, p.66.
Zygospira modesta, Hall, 1862; Regents' 15th Report State Cab., p. 154.

Shell small, rather depressed, nearly plano-convex, sub-orbicular, or sometimes a little wider than long; posterior lateral margins often slightly straightened and converging to the beaks at an obtuse angle; lateral margins more or less rounded; front rounded, or sometimes a little straightened, or very slightly sinuous at the middle.

Dorsal valve with a rather shallow, undefined mesial sinus of moderate breadth at the front, but becoming rapidly narrower, and less impressed posteriorly, so as often to die out before reaching the umbo; surface on each side of the sinus gently convex centrally, and sloping gradually to the lateral margins; beak but slightly prominent and incurved.

Ventral valve, with a low mesial ridge, corresponding to the sinus of the other valve, excepting that it is generally most prominent near the middle, and somewhat depressed anteriorly; while on each side of the ridge the slopes are distinctly compressed; beak small, abruptly pointed, projecting beyond that of the other valve, and rather distinctly arched; but not so closely incurved as to conceal the small fissure, which seems to be closed below by a deltidium, that leaves a minute aperture above, just under, or extending to, the apex; margin on each side of beak carinated, so as to give the appearance of a kind of false cardinal area.

Surface of each valve ornamented by about 16 to 18 small, simple, radiating plications, of which about three to five near the front of the dorsal valve occupy the mesial sinus, the middle one being usually a little the largest; while on the ventral valve about four of the largest occupy the mesial prominence, the furrow between the middle two being generally a little larger and deeper than the others; marks of growth undefined, or extremely minute and obscure.

Length of a mature, moderately large specimen, 0.26 inch; breadth, 0.30 inch; convexity, 0.15 inch.

* As I have elsewhere stated, this group seems to be closely related to *Anoplotheca* of Sandberger, 1856.

This neat, well-marked little shell is very abundant, and easily recognized. Its most marked characters are its small size, and sub-plano--convex form, with a shallow mesial depression in the dorsal valve, and a corresponding mesial elevation on the ventral valve, provided with a slightly larger and deeper furrow along its middle than those separating the other plications.

Locality and position: In New York, this shell is said to have been found only in the Utica Slate, or upper part of the Trenton Limestone, at Turin, Lewis county. In Ohio, it ranges from the lower part of the Cincinnati group, at that city, to the top of the series, and into the Clinton group. It occurs in the upper beds of the Cincinnati group at Richmond, Ind., and Oxford and many other localities in Ohio; also at Madison, Ind., and in the corresponding beds in Kentucky, as well as at many other western localities.

ZYGOSPIRA CINCINNATIENSIS, James.

Plate 11, figs. 5 *a, b,* c.

Zygospira Cincinnatiensis, 1871; Catalogue Lower Sil. Foss., Cincinnati Group, p. 11.

This variety or species differs from the last, in its larger size, greater proportional breadth, more prominent mesial elevation, with a larger and deeper sulcus along its middle, and in the deeper mesial sinus of its dorsal valve; and the more spreading character of its lateral plications. Its plications likewise differ in being proportionally coarser, and more angular, and more frequently show a disposition to bifurcate, particularly those on the sides of the mesial elevation of the ventral valve, and within or near the mesial sinus of the dorsal valve. Its lateral margins are likewise generally more compressed; and the beak of its ventral valve rather more strongly incurved.

Under a strong magnifier, in a favorable light, extremely minute, regular, and closely crowded concentric striæ may sometimes be seen on the sides of the plications, and other protected parts of the shell. These are similar to those sometimes seen on the last, but more distinct.

Although this is possibly a distinct species from the last, it would, I should think, be rather difficult to distinguish young or small examples of it from that shell. Hence I am inclined to think that it may be only a robust variety of the same.

Length of one of the largest examples, 0.41 inch; breadth, 0.52 inch; convexity, 0.25 inch.

Locality and position: Cincinnati group, at an elevation of 250 feet above low-water mark, Cincinnati, Ohio. I am indebted to Mr. James, of Cincinnati, for some fine examples of this form.

ZYGOSPIRA HEADI, Billings, (sp.).

Plate 11, figs. 1 *a, b,* c, *d.*

Athyris Headi, Billings, 1862; New Sp. Lower Sil. Fossils, p. 147, figs. 125 *a, b,* 126 *a, b,* and 127 *a, b;* also Geol. Canada, Palæozoic Foss., Vol. I., p. 147, with same figures; James (1871), Cat. Lower Sil. Foss., Cincinnati Group, p. 11.

? *Atrypa ?Headi, var. Anglica,* Davidson, 1867; Monogr. Brit. Foss. Brach., part VII., No.2, pl. XXII., figs. 1-7.

Zygospira Headi, Hall, 1872; Plate 13, figs. 23 and 25, of illustrations accompanying a re-issue of a paper entitled "Notice of New and Little Known *Brachiopoda,*" etc., dated March, 1871.

Shell attaining a medium or rather large size, longitudinally oval, the front being regularly rounded, and the lateral margins more broadly rounded, or sometimes slightly straightened along the middle; valves both rather evenly convex. Dorsal valve a little less convex than the other, its greatest prominence being near the middle, but without any traces of a mesial ridge; beak very short and incurved, Ventral valve with its greatest convexity behind the middle; mesial sinus almost obsolete, or only consisting of a slight flattening along the middle of the anterior slope, on each side of which the lateral slopes are sometimes very slightly compressed; beak only moderately prominent, obtusely pointed, and strongly incurved upon that of the other valve, while on each side of it a slight carination extends laterally, so as to give somewhat the appearance of a false area. Surface ornamented by fine, even, simple, radiating striæ. Interior unknown.

Length of a medium-sized specimen, 0.61 inch; breadth, 0.52 inch; convexity, 0.34 inch.

I have seen no specimens showing the interior of this shell, though one of those before me shows the hinge of the ventral valve. This has a rather prominent, compressed, oblique tooth on each side of the triangular fissure, which latter extends up nearly to the point of the beak. This fissure was doubtless closed below by a deltidium, so as to leave a minute, round perforation at the end of the beak.

Mr. Billings evidently had no specimens of this shell showing its interior at the time he described it, as he neither figured nor described its internal characters. He afterwards, however, wrote to Mr. Davidson that he had determined that it has internal spires arranged as in *Atrypa.* At a later date, Prof. Hall illustrated one of these appendages of this shell, showing it to have the paucispiral character, and to be accompanied

by other peculiarities characterizing his group *Zygospira*, which may be only a sub-genus or section of the genus *Atrypa.*

Locality and position: Upper part of the Cincinnati group, in Clinton county, Ohio, Madison, Indiana, etc. Mr. Billings's typical specimens were from the equivalent beds of the Cincinnati group, on the south shore of the St. Lawrence, opposite Three Rivers. I am indebted to Mr. James, of Cincinnati, for the only specimens of this species I have seen, as well as for a knowledge of its position in these western rocks.

Mr. Davidson refers doubtfully to this species, an English shell, from the Caradoc Limestone. It is a larger, more robust form, with a more decided sinus in the front of the ventral valve, and may be specifically distinct.

GENUS RETZIA, King, 1850.

(Permian Fossils of England, p. 137.)

RETZIA (TREMATOSPIRA) GRANULIFERA, Meek.

Plate 11, figs. 6 *a, b,* c, *d, e.*

Retzia (Trematospira) granulifera, Meek, 1872; Proceed. Acad Nat. Sci., Philad., p. 318.
Compare *Retzia Salteri,* Davidson (1848), as illustrated in his Monogr. British Sil. Brach., pl. XII., figs. 21 and 21 *a, b.*

Shell transversely oval, the length being about four-fifths the breadth, moderately convex, the convexity of the two valves being very nearly equal; lateral margins rather narrowly rounded in outline; front and anterior lateral margins broadly rounded, or perhaps the former sometimes straight or slightly sinuous in outline in the middle; cardinal margin nearly straight on each side, and sloping at an angle of about 140^0 from the beaks toward the lateral extremities.

Dorsal valve nearly evenly convex, its greatest prominence being slightly behind the middle; provided with about thirteen simple, angular, radiating plications or costæ, five of which on the middle are smaller than the others (the middle one being smallest and not continued to the beak), and forming together a very low flattened mesial elevation, scarcely rising above the general convexity; beak rather strongly incurved.

Ventral valve of much the same form as the other, excepting that its beak is somewhat more prominent, perforated,* and incurved upon that

* The immediate point of the beak of the ventral valve seems to be slightly broken in the specimen; though it has the appearance of having been naturally perforated before receiving the slight injury.

of the other valve; while two of its middle costæ are much smaller than the others, and the first one on each side of these is intermediate in size between the smallest central ones and the largest on the lateral slopes; these four smaller ones being a little depressed, so as to form a shallow mesial sinus that is not continued to the beak. Crossing all of these plications of both valves are numerous fine lines of growth; while the entire surface, as seen under a magnifier, is occupied by minute projecting points, like grains of sand, and between these, a higher magnifying power shows the whole surface to be very minutely and regularly punctate.

Length, 0.37 inch; breadth, 0.50 inch; convexity, 0.27 inch.

Until the distinctions between the genus *Retzia* and the proposed genus *Trematospira* (if any exist) are better defined, and the interior of the species here described can be determined, it is not possible to say to which of these groups it most properly belongs.

Specifically, however, it seems to be closely allied to *Trematospira gibbosa* of Hall, from the Hamilton group. Yet it differs not only in having two to three more plications on each valve, but also in having five, instead of three, a little raised, to form the mesial fold of the dorsal valve (the middle one being also much smaller), and four depressed, to form the mesial sinus (the middle two being much smaller than the others). It so nearly resembles the New York form, however, that I should almost be inclined to suspect that it might be only a variety of the same species, if it were not found at so much lower a horizon. It must be very rare, as I have only heard of the single typical specimen being found.

After publishing a description of this species, and since writing the foregoing, I have observed that it is even more closely allied to the English species *Retzia Salteri* of Davidson, than to the American form with which I have compared it above. Indeed, it so very nearly resembles Mr. Davidson's figure, that I strongly suspect that it will be found to be specifically identical. As I have already proposed a distinct name for it, however, I prefer to retain it under the same, until it can be compared with specimens of the English shell.

Locality and position: Cincinnati group of the Lower Silurian, at the base of the series exposed at Cincinnati, Ohio. Mr. Dyer's collection.

GENUS PHOLIDOPS, Hall, 1860.*

(13th Report of Regents, p. 92.)

PHOLIDOPS CINCINNATIENSIS, Hall.

Plate 5, figs. 2 *a, b.*

Pholidops Cincinnatiensis, Hall, 1872; Discr. New Sp. Fossils, pl. 3, fig. 10.

Shell small, ovate in outline. Larger valve about one-fifth longer than wide, with height one-third to one-fourth the breadth. Apex obtuse, near half way between the middle and the larger end. Anterior end narrowly rounded, posterior end somewhat more broadly rounded, or almost sub-truncate. Surface ornamented by six or seven sub-imbricating marks of growth. Smaller valve unknown.

Length, 0.14 inch; breadth, 0.12 inch; height of larger valve, 0.04 inch.

This species is very closely allied to *Pholidops ovatus* from the Upper Silurian Shaly limestone, from which it seems only to differ in having a less number of imbricating laminæ of growth; the figure of that species showing about twelve of these laminæ, while in the Cincinnati species there are only about seven or eight. Such a difference would scarcely warrant a separation, if it were not for the decidedly different horizons at which these forms occur.

Locality and position: Cincinnati group of the Lower Silurian, about three hundred feet above low-water mark of the Ohio, at Cincinnati, Ohio. Mr. James's collection.

LAMELLIBRANCHIATA.

GENUS AMBONYCHIA, Hall, 1847.

(Palæont. N. Y., Vol. I., p. 163.)

AMBONYCHIA COSTATA, James.

Plate 12, figs. 5 *a, b,* c.

Ambonychia costata, James, 1871; Catalogue L. S. Fossils, Cincinnati Group, p. 13 (without a description).

Shell of about medium size, moderately oblique, sub-ovate, very thin, rather compressed, the left valve being apparently a little more convex than the other; basal margin regularly rounded; posterior margin

* Mr. Davidson thinks this not distinct from *Pseudocrania* of McCoy, 1859; but it seems to me to differ sufficiently from Prof. McCoy's type to require a distinct generic name.

apparently broadly convex in outline; anterior side truncated, or a little concave above, and rounding into the base below; beaks pointed terminal, rather oblique, and rising moderately above the cardinal margin; umbonal slopes not angular, or very prominent; hinge line straight, short, and ranging at an angle of about 60° to the longer axis of the valves. Surface of both valves ornamented by about twenty simple, depressed, radiating costæ (narrower than the flat interspaces) and fine concentric striæ of growth.

Length, measuring obliquely from the points of the beaks to the most prominent part of the basal margin, about 1.63 inches; anterio-posterior diameter, about 1.10 inches; convexity of the two valves, 0.54 inch.

This form will be readily distinguished from the other known species by its small number, and more widely separated costæ, and rather compressed, narrow form. It also differs from *A. radiata,* in having its costæ separated by flat interspaces, instead of "regularly concave grooves, narrower than the radii."

Locality and position: Cincinnati group, 350 feet above low-water mark, at Cincinnati, Ohio. Mr. U. P. James's collection.

AMBONYCHIA (MEGAPTERA*) ALATA, Meek.

Plate 11, fig. 9; and 12, fig. 10.

Megaptera Casei,? James, 1871; Cat. Fossils Cincinnati Group, p. 13 (not of Meek and Worthen).

Ambonychia (Megaptera) alata, Meek, 1872; Proceed. Acad. Nat. Sci., Philad., p. 319.

Shell attaining a moderately large size, sub-trigonal in general outline, compressed posterio-dorsally, and more convex in the umbonal and

* In first proposing the name *Megaptera,* for these great winged species, in 1866, Mr. Worthen and the writer were not aware that this name had been previously used by Dr. Gray for a genus of Whiles. Naturalists do not agree in regard to the propriety of retaining the same name for different genera, or sub-genera, in such cases. Where the groups belong to the same class, nearly all agree that only the name first published can stand; but where they belong to different classes or sub-kingdoms, some would retain both names; while others would change the later name, even where the genera belongs to a different class, sub-kingdom, or kingdom of nature. In case it should be thought desirable to substitute another name for this group, as typified by *M. Casei,* and the species here described, I have proposed to call it *Opisthoptera.* (Proceed. Acad Nat. Sci., Philad., Feb'y, 1872, p. 319.) As yet very little is known in regard to the hinge of these shells, consequently we have not the means of determining whether they should be ranged as a sub-genus under *Ambonychia,* or as a distinct genus, though I at present incline to the former opinion.

anterio-central regions; umbonal slopes ranging at an angle of about fifty degrees below the hinge line, and broadly rounded; hinge line straight, very nearly or quite equaling the greatest anterio-posterior diameter of the valves, and ranging nearly at right angles to the anterior side of the same; posterior alation very large, not separated from the swell of the umbonal and central regions by any defined sulcus, slightly rounded at its immediate extremity above; posterior margin faintly sinuous a little below its intersection with the hinge margin above, thence sloping forward and downward, and finally rounding into the regularly rounded base; anterior side more or less concave and nearly vertical above, but rounding regularly into the base below; beaks terminal, rather pointed, rising little above the hinge line, and directed a little obliquely upward and forward, with more or less inward curvature.

Surface ornamented by about twenty-four to twenty-eight simple, strong, radiating costæ to each valve, that are nearly equal in breadth to the furrows between; those on the central portions of the valves passing nearly straight from the beaks obliquely to the posterior basal margins, those on the anterior side curving more or less forward below, and those near the cardinal margin curving a little upward behind, in some examples. Crossing all of these costæ, and the furrows between, are numerous fine, crowded lines, and at regular, distant intervals, a few strongly defined, imbricating marks of growth, that curve parallel to the basal and posterior margins.

Height, 2.30 inches; breadth, 2.20 inches; convexity, about 0.80 inch.

This species was referred with a mark of doubt, by Mr. James, to *Megaptera Casei* of Meek and Worthen, but, after a comparison of these shells, I can find no reason for doubting that they are really distinct specifically, the *M. Casei* being merely marked by very numerous alternating larger and smaller radiating striæ, while *M. alata* is ornamented with large, strong, radiating ribs. *M. Casei* also differs in having its umbonal slopes distinctly angular, instead of broadly and evenly rounded, as in the species under consideration; while its ventral margin is angular in outline at the termination of the umbonal ridge, instead of being rounded.

Its marks of growth also show that the extremity of its wing was rather acutely pointed, instead of being a little rounded, as in the one here described.

Locality and position: Clinton County, Ohio, in upper part of the Cincinnati group of the Lower Silurian. Mr. James's collection.

AMBONYCHIA (MEGAPTERA) CASEI, M. and W.?

Plate 11, fig. 8.

Ambonychia (Megaptera) Casei, Meek and Worthen, 1866; Proceed. Chicago Acad. Sci., Vol. I., p. 22; and Illinois Geological Report, Vol. III., p. 337, pl. 4, figs. 9 *a, b.*

The only specimen of this shell I have seen, agrees so nearly in form and general appearance with the type of the species *Casei,* that I scarcely feel warranted in regarding it as a distinct species. It presents some differences in the nature of its costæ, however, that may possibly be found to be of specific importance, if additional specimens should show them to be constant. In the typical specimens of *A. Casei,* the costæ are small, and rather closely arranged, or sometimes alternately a little larger and smaller; while in that here under consideration, they are of nearly the same size as those of the type, for about one-third to one-half their length, but separated by wider spaces than their own breadth, after which they bifurcate, or divide into three, with some other small ones intercalated between, so that the whole become much smaller near the free margins, though not exactly equal.

Should this character be found to be constant, and sufficiently distinct from the typical specimens found at Richmond, to render it desirable to designate the Cincinnati type by a different name, it might be called *A. fissicosta.*

Locality and position: Cincinnati group, Cincinnati, Ohio.

GENUS CYPRICARDITES, Conrad, 1841.

(Ann. Report Palæont. N. Y., p. 51.)

CYPRICARDITES STERLINGENSIS, M. and W.? (sp.).

Plate 11, figs. 12 *a, b.*

? Dolabra Sterlingensis, Meek and Worthen, July, 1866; Proceed. Acad. Nat. S., Philad., p. 260; Illinois Geological Report, Vol. III., p. 339, pl. 4, figs. 10 *a, b, c.*

Shell obliquely rhomboidal, or rhombic-subcordate, being cordate in outline as seen in an anterior or posterior view, and more or less rhomboidal as seen from either side. Posterior margin very obliquely truncated, with a long slope; posterior basal extremity produced and very narrowly rounded; basal margin ascending forward with a moderately convex curve, and rounding upward into the very short, more or less

rounded anterior margin. Hinge line short, ranging at an angle of about 45° to 50° from the umbonal axis. Umbonal ridges very prominent, or sub-angular, from the posterior side of the beaks obliquely backward and downward to the posterior basal extremity; area above and behind this ridge, flattened in each valve; and that below and in front of it, more or less convex. Surface unknown. Posterior muscular impression large, nearly circular, faintly marked, and placed near the middle of the posterior truncated margin. Anterior muscular scar smaller, more oval, and placed nearly against the anterior margin.

Length, measuring obliquely from the most prominent part of the front to the posterior basal extremity, 2.14 inches; height, at right angles to the hinge, 1.75 inches; convexity, 1.25 inches.

I am not sure that this is the form figured in the Illinois Report, from which it seems to differ somewhat in outline. As the typical specimen of that species, however, is a cast of the exterior, and that here illustrated is a cast of the interior, the differences of form may be due to that fact. In some respects, it resembles more nearly *Cyrtodonta Hindi* of Billings, to which species perfect specimens might possibly show it to belong; although in other characters it *seems* to be too distinct from that form to be the same species. That it belongs to the same genus, however, there can scarcely be any doubt.

In regard to which of the several generic names, *Cypricardites, Dolabra,* or *Cyrtodonta,* should be retained for such shells, it is not easy to decide, in the present state of our knowledge of their characters. The genus *Cypricardites,* as used by Mr. Conrad, was made to include a rather wide range of forms, now known to belong to several distinct genera, the hinges of which were unknown to him. From the sketch left by him with Prof. Hall, of the form from which his description of the hinge was evidently drawn up, it seems scarcely to admit of doubt, that it really belongs to the same genus called *Cyrtodonta,* by Mr. Billings, at a later date. Although Mr. Billings was entirely excusable for not perceiving the probable identity of his shells with Mr. Conrad's type (the figure of which had not at that time been published, while the genus had been entirely ignored in quarters where there should not have been the slightest doubt in regard to it), the inflexible rules of priority will, I think, compel us to adopt Mr. Conrad's name, *Cypricardites,* for such shells.

Cyrtodonta Hindi, and the form here under consideration, differ, however, in physiognomy, from both the typical forms of *Cypricardites* and *Cyrtodonta;* so that it is barely possible that they may belong to a differ-

ent group from that to which the names just mentioned were applied. If so, however, I should think that they would more probably fall into McCoy's genus *Dolabra,* some forms of which they nearly resemble. As originally proposed by Prof. McCoy, the genus *Dolabra* included two generic types, one of shells like that here under consideration, and that for which Prof. King afterwards proposed the name *Schizodus;* so that if the name *Dolabra* is to be retained at all (and I think the rules of nomenclature would certainly require that it should be retained), it would seem to apply to the group to which the shell here described, and *Cyrtodonta Hindi,* belong. But the probability is, that such forms have essentially the hinge characters of *Cypricardites,* in which case they will probably have to be ranged under that older name. At any rate, the specimen we have figured, of the form here under consideration, shows, at the point marked (*t*) in the figure, impressions of the anterior ends of one or two posterior lateral teeth, like those in *Dolabra angustata;* but also equally like those of *Cyrtodonta* or *Cypricardites.*

Locality and position: Richmond, Indiana, in the upper part of the Cincinnati group. Mr. L. B. Case's collection.

CYPRICARDITES? CARINATA, Meek.

Plate 12, figs. 6 *a, b.*

Dolabra? carinata, Meek, 1872; Proceed. Acad. Nat. Sci., Philad., p. 326.

Shell small, rhombic-cordate, very convex along the oblique umbonal slopes; posterior margin apparently obliquely truncated; posterior basal extremity more or less angular in outline; basal margin rounding and ascending obliquely forward from the posterior basal angle; anterior side extremely short, or with its margin descending and curving backward into the base, from immediately in front of the beaks; hinge line short, and a little inflected so as to form a kind of small area or escutcheon behind the beaks; beaks prominent, rather oblique, nearly terminal, strongly incurved or sub-spiral, and distinctly compressed anterio-posteriorly, so as to be sharply keeled on top, the keel being continued as a less angular umbonal ridge backward and downward to the posterior basal extremity; flanks in front of the umbonal ridge evenly convex; while the space above and behind it, near the beaks, is somewhat concave. Surface only showing obscure traces of lines of growth. Hinge and interior unknown.

Length, measuring obliquely from the posterior basal angle to the most prominent part of umbonal keels, 0.65 inch; anterio-posterior diameter,

measuring parallel to the hinge line (the specimen being defective behind), 0.40 inch; convexity of the united valves, 0.50 inch; length of hinge, about 0.30 inch.

The only specimen of this species I have seen, has lost, by erosion; some portions of the posterior margin, so as to leave doubts in regard to its exact outline; though it has the appearance of having been, when entire more or less truncated behind. The most remarkable features of the species are its prominent sub-spiral and very strongly carinated beaks, short hinge, and nearly obsolete anterior side. Its front margin seems to have been a little gaping, and the posterior side may have been more or less so, though the specimen is not in a condition to show whether or not this was the case.

In originally referring this little shell to *Dolabra,* I appended a mark of doubt after the generic name, and also distinctly stated that I really had very little idea that it belonged properly to that group, but suspected that it might be found to belong to an undescribed genus, when its hinge characters could be known, in which case I suggested that *Rhynchotropis* would be a good name for it.

Its hinge still remains unknown, and it is only here placed provisionally under the name *Cypricardites,* from its apparent relations to the last, which it is probable will be found not to differ essentially in its hinge characters from the typical forms of that genus.

Specifically, it will be readily distinguished from the foregoing form, not only by its much smaller size, but by its decidedly keeled umbonal slopes, more spiral beaks, and shorter anterior margin. It must be very rare, as I have only seen the single typical specimen among all the collections from this horizon.

Locality and position: Cincinnati group of the Lower Silurian, at Cincinnati, Ohio, where it was found at a horizon of about 175 feet below the tops of the hills. Mr. Dyer's collection.

GENUS MEGAMBONIA, Hall, 1859.

(12th Ann. Report Regents, p. 12.)

MEGAMBONIA JAMESI, Meek.

Plate 12, figs. 9 *a, b.*

Megambonia? Spinneri? James, 1871; Cat. Fossils Cincinnati Group, p. 12 (not *M. Spinneri,* Hall).

Megambonia Jamesi, Meek, 1872; Proceed. Acad. Nat. Sci., Philad., p. 321.

Shell attaining a rather large size, a little obliquely sub-ovate in general form, rather convex, the most gibbous part being somewhat

above, and in front of, the middle, more or less abruptly cuneate posteriorly and below; basal outline regularly rounded; posterior margin rounding into the base, and ascending with a convex curve, and forward inclination, to the posterior extremity of the hinge, which is not in the slightest degree alate behind; anterior margin rounding into the base below, and slightly sinuous under the lobe-like protuberance, or rudimentary wing, above; which latter is convex, slightly more prominent than the margin below, and defined from the swell of the umbonal regions on each side by an oblique sulcus, extending to the hinge margin in front of each beak; hinge equaling about two-thirds the anterio-posterior diameter of the valves; beak rather prominent, or rising distinctly above the hinge line, but slightly oblique, and distinctly incurved; umbonal slopes broadly rounded; longer axis of the valves a little oblique to the hinge line. Surface ornamented by very regular, rounded, simple and depressed, radiating costæ, a little wider than the furrows between, and numbering about five in a space of 0.30 inch near the middle of the lower margin.

Height about 2.50 inches; anterio-posterior diameter, 2.16 inches; convexity, 1.50 inches.

The only specimen of this species I have seen, is a cast of the exterior, with portions of the ventral and anterior ventral margins broken away. The beak of its right valve projects rather decidedly above that of the left, but I think this is due to accidental displacement of the valves, rather than to any inequality in their size. It shows distinct indications of a well-defined, moderately wide, cardinal area, widest under the beaks, and narrowing to the extremities of the hinge.

Mr. James referred this species, in his list of the Cincinnati fossils, with a mark of doubt, to the Lower Helderberg species, *M. Spinneri* of Hall. But in addition to the rather widely different geological horizons from which these two shells were obtained, they seem to me to differ so materially in form as to be clearly distinct species, even if similarly marked; while the typical specimen of *M. Spinneri* shows no traces of the regular radiating costæ seen on the species here described. It is true that the specimen of that species figured is an internal cast, and ours a cast of the exterior, which might account for the difference of surface characters, but this would not produce the degree of difference in form, obliquity, and general physiognomy. To me it appears to be much more nearly like the typical species *M. cardiiformis*, from the New York Upper Helderberg Limestone; though clearly distinct in having much larger costæ, as well as a wider and more defined cardinal area.

The group *Megambonia* of Hall, 1859, seems, so far as yet known, scarcely

more than sub-generically distinct from the typical forms of *Cypricardites,* Conrad. Mr. Billings thinks it also exactly agrees with the group for which he proposed the name *Vanuxemia,* in 1858, and placed by him as a sub-genus under his genus *Cyrtodonta,* 1858, a species of which, as already stated, seems to be the type of Conrad's *Cypricardites,* 1841. If the name *Vanuxemia* should be retained for the type under consideration, and that group placed as a sub-genus, then the name of our fossil, when written in full, would be *Cypricardites* (*Vanuxemia*) *Cincinnatiensis;* but if *Megambonia* is distinct from *Vanuxemia,* and a sub-genus under *Cypricardites,* then its full name would be *Cypricardites* (*Megambonia*) *Cincinnatiensis.*

Locality and position: Cincinnati group of the Lower Silurian, at Cincinnati, Ohio, about 350 feet above low-water mark of the Ohio river. Mr. U. P. James's collection.

GENUS CLIDOPHORUS, Hall, 1847.

(Palæont. N. Y., Vol. I., p. 300).

CLIDOPHORUS (NUCULITES?) FABULA, Hall, (sp.).

Plate 11, figs. 10 *a, b.*

Nucula fabula, Hall, 1845; Am. Jour. Sci. and Arts, Vol. XLIII., p. 295.

Shell minute, or very small, transversely sub-elliptic, moderately convex; extremities narrowly rounded, the anterior end being narrower than the posterior; basal margin forming a broad semi-elliptic curve; beaks rather depressed, slightly tumid, and placed a little in advance of the middle; dorsal margin sloping gently from the beaks, the anterior slope being rather less gradual than the other, and, in the cast, a little concave in front of the beaks. Anterior muscular impressions distinctly defined by the internal ridge, which leaves a rather deep furrow just in advance of each beak in casts of the interior.

Length, 0.06 inch; height, 0.03 inch; convexity, about 0.02 inch.

Although the proportions of this little shell do not conform to the literal meaning of the words used in Prof. Hall's description, as these terms are now most generally applied in describing bivalves, I have little doubt that his description was intended for this species. It is scarcely possible, however, to be positively sure of this, as he gave no figure, and but a brief description, with the measurement of only one of its diameters. If by the words “twice as wide as long,” he meant that the anterio-posterior diameter is twice the height of the shell, it would apply exactly to the

little shell under consideration; but if he meant the reverse, of course it would not. The terms height, length, and breadth, have been, at different times, and by different authors, variously applied, in describing such shells, and as it is very improbable that Prof. Hall's type is either twice as high, or twice as convex, as its anterio-posterior diameter, it is almost certain that he either inadvertently reversed the words “long” and “wide,” or that he viewed the anterio-posterior diameter as the breadth, and the height as the length, as is even yet done by some.

Locality and position: Near the middle of the Cincinnati group, at the tops of the hills at Cincinnati, Ohio. Specimens studied sent by Mr. Miller, of Cincinnati, to the Smithsonian Institution.

GENUS TELLINOMYA, Hall, 1847.

(Palæont. N. Y., Vol. I., p. 151).

TELLINOMYA? OBLIQUA, Hall (sp.).

Plate 11, figs. 11 *a, b,* c.

Nucula obliqua, Hall, 1845; Am. Jour. Sci. and Arts, Vol. XLIII., p. 292.

Shell very small, compressed, sub-circular, approaching sub-quadrangular; height and breadth about equal; anterior margin short and rounding into the rounded basal margin; posterior margin sub-truncated, or more or less rounded; beaks elevated, nearer the anterior margin; dorsal margin sloping from the beaks, the anterior slope being the more abrupt, and the margin behind the beaks straighter, more compressed and sharper; surface smooth; internal casts showing the muscular impressions to be comparatively rather distinct. Hinge unknown.

Length, 0.06 inch; height slightly less; convexity, 0.03 inch.

Prof. Hall's description of his *Nucula obliqua* is so very brief (about three lines) that it is impossible to be sure that the little shell here described is the same, especially as he gave no figure. As it is from the same locality and position, however, and agrees better with his description than any form I have seen from these rocks, it is probably his species. Should it prove to be distinct, however, it may take the name *T. microsperma,* which would probably not, in any event, be superfluous, since Portlock had named a little Silurian shell *Arca obliqua,* in 1843, that would apparently fall into the same genus with this, if the hinge of this shell (which I have not clearly seen) is crenulated.

Locality and position: Same as last. Specimens from Mr. Miller.

GENUS ANODONTOPSIS, McCoy, 1851.

(Brit. Pal. Foss., p. 270.)

ANODONTOPSIS? MILLERI, Meek.

Plate 12, figs. 1 *a*, *b*, c, *d*.

Anodontopsis? Milleri, Meek, 1871; Am. Jour. Sci. and Arts, Vol. II., p. 297 (issued Sept. 29th for Oct., 1871).

Shell ovate, rather compressed, or moderately convex, the greatest convexity being a little above and slightly in advance of the middle; extremities more or less narrowly rounded, basal margin longitudinally semi-elliptic in outline, the most prominent part being near the middle; cardinal margin sloping from the beaks at an angle of 130° to 135°, and rounding into the lateral margins, the anterior slope being more abrupt than the other; beaks depressed, and somewhat obtuse, not very convex, placed more than one-third the length of the valves from the anterior end. Surface smooth, or only with obscure lines of growth.

Length of a medium-sized adult specimen, 0.83 inch; height, 0.59 inch; convexity, 0.30 to 0.33 inch.

This shell has been referred by me with some doubt to *Anodontopsis* of McCoy, because it does not seem to correspond exactly in its hinge characters to his description of that genus, if I have correctly understood him. As the hinge of *Anodontopsis*, however, has not yet been illustrated, and it is generally difficult to form very exact conclusions in regard to the characters of the hinges of bivalves from a description only, the species is still retained here doubtfully in Prof. McCoy's genus. In first describing it, I proposed, in case that it should be found to be distinct, to designate the genus by the name *Orthodontiscus*, which may, in that case, be retained for it.

Prof. McCoy's description of the hinge of *Anodontopsis* reads as follows: “Hinge line shorter than the shell, with a posterior, long, slender tooth or cartilage plate extending just below it (double in the right valve), and another similar but shorter one in front of the beaks,” and then adds that there is “occasionally one small cardinal tooth beneath the beak.”

In the shell here described, the hinge may be characterized as having one rather well-defined, sub-trigonal, or somewhat obliquely extended, cardinal tooth under the beak of the right valve, and a corresponding pit under the beak of the left valve, with sometimes an appearance of a small rudimentary tooth just in advance of this pit. Of posterior lateral teeth, there is, in the right valve, a long one ranging parallel to the cardinal margin, with a parallel furrow above and below it for the reception of

two long posterior laterals in the left valve, the lower one of which is more prominent, and the upper merely linear or rudimentary. The furrow between these two posterior lateral teeth of the left valve is well defined, and receives the corresponding tooth of the other valve. Below the lower of these furrows, on the posterior side of the right valve, there is a very slight marginal ridge, that possibly may sometimes assume the character of a second posterior lateral tooth; but it is most prominent anteriorly, where it connects with the cardinal tooth, of which it seems rather to be an oblique posterior prolongation, than a distinct tooth.* On the anterior side, there is one shorter, anterior lateral tooth in the right valve, also ranging parallel to the hinge margin, and above and below this a little furrow for the reception of two small anterior laterals in the left valve, which receive between them that of the right valve.

The pallial line is certainly simple, and the muscular impressions well defined, the posterior one being larger than the other, and provided with a small accessory scar above, just under the posterior ends of the posterior lateral teeth. The ligament or cartilage was probably small and internal, as there are no traces of an external ligament to be seen, the valves fitting closely all along the hinge margin. No lunule or eschutcheon is to be seen in any of the specimens.

It is of course generally very difficult to determine, with certainty, the family affinities of such fossil shells, but I am inclined to regard this type as more probably belonging to the *Crassatellidæ*, than to the *Mytilidæ*, with which Prof. McCoy associates *Anodontopsis.*

The species here described was named in honor of S. A. Miller, Esq., of Cincinnati, who sent to the Smithsonian Institution the first specimens of it I have seen. I am also indebted to him for some broken valves showing the hinge. For the use of a specimen with the hinge of the left valve exposed, I am likewise under obligations to C. B. Dyer, Esq., of Cincinnati.

Locality and position: Forty miles west of Cincinnati, Ohio, from above the middle of the Cincinnati group of the Lower Silurian.

ANODONTOPSIS (MODIOLOPSIS?) UNIONOIDES, Meek.

Plate 12, figs. 2 *a*, *b.*

Anodontopsis? unionoides, 1871; Am. Jour. Sci. and Arts, Vol. II., p. 299 (issued Sept. 29th, for Oct., 1871).

Shell thin, sub-ovate, rather compressed, most convex slightly above and in advance of the middle; anterior margin regularly rounded; basal

* Unfortunately, figure 1 *d* does not give a very correct idea of some of the details of the hinge of the right valve.

margin forming a broad semi-elliptic curve, or nearly straight along the middle; posterior margin sloping from the posterior extremity of the hinge above, and rounded into the base below; hinge line straight apparently rather short; beaks depressed nearly to the hinge margin, small, and placed between one-fourth and one-fifth the length of the valves from the anterior end. Surface showing only a few distant sub--imbricating marks of growth.

Length, 1.75 inches; height, 1.14 inches; convexity, 0.63 inch.

Having no very satisfactory knowledge of the hinge of this shell, I am in considerable doubt regarding its generic characters. Mr. Miller sent me a right valve *apparently* belonging to it, that shows the interior and something of the hinge. It has been worn or macerated, however, so as nearly to obliterate the hinge characters. It, nevertheless, shows some appearance of a pit nearly under the beak for the reception of a cardinal tooth in the other valve; and just in front of the pit, the margin shows a slight prominence that may be the remains of a cardinal tooth. I cannot see any satisfactory evidence, however, that it had either anterior or posterior lateral teeth. Its anterior muscular impression is moderately distinct, without being very deep. Its outline is ovate, and it is placed quite near the anterior margin. The posterior muscular impression is not seen in the specimen, but was evidently very faintly defined.

This valve is a little shorter, and proportionally higher, than the typical form of the species under consideration, and may or may not belong to the same. As far as it gives any indications of the nature of the hinge, it would seem not to agree with that of *Anodontopsis* or *Modiolopsis,* but we yet want positive information on this point.

Locality and position: Cincinnati, Ohio, in the Cincinnati group of the Lower Silurian, at the horizon of 340 feet above the Ohio river.

In first publishing a notice of this species, owing to a misunderstanding, I erroneously gave 40 miles below Cincinnati as the locality at which it was found. Mr. Miller has since informed me that he found the typical specimens, as stated above, at Cincinnati.

GENUS SEDGWICKIA, McCoy, 1844.

(Synop. Carb. Fossils of Ireland, p. 61.)

SEDGWICKIA (? GRAMMYSIA) NEGLECTA, Meek.

Plate 12, fig. 8.

Sedgwickia (*Grammysia?*) *neglecta,* Meek, 1872; Proceed. Acad. Nat. Sci., Philad., p. 325.

Shell transversely ovate, about one-third longer than high, rather distinctly compressed, most convex, and most elevated, in the central and

umbonal regions, and compressed-cuneate behind; anterior margin rounding from the lower end of the lunule into the base, which forms a nearly semi-oval curve, its most prominent part being near the middle; cardinal margin apparently straight and declining posteriorly from the beaks; posterior margin rather narrowly rounded; beaks moderately prominent, and scarcely one-third the length of the valves from the anterior margin. Surface ornamented with regular, distinct, but not very prominent concentric costæ, that become suddenly obsolete on the posterior third of the valves. Lunule narrow, but sharply defined.

Length, about 1.04 inches; height, 0.67 inch; convexity, about 0.35 inch.

The only specimen of this species I have seen, is an external cast of the right valve, that has evidently been, to some extent, accidentally compressed in the region of the beak, but the shell was certainly never very convex. It has almost exactly the general aspect, and kind of ornamentation, seen in the typical forms of *Sedgwickia,* a group that has been, since it was first proposed by Prof. McCoy, included by him in his genus *Leptodomus,* which seems to me to have been originally founded on a very distinct type.

Our shell also resembles, rather closely, some forms apparently falling into the genus *Grammysia;* that is, some of the species that present the aspect of that genus, excepting that they want the characteristic oblique ridge of the typical species. Until other specimens can be examined, and more is known in regard to the hinges of *Grammysia* and *Sedgwickia,* as well as that of the shell under consideration, its generic relations cannot be satisfactorily determined.

Locality and position: Upper part of the Cincinnati group of the Lower Silurian, Clinton county, Ohio. Mr. James's collection.

SEDGWICKIA? FRAGILIS, Meek.

Plate 12, figs. 3 *a, b.*

Sedgwickia? fragilis, Meek, 1872; Proceed. Acad. Nat. Sci., Philad., p. 323.

Shell rather small, apparently very thin, longitudinally oblong, or sub-oval, rather distinctly convex along the umbonal slopes, from the beaks toward the posterior basal margin, and down near the anterior side; while just under the beaks, a rather strongly marked impression descends, widening and deepening as it approaches the base; basal margin sub-parallel in its general outline to the dorsal, but diverging more

or less posteriorly, where it is most prominent, while it is rather distinctly sinuous toward the front; posterior margin wider than the anterior, and more or less truncated; anterior extremity very short, and rounded or somewhat truncated; hinge line straight and shorter than the entire length of the valves, apparently very slightly inflected behind the beaks, which are raised a little above the cardinal margin, incurved, contiguous, flattened on the outer sides, and placed near the anterior end, with a slight, forward inclination. Surface ornamented with moderately distinct lines and irregular minute wrinkles of growth.

The only specimens of this species yet known to me, are too imperfect to afford exact measurements, though they seem to have been, when entire and undistorted, about 0.90 inch in length, 0.73 inch in height, and 0.40 inch in convexity. They present some appearance of having been gaping behind, and in the anterior ventral region. One specimen looks as if it had been truncated, with a backward obliquity, from below upward, behind, but this may be due to distortion.

I am far from being satisfied that this shell is congeneric with the forms for which Prof. McCoy proposed the name *Sedgwickia,* as nothing can be determined, from the specimens yet known, in regard to its hinge and muscular and pallial impressions. Possibly I would be nearer right to call it *Modiolopsis fragilis,* but there is something in its physiognomy that suggests affinities to Carboniferous types referred to *Sedgwickia* and *Allorisma.*

Locality and position: Cincinnati group of the Lower Silurian, at about 350 feet above low-water mark of the Ohio river, at Cincinnati, Ohio. Mr. U. P. James's collection.

SEDGWICKIA? COMPRESSA, Meek.

Plate 12, figs. 7 *a, b.*

Anatina sinuata, James, 1871; Catalogue Fossils, Cincinnati Group, p. 12 (not *Anatina? sinuata,* Hall).
Sedgwickia? compressa, Meek, 1872; Proceed. Acad. Nat. Sci., Philad., p. 324.

Shell longitudinally oval, compressed, about one-fourth longer than high, cuneate posteriorly, and more convex in the central and anterior regions, with a slight concavity descending from the beak to the base of each valve; posterior margin regularly rounded; base straight and parallel to the cardinal margin in the middle, and rounding up to the anterior and posterior margins; anterior side short, rounded, or somewhat

truncated, but apparently most prominent below; hinge line shorter than the valves, straight behind the beaks, but rounding into the posterior margin at the extremity, erect behind, with some appearance of a narrow space for an external ligament farther forward; beaks about one-fourth the length of the valves from the anterior margin, raised a little above the cardinal margin, nearly contiguous, but not much incurved. Surface of a cast that seems to be a little weathered or smoothed by attrition, showing obscure marks of growth.

Length, 0.77 inch; height, 0.59 inch; convexity, 0.29 inch.

I have only seen a single specimen of this species, and as it is a mere cast, not showing clearly even the surface markings, little can be said in regard to its affinities. I am even left in some doubt whether its shorter side may not be the posterior instead of the anterior, as there is some appearance about the points of the beaks of their being rather directed toward the longer than toward the shorter side. The appearance, however, of a narrow space along the cardinal margin on the longer side, as if for an external ligament, seems to indicate that this is the posterior. The margins of the valves on the anterior? (shorter) side are a little defective above in the specimen, so as to leave room for some doubts whether it was regularly rounded in outline or not.

Although the specimens of the last described species are much distorted, it is evident, I think, that they are quite distinct from this, as it would seem impossible to make this shell assume the shape and convexity of the last by any conceivable degree of distortion.

Mr. James referred this species, in his list, to the Upper Silurian fossil *Anatina? sinuata*, Hall, which it resembles in form. Still it seems to me to differ too much in its more elevated beaks, shorter anterior, and straighter basal outline, to be referred to that species, even if found in rocks of the same age; while the rather wide interval between the horizons at which the two forms occur, renders it still more improbable that they belong to the same species.

It is extremely difficult to arrive at correct conclusions in regard to the generic affinities of such shells from the study of mere casts, and it is therefore only provisionally that I have referred this and the last described species to the genus *Sedgwickia*. We may rest quite well assured, however, that palæozoic forms of the kind cannot be properly referred to the existing genus *Anatina*.

Locality and position: Same as last. Mr. James's collection.

GENUS CARDIOMORPHA, de Koninck, 1844.

(Anim. Foss. Carb., Belg., p. 101.)

CARDIOMORPHA?? OBLIQUATA, Meek.

Plate 12, figs. 4 *a, b.*

Cardiomorpha?? obliquata, Meek, 1872; Proceed. Acad. Nat. Sci., Philad., p. 327.

Shell small, rhombic-cordate; very convex, higher than long; posterior margin sloping rather abruptly, and sub-truncate, or a little convex in outline from the posterior extremity of the hinge to the posterior basal extremity, which is more or less angular or narrowly rounded; basal margin short, nearly straight or a little convex from the posterior basal extremity to the front; anterior margin short or truncated from immediately in front of the beaks obliquely downward and backward to the base, which it joins at an obtuse, slightly rounded angle; hinge line very short, ranging at an angle of about fifty degrees to the umbonal axis, and apparently having its margins a little inflected behind the beaks; beaks very prominent, oblique, nearly or quite terminal, and strongly incurved; posterior umbonal slopes sub-angular near the points of the beaks, but becoming rounded below, while the dorsal region between this and the hinge is a little concave; anterior umbonal slopes forming a kind of ridge, that extends, at something less than a right angle to the hinge, to the anterior basal margin, the anterior side thus circumscribed being somewhat flattened, and, as seen from the front, presenting a cordate outline. Surface ornamented with small, very regular, simple concentric costæ, that seem to be obsolete on the anterior and posterior portions of the valves. Hinge and interior unknown.

Length parallel to the cardinal margin, about 0.45 inch; height at right angles to hinge, to the tops of the beaks, about 0.45 inch; length, measuring from the points of the beaks obliquely to the posterior basal extremity, 0.57 inch; convexity, 0.39 inch.

I have referred this shell provisionally to *Cardiomorpha,* rather because it seems to present at least as many external points of resemblance to some species of that genus as to any known palæozoic group, than from any strong impression that it really is a true *Cardiomorpha.* In some respects, its general physiognomy suggests affinities to the group of secondary shells for which Prof. Agassiz proposed the name *Ceromya,* though I do not think it would fall into that genus. When all of its characters can be determined, it will probably be found to belong to an

undescribed genus. If so, I would propose for the group *Ceromyopsis*, from its resemblance to some species of *Ceromya*.

Although presenting some points of resemblance to the last described species, this shell may be distinguished at a glance, not only by its small, distinct concentric costæ, but by its much less sharply carinated beaks, and more rounded posterior umbonal slopes, as well as by its flattened anterior side, which flattening imparts a sub-angular character to its anterior umbonal slopes, not seen in the last.

Locality and position: Cincinnati group of the Lower Silurian, at Cincinnati, Ohio. Mr. Dyer's collection.

GASTEROPODA.

GENUS CYRTOLITES, Conrad, 1838.

(Ann. Rept. Palæont. N. Y., p. 118.)

CYRTOLITES (MICROCERAS*) INORNATUS, Hall (sp.).

Plate 13, figs. 4 *a, b.*

Microceras inornatus, Hall, 1845; Am. J. Sci. and Arts, Vol. XLVIII., p. 294.

Shell very small, sub-discoid; volutions apparently about two, increasing rapidly in size, slightly embracing, most convex near the umbilicus (into which the sides round abruptly), and sub-carinate around the periphery; umbilicus scarcely as wide as the dorso-ventral diameter of the outer volution at the aperture, and rather deep; aperture sub-cordate, approaching sub-triangular; surface smooth.

Greatest diameter, 0.07 inch; convexity, 0.04 inch.

There are two varieties, or possibly species, of these little shells, the only differences between which seem to be, that one is rather decidedly more compressed than that I have described above; and, as Prof. Hall gave no measurement of the convexity of his type (which has never been figured), I am left in some doubt which form it was that he named. As he described the aperture, however, of his species as being "somewhat quadrangular," which would be very inapplicable to that of the more compressed form, I infer that it was the convex one he named. Should it be thought desirable to designate the more compressed form by another name, it may be called *C. subcompressus.*

Prof. Hall thought these little shells probably septate, and proposed

* Not *Microceras*, Hyatt, 1868.

to found a new genus, *Microceras*, for them. As I have been unable to see any indications, however, of septa, either in broken specimens, or in a ground section of one, made parallel to the plane of its greater diameter, I cannot believe they are septate; and their form being exactly that of *Cyrtolites*, I know of no other reasons than their small size, smooth surface, and perhaps their less acutely angular dorsal margin, for separating them from that genus. Their small size, however, would be a still stronger objection to the conclusion that they are Cephalopods, even if we know them to be chambered shells, because we have no example of so small a form in that class; while some Gasteropods, and, I believe, Pteropods also, are known to secrete partitions across the shell behind the animal, as it increased in size, and, at intervals, withdraw itself from the smaller part of the shell. For these reasons, it seems to me that we are more apt to be right in referring these shells to *Cyrtolites*, than by viewing them as typical of a distinct genus, either of Gasteropods or Cephalopods.

Locality and position: Cincinnati group, top of hills, at Cincinnati, Ohio. Specimens received from Mr. James, Mr. Miller, and Mr. Dyer, of Cincinnati.

CYRTOLITES ORNATUS, Conrad.

Plate 13, figs. 3 *a, b.*

Cyrtolites ornatus, Conrad, 1838; Ann. Geol. Report, N. Y., p. 118; *ib.* (1839), p. 63, and *ib.* (1841), p. 37; Vanuxem (1842), Geol. Report, p. 65, fig. 2; Emmons (1842), p. 402, fig. 2; Hall (1847), Palæont. N. Y., Vol. I, p. 308, pl. LXXXIV., figs. 1 *a-g.*

Shell attaining a rather large size; volutions two to three, rapidly increasing in size, very strongly and sharply carinate around the dorsal margin, and the outer one with a sharp furrow on its ventral side for the reception of the dorsal keel of the inner turns; in internal casts, all the whorls appearing rather widely separated; sides of volutions prominent or sub-angular around somewhat within the middle; umbilicus wide and deep; aperture rhombic subquadrate. Surface ornamented by strong, distant sub-angular ridges, and deep, rounded, wider furrows between; both ridges and furrows extending obliquely outward and backward from the most prominent part of the sides of the volutions, to or toward the dorsal carina; covering the whole, there are also numerous very fine, regular, transverse striæ, and crossing between these, numerous little, short, alternately arranged, raised lines, thus forming a very delicate reticulate style of sculpturing, somewhat resembling the pitting of a thimble.

Greatest diameter of an adult specimen, 1.05 inches; convexity at the aperture (which is also the breadth of the same), 0.60 inch; dorso-ventral diameter of aperture, 0.56 inch.

Locality and position: In New York this species occurs at many localities, and ranges from the Trenton limestone into the equivalent of the Cincinnati group. It also occurs in Canada. The specimen here figured is from the latter group at Cincinnati, and belongs to Mr. Dyer's collection.

CYRTOLITES DYERI, Hall.

Plate 13, figs. 2 *a, b, c, d, e.*

Cyrtolites Dyeri, Hall; Advance sheets Regents' 24th State Cab. Report, dated Oct., 1871; and reissue of same (1872), pl. 4, figs. 7 and 8.

Shell discoid, with convexity about two-fifths the greatest breadth; periphery carinated; sides moderately convex, rounding more abruptly into the umbilicus than to the periphery; volutions apparently three or four, increasing rather gradually in size, slightly wider than their dorso--ventral diameter, and more or less embracing; umbilicus about equaling the dorso-ventral diameter of the last turn at the aperture, which is cordate in form. Surface ornamented by about ten small revolving ridges on each side, and numerous very closely crowded, regularly undulating, raised transverse lines, that make a short forward curve between each two of the revolving ridges.

Convexity, 0.29 inch; greatest diameter, 0.45 inch; breadth of umbilicus, about 0.15 inch; spaces between the revolving ridges at the aperture, 0.03 inch; number of transverse undulating lines in same space near aperture, three or four.

The beautifully ornate species seems to be most nearly related to *C. compressus* of Conrad, but may be readily distinguished by its regular, continuous revolving ridges, and densely crowded transverse undulating, raised lines; which latter are greatly more distantly separated in Mr. Conrad's species. It is also a smaller shell, with more embracing volutions.

One specimen in Mr. Dyer's collection from the Cincinnati rocks, only shows about five of the revolving ridges on each side, and these are very obscure. Its dorsal keel has a marginal line on each side, and shows the raised marks of growth crossing the very narrow space between these to be distinctly curved backward, like those usually seen on the band of *Pleurotomaria.* In some respects, this form resembles *C. compressus,* Con-

rad, but it differs materially in having the undulating lamellæ of growth *much* more crowded, and in the presence of obscure revolving lines. It seems to me to be only a variety of the above described species.

Locality and position: Cincinnati group, at Cincinnati, Ohio. Mr. Dyer's collection.

CYRTOLITES? COSTATUS, James.

Plate 13, figs. 1 *a, b,* c.

Cyrtolites costatus, James, 1872; Am. Jour. Sci. and Arts, Vol. III., 3d series, p. 26.

Shell thin, composed of two and a half to three rapidly enlarging, rounded volutions, the inner of which are contiguous, or possibly very slightly embracing, while the last half-turn becomes a little disconnected from the others; umbilicus rather large and deep; dorsum rounded, and without any traces of a keel; aperture unknown, but section of volutions nearly or quite circular. Surface ornamented by distinct, raised revolving lines or costæ, which increase in number by the intercalation of smaller ones between the others, as the shell increased in size, so as to present an alternately larger and smaller series, or at some stages of growth, showing three smaller between each two of the largest, in which case the middle one of the smaller three is usually a little larger than the other two; crossing the whole, thin, raised laminæ of growth generally occur at irregular distances, and between these, numerous minute, crowded transverse striæ may be seen, by the aid of a magnifier.

Greatest diameter, about 0.84 inch; convexity of the body volution, about 0.54 inch.

This seems to me not to be a true *Cyrtolites,* or at least to belong to a very distinct section of the genus from the typical species, on account of having no traces of the dorsal keel so strongly defined on the other species included in the group. It agrees, however, with *Cyrtolites,* and differs from *Bellerophon* and *Bucania* in its habit of growth, particularly in having its body volution partly disconnected from the others. It doubtless also differs from the latter two groups—more particularly the latter—in not having its lip expanded.

Its larger size, rounded dorsum, without a keel, and stronger revolving lines, will at once distinguish it from the last, from which it also differs in wanting the regular, waved, transverse marks of growth of that shell.

Locality and position: About the middle of the Cincinnati group of the Lower Silurian, in Warren county, Ohio. Mr. James's collection. I am also under obligations to Mr. Klippart, of Columbus, for the use of a specimen of this species.

GENUS CYCLONEMA, Hall, 1852.

(Palæont. N. Y., Vol. II., p. 89.)

CYCLONEMA BILIX, Conrad (sp.).

Plate 13, figs. 5 *a, c, d, g;* and 5 *e, f?*

Pleurotomaria bilix, Conrad, 1842; Jour. Acad. Nat. Sci., Vol. VIII., p. 271, pl. 16, fig. 10.
Pleurotomaria (?) *bilix,* Hall, 1847; Palæont. N. Y., Vol. I., p. 305, pl. LXXXIII., figs. 4 *a, b, c, d, e.*
Cyclonema bilix, Hall, 1852; 12th Report Regents (1859), p. 74.

Shell varying from rhombic sub-globose to conoid-sub-trochiform; spire conical, but very variable in its elevation, thus causing considerable variation in the relative length and breadth of the entire shell, which, however, is most generally somewhat longer than the breadth; volutions four to five, increasing rather rapidly in size, compressed-convex, the compression being very variable in degree, and usually parallel to the general slope of the sides of the spire; last, or body turn, more or less narrowly rounded, or sometimes almost sub-angular below the middle; suture varying from merely linear to rather deeply channeled; aperture broad ovoid to subquadrate; inner lip thickened, a little straightened and rather distinctly flattened, from near the middle downward; outer lip sharp and very oblique. Surface ornamented by revolving lines and furrows, that vary greatly in size, arrangement and distinctness, and are crossed by fine, very oblique, regular, thread-like lines, and sometimes irregular ridges of growth; both of which, however, are subject, occasionally, to become nearly or quite obsolete.

Height of a medium-sized specimen of typical form, 0.84 inch; breadth, 0.82 inch.

This is an exceedingly variable shell, so much so, indeed, that it is difficult, even after excluding some extreme forms that may be distinct species, to assign it definite characters. These variations consist not only of differences of general form, but also in the depth of the suture, the convexity of the volutions, and the outline of the aperture, as well as in the nature of the surface markings. The fine, regular, very oblique lines of growth, are most constant, but the revolving lines, ridges and furrows, are very variable in size and arrangement. All of these different varieties of form and surface markings, however, shade into each other by intermediate gradations, to such an extent that it seems hardly possible to separate them more than as varieties. Prof. Hall has sepa-

rated one of the extreme forms, under the name *C. varicosa.* (See Regents' 14th State Cab. Report, p. 91; and pl. 4, figs. 1 and 2, issued with a paper extracted from Regents' 24th Report.) This form has remarkably strong and irregular revolving ridges and furrows, as well as an unusual straightness of the columella. It is probably a distinct species; but I have seen such a series of gradations in these characters, as to lead me to suspect that it *may* be only an extreme variety.

Another form going to the opposite extreme, now before me, is so much depressed as to be decidedly wider than high, and has, along with the usual fine regular revolving lines, and minute oblique striæ of growth, strong oblique rounded ridges, interrupted by a broad shallow depression around the middle of the upper slope of the body volution. For this form (represented by our figures 5 *e, f,* of plate 13) I would propose the name *C. bilix var. lata.* It seems to me to be as strongly separated from the typical *C. bilix,* as that named *C. varicosa* by Prof. Hall (though in a different way), as may be seen by our figure 5 *a,* of plate 13, drawn from the typical variety.

Our figs. 5 *c, d,* of the same plate, represents another form coming very near *C. Hageri,* Billings. There are also among the collections now before me, others that have a decidedly more elevated spire, and a more narrow conical general form than any of those figured; and still others with the spire *much* depressed, and the body volution comparatively large, rounded and ventricose, with a deep suture. In short, it would require almost an entire plate to illustrate all the varieties of this protean group of varieties or species.

Locality and position: Mr. Conrad's typical specimens of this shell were from Richmond, Indiana, where they occur in the upper part of the Cincinnati group. Those here figured are all from Cincinnati, where they range through several hundred feet of the same group, at lower horizons. It also occurs near the top of the group, at Madison, Indiana. It is likewise found at numerous places in this group, in Kentucky, Wisconsin, Iowa, etc.

GENUS CYCLORA, Hall, 1845.

(Am. Jour. Sci. and Arts, Vol. XLVIII., p. 294.)

CYCLORA MINUTA, Hall.

Plate 13, figs. 7 *a, b,* c, *d, e.*

Cyclora minuta, Hall, 1845; Am. Jour. Sci. and Arts, Vol. XLVIII., p. 294.

Holopea (Cyclora) nana, Meek, 1871; Proceed. Acad. Nat. Sci., Philad., Aug., 1871, p.172.

Shell very small, sub-globose, wider than high; spire much depressed; volutions three, rounded, increasing rather rapidly in size, so that the

last one forms the larger bulk of the shell; suture deep, or almost channeled; surface smooth; umbilicus small; aperture circular; lip thin.

Height of largest specimen seen, 0.05 inch; breadth, 0.07 inch.

At the time I described this little shell under the specific name *nana,* I had no specimens known to be authentic examples of Prof. Hall's *Cyclora minuta* from Cincinnati at hand for comparison, though I was aware, and so stated in my remarks, that it must be closely related to his type, as appeared evident from his description. Being under the impression, however (owing to the almost illegible condition of the label), that the specimens studied by me had been found in the equivalent of either the Clinton or Niagara group, and knowing how improbable it must be for the same species of such a shell to occur both in the Cincinnati group and at either of these higher horizons, I confidently believed there must be some specific differences between the specimens I had under consideration and those found at Cincinnati.

After the publication of my paper, specimens of *Cyclora minuta* were sent on from the original locality at Cincinnati, along with others of different kinds, by several gentlemen; and a critical comparison of these with those I had described, and of both with the description of *Cyclora minuta,* soon led me to the conclusion that they are almost certainly the same species. On inquiry, I have also been informed that the specimens described by me, under the name *nana,* must have been found in the Cincinnati group, as none of the gentlemen connected with the Survey remember having collected any such specimens from any higher horizon. This being the case, I have placed my name, *nana,* as a synonym under *C. minuta,* though figures of the type specimens are also given on the same plate, by the side of others certainly known to have been found at the original locality from which *C. minuta* was first obtained.

In regard to the genus *Cyclora,* not much can be said. It seems to differ from *Holopea,* mainly in size; but the difference of size alone is so great as to favor the conclusion that these little shells belong to a distinct genus, probably belonging to the *Rissoidæ.*

Locality and position: Cincinnati group, Cincinnati, Ohio, where it is found associated with other very small shells of several genera, near the tops of the hills. I have also received specimens of apparently the same shell from several lower positions at and near Cincinnati; and Prof. Orton thinks it ranges through nearly the whole thickness of the Cincinnati group. Specimens were received from Mr. James, Mr. Miller, and other persons at Cincinnati.

CYCLORA? PARVULA, Hall, (sp.).

Turbo? parvulus, Hall, 1845; Am. Jour. Sci. and Arts, Vol. XLVIII., p. 294.

Shell very small, conoid-sub-ovate; spire conical; volutions three or four, increasing moderately in size, strongly convex, the upper ones being nearly round, and the lower obtusely angular around the middle; suture very deep in consequence of the convexity of the whorls; aperture nearly circular; umbilical perforation very small; surface smooth.

Length, 0.05 inch; breadth, scarcely 0.04 inch.

This little shell will be at once distinguished from the last by its more elevated spire, and obtusely sub-angular lower volutions. It may, and probably does, belong to a different genus from the last, but we may feel well assured that it does not belong to the genus *Turbo,* nor even to the same family.

Locality and position: Found associated with the last, near the tops of the hills, Cincinnati, Ohio, in the Cincinnati group of the Lower Silurian. I have also seen specimens of the same, or a very similar form, from not more than twenty feet above low-water mark of the Ohio, at Cincinnati, associated with a form very like the last. The specimens from this horizon, however, were imbedded in the matrix, so that a very critical comparison could not be made.

GENUS PLEUROTOMARIA, Defrance, 1826.

(Dict. Sci. Nat., p. 381, Vol. XLI.)

PLEUROTOMARIA (SCALITES?) TROPIDOPHORA, Meek.

Plate 13, figs. 6 *a, b,* c.

Pleurotomaria (?Scalites) tropidophora, Meek, 1872; Am. Jour. Sci. and Arts, Vol. IV. (3d series), p. 278.

Shell rather small, obliquely rhombic in general outline, as seen in a side view; height somewhat greater than the breadth; spire conical, with an apical angle of about 70° to 90° ; * volutions four to four and a half, each flattened, or sometimes slightly concave above, with an outward slope from the suture to a prominent angle that passes around the middle of the body turn, and below the middle of those of the spire, to

* The larger specimens have the spire proportionally more elevated.

which it imparts a somewhat turreted appearance; suture moderately distinct, but not channeled; lower side of body volution sloping rapidly inward from the mesial angle, a little below which there usually revolves an obscure, undefined ridge; aperture rhombic subquadrate. Surface nearly smooth, but sometimes showing, under a magnifier, very obscure lines of growth, that curve very strongly backward as they approach the angle around the middle of the body volution, both above and below; thus indicating the presence of a deep sinus in the lip, widening rapidly forward, though there is no defined revolving band at the angle.

Length or height, 0.55 inch; breadth, about 0.50 inch.

This shell seems to possess some of the characters of both *Pleurotomaria* and *Scalites*. In general appearance, it is most like some forms of the former; but it seems to be entirely without the revolving band seen on the species of that genus. Its lines of growth, however, have the very strong, oblique backward curve seen in those of *Scalites*, thus showing that its lip, when entire, must have had a deep notch at the termination of the angle of the body whorl. This notch, however, does not appear to terminate in a sharply cut slit, as is most generally the case in *Pleurotomaria*, but seems to have terminated at, and widened rapidly forward from, the angle of the volutions.

Specifically, this shell is related to *Pleurotomaria selecta* of Billings, from which it differs in having its striæ of growth nearly obsolete, and in wanting the revolving angle just below the suture, seen in that species.

Locality and position: Cincinnati group, at Cincinnati, Ohio. Mr. Miller's collection.

CEPHALOPODA.

GENUS ORTHOCERAS, Auct.

ORTHOCERAS ORTONI, Meek.

Plate 13, fig. 8.

Orthoceras Ortoni, Meek, 1872; Proceed. Acad. Nat. Sci., Philad., p. 330.

Shell rather rapidly expanding from the posterior toward the aperture; section oval or more or less nearly circular; septa rather closely arranged; siphuncle lateral, being at one of the narrow ends of the compressed section, but not quite marginal, of comparatively moderate

size, and apparently beaded; surface of cast showing traces of regular, obscure longitudinal ridges, that were probably not defined on the exterior of the shell, which is unknown.

I have seen but two specimens of this species, and they are accidentally compressed and incomplete at both extremities. The more nearly complete one of these specimens is about 2.30 inches in length, and septate throughout, as may be seen by the figure. At the larger end, it measures about 1.37 inches in breadth, and only 0.44 inch in its smaller diameter; while at the smaller end, its greater diameter is 0.38 inch, and its smaller 0.24 inch. It has manifestly, however, been accidentally compressed, more strongly at the larger end, which gives the appearance of more rapid expansion toward the aperture than the natural form. The septa near the larger end are separated by spaces measuring 0.15 inch, and at the smaller end measuring 0.07 inch. At the larger end, the very obscure longitudinal ridges measure each about 0.05 inch in breadth, with furrows of the same breadth between, and both diminish proportionally in size, and become nearly obsolete toward the smaller end.*

This species apparently belongs to the section of the genus consisting of rather rapidly expanding shells, with a nearly marginal siphuncle, sometimes showing faint longitudinal ridges on the internal cast, that are not defined on the external surface, such, for instance, as *O. compulsum, O. robustum, O. indocile,* etc., etc., of Barrande. It resembles several of Barrande's Bohemian species of this type, but after repeated comparisons, I have been unable to identify it with any of the numerous species described by him; and it seems to be equally distinct from all of those described in this country and Canada.

The only specimens of this shell I have seen, are so imperfect and flattened by accidental pressure, as to leave some doubts whether it may not have been, in its perfect condition, slightly curved. If so, it will have to take the name *Cyrtoceras Ortoni,* as it could not, in that case, be properly retained in the genus *Orthoceras.*

The specific name is given in honor of Prof. Edward Orton, of the Ohio Geological Survey.

Locality and position: Cincinnati group, at Cincinnati, Ohio. Mr. Dyer's collection.

* The figure of this species, given on pl. 13, is defective, in making the merely white edges of the septa, as seen in the cast of the interior, look like prominent transverse ridges.

GENUS TROCHOCERAS, Barrande, 1847.*

(Haid. Mith. Wien. Natf. Fr. III., p. 266.)

TROCHOCERAS? BAERI, M. and W.

Plate 13, fig. 9..

Trochoceras? Baeri, Meek and Worthen, 1865; Proceed. Acad. Nat. Sci., Philad., Dec., 1865, p. 263.

Shell sub-discoidal, consisting of about two or three rather rapidly enlarging volutions, which are more broadly rounded on the outer surface than on each side, and about one-fourth wider transversely than the dorso-ventral diameter; each inner volution slightly impressing the inner side of the succeeding turn. Umbilicus a little more than half the dorso-ventral diameter of the outer volution, and showing all the inner turns. Spire apparently scarcely (or perhaps not) rising above the upper surface of the last turn. Septa rather distinctly concave on the side facing the aperture; separated on the outer side of the whorls (at a point where the dorso-lateral diameter is about 1.25 inches) by spaces measuring 0.35 inch; all showing a very slight backward curve on the broadly rounded periphery, and passing nearly straight across each side. Surface, siphuncle, and non-septate part of the shell not certainly known.

Greatest breadth of the typical specimen (which is septate) to the broken outer extremity, 5 inches; height, or thickness of same, about 2.50 inches. Dorso-ventral diameter of the volutions increasing about three-fold each turn.

The specimen from which this description was drawn up, is defective on one side, so that it is not easy to determine whether or not its whorls are coiled exactly in the same plane, though they have the appearance of being somewhat oblique, and hence it was placed provisionally in the genus *Trochoceras.* Should it be found, however, when better specimens can be examined, that its whorls are coiled all in the same place, it would belong either to the genus *Lituites,* or to some section of the genus *Nautilus,* as the latter group is understood in its less restricted sense, and of course have to take the name *Lituites Baeri* or *Nautilus Baeri.*†

* Prof. Hall proposed this name for this same genus, during the same year, but I do I not know which issued the description first.

† As the outer volution shows some tendency to become free at the point where it is broken, this would favor the conclusion that it may be a Lituite.

The typical specimen does not show the position of the siphuncle, but fragments from the same locality and position, apparently belonging to this shell, have the siphuncle located rather more than its own breadth outside of the center; and it pierces the septa from without inward, or backward, as in *Nautilus*.

At a first glance, this shell reminds one of *Lituites undatus*, as represented in the Palæontology of New York. Vol. I., pl. 13, fig. 3, but on a closer examination, it will be at once seen to differ materially in the more rapid increase in the breadth of its whorls, and in the proportionally smaller size, and greater depth of its umbilicus, as well as in being apparently not coiled on a plane.

The specific name was given in honor of Dr. O. P. Baer, of Richmond, Indiana, to whom I am under obligations for the use of the typical specimen.

Locality and position: Upper beds of the Cincinnati group, at Richmond, Indiana, and in Warren and Clinton counties, Ohio.

ARTICULATA.

CRUSTACEA.

ENTOMOSTRACA.

GENUS CYTHERE, Muller, 1785.

CYTHERE CINCINNATIENSIS, Meek.

Plate 14, figs. 1 *a, b,* c, *d.*

Cythere Cincinnatiensis, Meek, 1872; Proceed. Acad. Nat. Sci., p. 331.

Carapace-valves varying from transversely sub-oval to sub-circular; moderately and rather evenly convex, the greatest convexity being in the central and anterior regions; without any visible eye-tubercle or node; ventral margins rounded or semi-oval, and but slightly unequal or thickened; anterior and posterior margins more or less rounded, the former being more broadly rounded generally than the latter; hinge margin very short, very slightly sinuous just behind the umbones, and rounding into the posterior margin so as scarcely to produce any visible angularity; umbones, near the anterior, a little tumid, rising very slightly above the hinge, and rounding off regularly into the anterior margin. Surface nearly smooth.

Length of one of the larger, nearly circular specimens, 0.21 inch; height, 0.17 inch; convexity, 0.11 inch. Length of a smaller, more oval specimen, 0.14 inch; height, 0.08 inch; convexity, 0.07 inch.

This species seems to vary a good deal in form, some specimens being, as the above measurements indicate, proportionally higher, and thus presenting a more rounded outline. It is possible that these forms may belong to two distinct species, but with the specimens yet accessible for study, I have not felt warranted in separating them.

Locality and position: Cincinnati group, at Cincinnati, Ohio. Mr. Dyer's collection.

GENUS ASAPHUS, Brougniart, 1822.

(Crust. Foss., p. 17.)

ASAPHUS (ISOTELUS) MEGISTOS, Locke?

Plate 14, fig. 13.

Isotelus megistos, Locke, 1842; Am. Jour. Sci. and Arts, Vol. XLII., p. 366; and (1843) in Reports of 1st, 2d and 3d meetings of Association Am. Geologists and Naturalists, p. 221, pl. VI.

Entire outline subelliptic, the breadth being nearly two-thirds the length, in a specimen apparently a little contracted by the drawing together of the thoracic segments, rather depressed convex; extremities elliptically and subequally rounded.

Cephalic shield forming about one-third the entire length, exclusive of the posterior lateral spines, nearly semi-circular, the anterior margin being rounded, and the posterior broadly and moderately sinuous, with the posterior lateral angles produced backward in the form of mucronate spines, that nearly or quite equal the length of the thorax. Lateral borders each provided with more or less defined marginal furrows, that extend from the anterior ends of the lateral spines forward, becoming very narrow or obsolete around the anterior end of the glabella. Glabella not rising above the general convexity of the cephalic shield, and but very faintly defined; anterior lobe or division transversely subelliptic, being nearly twice as wide as its anterio-posterior diameter back to the eyes, at which point the narrowest part, or neck of the glabella, is only about two-thirds as wide as its anterior lobe. Facial sutures extending forward and outward in advance of the eyes, then curving and converging to the middle of the front margin; posteriorly, extending at first obliquely outward and backward, and then curving backward so as to intersect the posterior margin at points less than half way out from the anterior ends of the furrows between the thoracic lobes. Neck furrow entirely obsolete. Eyes lunate, or forming about a semi-circle, of moderate size, and situated a little less than their direct length in advance of the posterior margin of the shield.

Thorax slightly less than the length of the cephalic shield, at its middle, composed of eight narrow segments. Lobes moderately well defined; mesial one depressed-convex, about one-fifth of its breadth wider than the lateral ones, and having its segments flattened; lateral lobes also depressed or flattened within, and rounding or sloping gently from near the middle to the lateral margins; pleuræ curving a little backward near the middle, furrowed for about half way out, rather obtuse at the ends, and each distinctly leveled along its anterior outer-half, so as readily to slip under the next one in advance of it, in rolling up.

Pygidium a little longer and slightly narrower than the cephalic shield, as well as rather more narrowly rounded at its middle, behind, with a more or less flattened margin; lobes and segments undefined, or only very obscurely visible.

Entire surface apparently smooth.

Length, 1.16 inches (may have been a little more when the thoracic segments were a little relaxed); length of pygidium, 0.38 inch; length of thorax, 0.40 inch; length of cephalic shield at its middle, 0.40 inch; length of its spines, each 0.33 inch.

If this form belongs to Dr. Locke's species, it must, of course, be a young individual, which might possibly account for its shorter, more nearly oval form. There are some other differences, however, that I am at a loss to account for, apparently distinguishing it from Dr. Locke's form, as restored by him, as well as from some of the characters given in his description; such, for instance, as the much greater proportional length of the posterior lateral spines of its head, which are very nearly as long as its thorax, instead of being only a little longer than the anterior two segments of the same. It also differs in having distinct marginal furrows along the cheeks, and a kind of flattened margin around the pygidium, as well as in having its pleuræ distinctly furrowed. There are also differences in the form of the glabella, particularly its anterior part, in front of the eyes.

As Dr. Locke's figure and description, however, were prepared from fragments only, and the species of this genus are known to be very variable, I prefer to refer this specimen provisionally to his species, rather than to undertake to separate it without other examples for study and comparison.

Locality and position: Cincinnati group, Cincinnati, Ohio.

GENUS PROETUS, Steininger, 1831.

(Mem. Soc. Geol. France, Vol. I., p. 355.)

PROETUS SPURLOCKI, Meek.

Plate 14, fig. 12.

Proetus Spurlocki, Meek, 1872; Am. Jour. Sci., Vol. III., 3d series, p. 426.

General form, exclusive of the spines of the cephalic shield, ovate subelliptic, with moderate convexity. Cephalic shield having the form of one of the halves of an ellipse divided through its shorter diameter, its posterior margin being straight, and its anterior narrowly rounded; posterior lateral angles produced into long, sharp spines, that extend back nearly or quite the entire length of the thorax; glabella nearly one-third the breadth of the posterior part of the head, separated from the cheeks on each side by a well-defined furrow, but without having the neck furrow distinctly marked; other details of glabella unknown. Eyes sublunate, nearly their own length in advance of the posterior margins of the cheeks.

Thorax apparently shorter than the head, showing (in the specimen examined) only seven segments (one or two being probably covered by the slipping backward of the cephalic shield). Mesial lobe moderately prominent, scarcely equaling the breadth of the lateral lobes anteriorly, and tapering more rapidly backward, with its segments not arching forward. Lateral lobes less convex than the middle one; pleuræ nearly straight and transverse, or very slightly curved backward, and furrowed for a little more than half way out with their extremities rounded in front, and nearly rectangular behind.

Pygidium sub-semicircular, about one-half as long as the cephalic shield, and provided with a smooth, flattened margin. Mesial lobe moderately prominent, narrower than the lateral, tapering posteriorly, where it terminates rather abruptly, without passing quite upon the flattened margin, showing only very obscure traces of five or six segments on its anterior half. Lateral lobes more depressed than the mesial one, and with their flattened margin rather more than one-third the breadth of the anterior end of each, and each showing obscure traces of six or seven furrowed segments.

Entire surface smooth.

Length of a specimen apparently slightly shortened by the slipping of the cephalic shield a little back upon the thorax, 0.33 inch; breadth at the widest point across the posterior part of the head, 0.25 inch; length of head, 0.27 inch; length of pygidium, 0.11 inch.

Until I saw the published figure of *Proetus parviusculus,* Hall, I had thought it possible that this might be the same, although it seemed not to agree in several characters with the description of that species previously published. On comparing it with the figure of that form, however, it will at once be seen to present well-marked differences. In the first place, its cephalic shield is decidedly longer in proportion to its breadth, and more narrowly rounded in front; while the posterior lateral spines of its cheeks are nearly or quite twice the proportional length of those in *P. parviusculus.* Its eyes are also placed decidedly farther forward, and its neck segment much less distinctly defined. When we come to its thorax, we also see equally well-marked differences, its pleuræ not being curved backward and falcate as in that species, nor having their furrows extending so far outward. It also almost certainly has one or two segments less, though the slight slipping backward of the cephalic shield leaves room for some little doubt on this point. I have, however, another, but inferior specimen before me, from the collection of Dr. H. H. Hill, of Cincinnati, believed to belong to this species, and this certainly has only eight thoracic segments. Again, the pygidium of our species differs in having a distinctly flattened smooth border, and very obscurely furrowed segments on the lateral lobes, that do not extend outward upon this border; while on that of *P. parviusculus,* the segments are strongly defined, without furrows, and extend very nearly or quite to the border, so as scarcely to leave any flattened margin.

The specific name of this trilobite was given in honor of T. W. Spurlock, Esq., of Cincinnati, who discovered some of the new fossils loaned to the Survey, and is well known in that city for his long devotion to the study of the natural sciences.

Locality and position: Cincinnati group of the Lower Silurian, at the horizon of about 100 feet below the tops of the hills at that city. Mr. Dyer's collection.

GENUS CERAURUS, Green, 1833.

(Monogr. Trilobites, p. 83.)

CERAURUS ICARUS, Billings.

Plate 14, figs. 11 *a, b,* c.

Cheirurus icarus, Billings, 1859; Canadian Naturalist and Geologist, Vol. V., p. 67; also Geol. Canada, Report of Progress (1863), page 219, fig. 231.

General outline ovate-sub-elliptic, moderately convex. Cephalic shield nearly semicircular, rather more than twice as wide as long, regularly rounded anteriorly, and nearly straight behind, excepting near the lat-

eral angles, where it curves somewhat abruptly backward, on each side, into the lateral spines, which are small, and scarcely extend farther back than to the second thoracic segment. Glabella, exclusive of the neck segment, about as wide as long, with its lateral margins so nearly straight and parallel, as to make its breadth almost as great anteriorly as behind; separated from the cheeks by narrow but well-defined furrows, that unite around the front so as to leave a very narrow border between its anterior margin and that of the cephalic shield; lateral furrows well defined, and extending inward on each side about one-third the entire breadth; posterior lateral lobes a little smaller than the next two on each side in front of them, and sometimes nearly isolated by the furrows immediately before them, being so oblique as nearly or quite to run into the neck furrow before reaching the middle; succeeding two lateral lobes on each side, nearly transverse; anterior lobe larger, about twice as wide as long, rounded on each side, and somewhat straightened across the front. Neck segment well defined, arched upward so as to be as high in the middle as any part of the glabella in front of it, and wider in the middle than at either end; neck furrow rather distinctly arched forward in the middle. Cheeks sloping anteriorly and laterally from the eyes, with the continuation of the neck furrow along their posterior margins strongly defined, straight, transverse, and terminating laterally some distance within the margins, where they meet, nearly at right angles, a furrow that passes forward on each side to the anterior end of the glabella; outside of the latter, a more shallow furrow also passes around the lateral borders. Eyes of moderate size, scarcely as prominent as the middle of the glabella, situated their own length in advance of the posterior margins of the cheeks, and nearly the same distance from the front of the same; visual surface a little arched, and showing under a good lens, when moistened, very minute reticulations, that seem to be mainly seen *through* the thin crust. Facial sutures starting at the middle of the anterior margin of the head, and cutting rather close around the anterior lateral corners of the glabella; thence extending backward, with a slight outward obliquity, to the eyes, where they make slight curves (to form small, moderately prominent, palpebral lobes) to the posterior end of each eye; from which points they extend outward, at first, with a slight forward obliquity, after which they are deflected backward and outward, so as to cut the lateral margins a little in advance of the points where the continuations of the neck furrow along the posterior margins of the cheeks, would intersect the same, if continued outward.

Thorax about twice as long as the cephalic shield, nearly as wide anteriorly as long, and distinctly trilobate; axial lobe scarcely equaling

the breadth of the lateral lobes anteriorly, and proportionally a little narrower behind, but rather distinctly more prominent and rounded; segments eleven, nearly transverse, and regularly arched upward. Lateral lobes a little flattened on top, nearly half way outward, at which point they slope off rather abruptly laterally; pleuræ straight and transverse for nearly half their length, where they are geniculated, obscurely subnodose, and curve downward and a little backward, to their falcate extremities, which lap upon each other in rolled-up specimens, about half their breadth, each a little thickened, and divided at its inner end, by a short oblique furrow, into two little subnodose prominences.

Pygidium small, transversely sub-elliptic, being twice as wide as long, and broadly rounded in outline behind; axial lobe small, and composed of three obscurely defined segments; lateral lobes large, and composed each of three segments, which terminate at the margin in moderately prominent, somewhat thickened, digitations, the anterior of which are largest, somewhat carinate on top, and strongly curved backward, while the others decrease in size inward to the central two, which are smallest.

Surface finely and obscurely granulated, excepting that of the cheeks, which is sometimes marked with very small pits.

Length of the largest known specimen, 2.15 inches; length of head, 0.62 inch; breadth of do., 1.22 inches; length of thorax, 1.15 inches; breadth of do., 0.60 inch; length of pygidium, 0.37 inch; breadth of do., 0.65 inch.

This species may be so readily distinguished from the common *C. pleurexanthemus* of the same formation, by nearly all of its specific characters, that it is not necessary to compare it with that form. It is much more nearly allied to several European species, but still too distinct to require comparison.

Suspecting that our specimens might belong to Mr. Billings's species, I sent a photograph of one of them to him for comparison, and he wrote back that he had no doubt of its identity with his *C. icarus;* though he noticed that the posterior outline of its pygidium is not so straight across as in his specimens. Subsequently I had an opportunity, through the politeness of Mr. Billings, to make a direct comparison of our specimens with his types, and I fully concur with him in the opinion that there are no specific differences between the Ohio and Canadian specimens. It is worthy of note, however, here, that Mr. Billings's published figure was made out from a small rolled-up specimen, that did not show clearly the lateral extremities of the pleuræ, nor the posterior terminations of the facial sutures. Consequently, his figure represents the ends of the

pleuræ too narrow and straight, instead of falcate; to which fact Mr. B. called my attention. Our specimens also show that the facial sutures curve backward after passing about half way out from the eyes, so as to reach lateral margins farther back than represented in his figure.

Locality and position: Upper part of Cincinnati group, in Butler county, Ohio, and at same horizon at Richmond, Indiana. The rolled-up specimen represented by figure 11 *b*, of pl. 14, belongs to the collection of Mr. U. P. James, of Cincinnati; and the larger one, represented by fig. 11 *a*, of same plate, belongs to the collection of Mrs. M. P. Haines, of Richmond, Indiana, who discovered it at that place. I have also seen either the same, or a very closely allied species, from the Lower Silurian beds at Dixon, Illinois.

GENUS ACIDASPIS, Murchison, 1839.

(Silurian System, p. 658.)

ACIDASPIS CROSOTUS, Locke?

Plate 14, figs. 10 *a, b.*

Ceraurus crosotus, Locke, 1842; Am. Jour. Sci. and Arts, Vol. XLIV., page 347, with a wood cut.

Acidaspis crosotus, James, 1871; Catalogue Fossils Cincinnati Group, p. 14.

Body small, with a general subovate or sub-elliptic outline, rather distinctly convex. Cephalic shield sub-semicircular, and rather more convex than the body, apparently rounded in front, with the lateral angles produced into slender, mucronate, somewhat curved spines, that extend obliquely outward and backward to points opposite the fifth or sixth thoracic segment. Glabella, including the neck segment, one-third longer than wide, with an oblong sub-elliptic outline, the widest part being slightly behind the middle and between the eyes; lateral lobes two on each side, of slightly oval outlines, with their longer diameters directed a little obliquely outward and forward, the posterior one being slightly larger than the anterior, while both are separated by as well-defined furrows from the central, rather narrow part of the glabella, as they are separated from each other, or from the cheeks on each side; anterior lobe about as large as all four of the lateral lobes, twice as wide as the narrowed central part of the glabella behind it, and apparently rounded in front; between the lateral lobes and each eye, a kind of outer or supplementary lobe, or protuberance, as large as each two of the lateral lobes, occurs; while from the outer side of each of these protrudes the small prominent palpebral lobe, which arrangement places the small eyes quite remote from each other; eyes unknown, but apparently small,

prominent, and directed laterally; movable cheeks not well preserved in the specimen studied, but apparently narrow, and sloping abruptly from the eyes laterally; neck segment comparatively large, prominent, with a central tubercle, and well defined by the neck furrow, which arches forward in the middle.

Thorax nearly twice as long as the cephalic shield, and about one-fourth wider than long, exclusive of the produced extremities of the pleuræ, with its segments strongly arched upward, but not forward. Lateral lobes comparatively rather depressed, and rounding off gradually toward the lateral margins; pleuræ terminating in mucronate spines directed outward and more or less backward, the posterior ones being longer, and directed more nearly backward.

Pygidium small, and with its mesial lobe composed of about three segments; lateral lobes consisting apparently of about three or four segments, each of which terminates in an acute spine, the lateral ones of which are larger than the others, and curved backward.

Entire surface comparatively rather coarsely granular, the granules being larger on the head than elsewhere; while on each of the pleuræ, a larger granule or very minute tubercle occurs, at a point about half way out to the knee, or geniculation, at which latter point there is also some appearance of another, thus making two rows of these coarse granules along each lateral lobe.

Entire length, exclusive of the spines of the pygidium, about 0.25 inch; length of head, 0.08 inch; breadth, exclusive of lateral spines, 0.15 inch; breadth between eyes, 0.10 inch; length of thorax, about 0.11 inch; breadth of same anteriorly, exclusive of the extended ends of the pleuræ, 0.14 inch.

I am far from being entirely satisfied that this little trilobite is the same species figured by Prof. Locke, under the foregoing name. If his figure is entirely accurate in all its details, the form under consideration would certainly be distinct; but knowing how difficult it is for one not trained to drawing such objects with the degree of precision required by the present more advanced state of natural history, especially such small ones, and the equally great difficulty in getting such drawing accurately cut in wood, I am prepared to believe that he may have had the same species before him. Our specimen is not in a condition to show the digitations along the margins of the cheeks, if they exist. The lateral spines of its cheeks are longer, more slender, and more curved than represented in Dr. Locke's figure, while its neck segment is much thicker in the middle, and the form of the lobes of its glabella entirely

different. The extremities of its posterior pleuræ, and some of the segments of its pygidium, are also much more produced backward. His figure being, as he states, only magnified three diameters, would show that his specimen must have been full twice the linear dimensions of ours. Unfortunately, his whole collection was boxed up, and could not be seen, when I was in Cincinnati during the summer of 1871, so that I have had no opportunity to compare the form here figured with his type, which he did not describe in detail.

I have before me another specimen of a still smaller size, belonging to Mr. James's collection, and from a higher position in the series, that seems to be the same as the foregoing, though it may possibly be distinct, as the number and arrangement of the spines of its pygidium are different. It is represented by our figure 10 *b*, of plate 14. It shows the inner side of the dorsal crust, as seen lying in a dark shaly matrix. This shows minute digitations around the margins of the cheeks (13 or 14 to each side), and has the same slender arched spine at the posterior angle of each cheek. The free ends of its pleuræ are very slender and much produced. This specimen is not in a condition to show the eyes, or the details of its glabella.

Locality and position: Cincinnati group, Cincinnati, Ohio. The specimen represented by figure 10 of plate 14, belongs to Dr. C. A. Miller, of Cincinnati, who found it in one of the lowest beds exposed there. The other, represented by figure 10 *b*, of the same plate, belongs to Mr. U. P. James, of Cincinnati, and was found by him there at a horizon of about 150 feet above low-water mark of the Ohio river.

ACIDASPIS CINCINNATIENSIS, Meek.

Plate 14, fig. 3.

Cephalic shield, and most of the thorax, unknown. Pygidium, exclusive of its spines, about three times as wide as long, and approaching a sub-semicircular outline; its anterior margin being straight all the way across, and about one-third of its posterior margin in the middle transversely truncated, while on each side of this the posterior lateral margins are straight to the anterior lateral angles; mesial lobe prominent at the anterior end, where it is about as wide as each lateral lobe, but becoming rapidly depressed and narrowed posteriorly, composed of only two well defined segments; lateral lobes flat, excepting a ridge that extends obliquely backward and outward from the anterior segment of the mesial lobe, across each, to the posterior lateral margins, where these ridges terminate in prominent, rounded, diverging spines; while the posterior lateral margins between these spines and the lateral angles,

are each armed with four smaller slender spines directed obliquely backward and outward; four similar smaller spines also occupy the truncated middle part of the posterior margin between the two larger ones. Surface smooth, excepting a few very minute scattering asperities on the spines.

Of the thoracic segments, the posterior one, and a part of the next one in advance of it, are seen in connection with the pygidium in the matrix. These show that the posterior extremity of the mesial lobe of the thorax is about as wide as the lateral lobes, moderately arched upward (not forward), and nearly or quite smooth, while the lateral lobes are flat. The pleuræ of the posterior thoracic segment are smooth, and have each a strong mesial ridge extending straight outward to the lateral extremity, where it curves abruptly backward, and is produced into a long, sharp spine, extending as far backward as the longest spines of the pygidium, or farther. The anterior margin of each of these pleuræ has also the character of a more slender, depressed marginal ridge, that likewise terminates in a backward curve, but much smaller lateral spine, just in front of the larger one, while there is behind the larger mesial ridge a narrower, flat margin, that runs out to nothing before reaching the outer extremity.

Length of pygidium, exclusive of spines, 0.19 inch; breadth of do., 0.55 inch. Transverse diameter of first thoracic segment in advance of pygidium, 0.70 inch; length of each pleuræ, 0.23 inch; anterio-posterior diameter of the same, 0.08 inch; length of larger lateral spine of each, 0.38 inch.

That this species is distinct from the form I have referred to Dr. Locke's *A. crosotus*, seems to be evident, not only from its much larger size, but because it shows no traces of the rather distinct, closely set granulations seen on all parts of that species, and differs in other details. In many respects, it appears to be closely related to *A. Prevosti* of Barrande, so far as we have the means of comparison; but still it wants the distinct surface granulations of that form, and hence would doubtless be found to present other differences, if we had the entire fossil to compare.

I have also before me, a right, movable cheek of an *Acidaspis* from Cincinnati, that may, judging from its size and general appearance, belong to this species. Its posterior extremity is produced in the form of a long, stout, rounded spine, covered with little asperities, while the margin of this cheek is armed by about twelve short digitations. The inner or under side of this specimen is represented by our figure 4, of plate 14. Fig. 5 of the same plate, represents the inner side of another similar

cheek, with a more slender terminal spine, longer digitations, and a greater breadth between the eye and the digitate margin, from a higher position in this series, at Dayton, Ohio.

Mr. James's collection also contains two specimens of the glabella of one or two species of *Acidaspis,* with a long spine projecting backward from the occipital portion. These are represented by our figures 6 and 7 of the same plate. They differ enough in details to belong to two distinct species, and yet may belong to varieties of the same form. Of course, without other specimens showing these parts in connection, it is not possible to determine what relations they may bear to the pygidium for which I have proposed the name *A. Cincinnatiensis.* I suspect, however, that one or the other, or both, belong to that species, and yet they may be quite distinct from it. It was evidently to one of these forms that Dr. Locke referred, in Vol. XLV., p. 223, of the Am. Jour. Sci. and Arts, published in 1843, as possibly belonging to his *A. crosotus.* They are certainly distinct from that form, however, not only in their much larger size, and the possession of the long appendage to the back part of the head, but in the form and comparative sizes of the lateral lobes of the glabella. They seem to be related to *A. Grayi* of Barrande, though differing in details.

If these specimens should be found to belong to a distinct species from any of those yet named, I would propose for it the name *Acidaspis rhyncocephalus,* in allusion to the beak-like appendage of the back of the head.

Locality and position: The pygidium for which I have proposed the name *A. Cincinnatiensis,* belongs to Mr. Dyer, who found it at Cincinnati, at the horizon of about 100 feet below the tops of the hills. The cheek represented by figure 4, of the same plate, was also found at Cincinnati by Mr. James; and that represented by fig. 5 belongs to Mr. O'Neall, of Lebanon, Ohio, and was, I believe, found by him near that place, in the upper part of the Cincinnati group. The two specimens of glabella, illustrated by figures 6 and 7 of the same plate, were found by Mr. James, at about 15 to 20 feet above low water of the Ohio, at Cincinnati; but he informs me that he has found the same forms as much as 200 feet higher in the series at that city.

ACIDASPIS CERALEPTA, Anthony (sp.)?

Plate 14, figs. 8 and 9.

Ceratocephala ceralepta, Anthony, 1838; Am. Jour. Sci., Vol. XXXIV., p. 379, figs. 1 and 2.

Among the specimens from Cincinnati loaned to me by Mr. James, there are two of the pygidium of one or two species of *Acidaspis,* that

probably belong (one or both) to the form for which Mr. Anthony proposed the above name. They have a sub-semicircular or transversely semi-elliptic form, and are each provided with two long diverging spines behind, and three much shorter digitations on each posterior lateral margin. They differ, however, in the proportional size of the posterior spines; and one (fig. 8) shows no digitations on the posterior margin between the spines; while the other (fig. 9) has about six very short, little projections there.

Mr. Anthony's figures, being rough wood-cuts, do not show the digitations clearly, but as he describes his species as having the margin crenulated, his specimens must have shown some such character. It is possible that the form for which I have proposed the name *A. Cincinnatiensis,* may not be distinct from this; but from its larger size, proportionally much longer marginal digitations, and smoother surface, I think it probably distinct. If comparisons of much better specimens, however, should show them all to belong to one species, Mr. Anthony's specific name, having priority of date, ought to be adopted. The fact that he mistook the pygidium for the head, and the posterior spines for antennæ (a pardonable error, at that early day, when these trilobites were only known as detached fragments), is no reason, I should think, why his specific name should be rejected, although such has been the practice, in similar cases, with some distinguished naturalists.

Locality and position: Cincinnati group, at Cincinnati, Ohio. Ranges, according to Mr. James, from 20 feet to 350 below low-water mark of the Ohio, at Cincinnati.

GENUS DALMANITES, Barrande, 1852.*

(Silur. Syst. Boh. I., Explanation, pl. 21, etc.)

DALMANITES CARLEYI, Meek.

Plate 14, figs. 2 *a, b,* c, *d.*

Dalmanites Carleyi, Meek, 1872; Amer. Jour. Sci. and Arts, Vol. III. (3d ser.), p. 424.

Size small; general outline unknown, but probably ovate. Cephalic shield about twice as wide as long, rounded in front, and more or less straight behind, so as to present a nearly semicircular outline, exclusive

* Emmrich described this genus under the name *Dalmania,* in 1845; but as that name was preoccupied for several genera of Insects, etc., I prefer to use *Dalmanites,* which was, I believe, first published by Barrande, as cited above, though he used it as a mere modification of Emmrich's name.

of the produced posterior lateral extremities, which are about as long as the glabella, rather broad anteriorly, and tapering rapidly to the posterior ends. Glabella wide in front and rapidly narrowed behind, defined by a moderately distinct furrow on each side, and not very prominent at any point; anterior lobe comparatively large, transversely elliptical or sub-rhombic; lateral lobes small, and separated by furrows that extend inward so as to leave only a very narrow central space; anterior pair each sub-trigonal, about twice as large as the middle lobe, which is transversely ovate, while those of the third or posterior pair are smallest; neck-furrow moderately well defined, and continued as posterior marginal furrows of the cheeks nearly to their outer margins; occipital segment comparatively rather wide anterio-posteriorly, and elevated and convex in outline behind; palpebral lobes ascending and narrowing rapidly outward to the summit of the eyes. Cheeks sloping laterally from the eyes, rather abruptly, to a shallow marginal furrow, that is continued so as to form a very narrow margin around the front of the glabella. Eyes moderately large, situated full half their length from the posterior margins of the cheeks, and elevated somewhat above the height of the glabella, truncato-sub-conical in form, the visual surface curving around so as to form about three-fourths of a circle at its base; lenses of comparatively moderate size, showing about seven in a vertical row at the middle, and twelve or fourteen in the longest oblique rows. Surface of anterior lobe of glabella showing small, obscure granulations; other parts of the cephalic shield nearly smooth, or less distinctly granular.

Thorax unknown. Pygidium sub-trigonal, rather depressed, as wide as long, or a little wider, very narrowly rounded, or almost sub-angular behind, the posterior extremity being curved a little upward; mesial lobe depressed, but a little more convex than the lateral, and of about the same breadth, or slightly narrower, at the anterior end, and narrowing to the posterior extremity, which does not reach the margin, composed of about thirteen distinct segments, and two or three other very small obscured ones behind these; lateral lobes separated from the mesial lobe by moderately distinct furrows, and sloping off gently, with slight convexity of outline, to the lateral and posterior margins, showing each about thirteen segments, which are not furrowed, and extend very nearly, but not quite, to the margin, the smaller posterior ones being directed very obliquely backward; surface showing rather fine, irregular scattering granules.

Length of cephalic shield, exclusive of the posterior lateral spines, 0.35 inch, including do., about 0.60 inch; breadth, 0.67 inch; anterio-posterior diameter of eyes, 0.12 inch; height of same on outer side, 0.08

inch. Length of a detached pygidium of apparently about corresponding size, 0.42 inch; breadth of do., about 0.48 inch.

It is not absolutely certain that the cephalic shield and pygidium here described belong to the same species; but as several specimens of each have been found in the same beds together, and they correspond well in size and surface granulation, there is very little reason for doubting that they belong to the same trilobite.

This species has, I believe, sometimes been referred to *D. callicephalus*, Hall, from the New York Trenton group; but it differs materially from the figures and description of that species, which represent the posterior lateral angles of the cephalic shield as being each merely produced "into a broad, rounded, wing-like expansion," instead of terminating in long pointed spines. That species also has the eyes represented proportionally longer, nearer the posterior margin, and each only forming about a semicircle; while in the form under consideration, they curve around so as to form quite three-fourths of a circle. The surface of the cephalic shield of our species is also much less distinctly granulated. There are likewise equally well-defined differences in the pygidium found associated with the cephalic shied of our species, which shows in each lateral lobe thirteen well-defined segments, without sulcations; while in *D. callicephalus* these lobes are described as having each only nine segments, with strong furrows.

At one time I was inclined to think this might be the form published by Prof. Hall under the name *D. breviceps*, although I noticed that it differed in several respects from the characters given in the description of that species. Since seeing the figure of that form, however, recently published, I am satisfied that our specimens belong to an entirely distinct species. The differences distinguishing these two forms are the following: In the first place, the anterior lobe of the glabella of our species has a more nearly rhombic form, its lateral extremities being much more narrowly rounded. Again, its glabella differs in having three well-defined pairs of lateral lobes instead of only two, the anterior pair being as large as both of the others, and each triangular in form. The neck-segment of our spines likewise differs in being fully twice as thick as that of *D. breviceps*, while its palpebral lobes have an entirely different form, and its eyes are decidedly more strongly curved, and farther removed from the posterior margins of the cheeks.

The specific name was given in honor of S. T. Carley, Esq., formerly of Cincinnati, and one of the earliest and most successful collectors and students of the Cincinnati fossils.

Locality and position: Cincinnati, Ohio, where it was found by Mr. U. P. James, in the Cincinnati group of the Lower Silurian, at the horizon of about 300 feet above low-water mark of the Ohio river.

GENUS CALYMENE, Brougniart, 1822.

(Crust. Foss., p. 9.)

CALYMENE SENARIA, Conrad.

Plate 14, figs. 14 *a, b,* c, *d, e, f.*

Calymene Blumenbachii, Green (in part), 1832; Monograph, p. 28, and cast No.1; and of many others (not of Brougniart, 1822).

Calymelle senaria, Conrad, 1841; Ann. Report Geol. N. Y., p. 49; Emmons, 1842, Geol. Rep., p. 390, fig. 2; Hall, 1847, Palæont. N. Y., Vol. I., p. 238, pl. LXIV., figs. 3 *a-n;* Salter (1865), Monogr. Brit. Trilob., p. 97, pl. IX., figs. 6-11 (as *var. C. Blumenbachii*) .

Calymene brevicapitata, Portlock, 1843; Geol. Report Londonderry, etc., p. 286, pl. III., fig. 3; Salter (1848), Mem. Geol. Survey, Vol. II., 341, pl. XI., figs. 1, 2; and Vol. III., pl. 17, figs. 10-12, not 9; McCoy (1865), Palæozoic Fossils Woodw. Mus., 165, tab. 1 F, figs. 4-6.

Calymene forcipata, McCoy, 1846; Sil. Fossils Ireland, pl. IV., fig. 14.

Calymene Bayleyi, McCoy, 1865; Pal. Fossils Woodw. Mus., tab. 1 F, figs. 4-6.

General form subovate, the length being usually about one and a half to one and three fourths the breadth; convexity rather more than one-third the breadth.

Cephalic shield, as seen in a direct view from above, sub-semicircular, approaching sublunate, the anterior outline being more or less nearly regularly rounded, and the posterior broadly sinuous, with the posterior lateral extremities bluntly sub-angular, or abruptly rounded. Glabella more prominent than the cheeks or eyes, about as wide behind as its length, including the neck segment, very strongly defined from the cheeks and the front margin (which latter is very prominent, and strongly recurved and arched upward in the middle) by profound furrows; lateral lobes, particularly the posterior two pairs, distinctly defined by deep lateral furrows that curve a little backward, the posterior pair being transversely, or obliquely, a little oval, and about three times as large as those of the next pair, which are as much larger than the third pair, all being nearly round; neck furrow well defined; neck segment about of the same size as the first thoracic segment, often slightly thickened at each end, arched a little forward, and nearly or quite as high as the most prominent part of the glabella in front. Eyes rather prominent, small, nearly surrounded, excepting on the inner side, by a shallow con-

cavity, and situated opposite the furrows between the anterior and middle lateral lobes of the glabella; visual surfaces very small, about twice as long as high, a little arcuate, and directed nearly laterally; palpebral lobes small, rather prominent, and capping, as it were, the visual surfaces. Movable cheeks, with thick, rounded, lateral margins, defined by a distinct, rounded marginal furrow, continuous with that separating the anterior end of the glabella from the prominent, arched middle of the anterior margin. Fixed cheeks, provided with a very deep, broad furrow along their posterior margins. Facial sutures directed forward anteriorly, so as to intersect the margins somewhat nearer together than the breadth across between the eyes; posteriorly, sometimes slightly furrowed, and directed at first a little obliquely backward and outward from the eyes, for less than half their length, then curving somewhat abruptly, and extending more obliquely backward, nearly straight to, or very slightly in front of, the posterior angles of the cheeks; rostral shield strongly arched, about twice and a half as long, measuring directly across from its lateral extremities, as the height from its upper to its lower margin, at the middle. Labrum or hypostome longitudinally oblong, with sinuous lateral margins; anterior end a little wider than any other part, with a convex outline; anterior margin prominent, rather deeply notched in the middle, with a projecting point on each side of the notch. Internal surface concave; external, convex and smooth.

Thorax about twice the length of the middle of the cephalic shield, narrowing backward, and very strongly trilobate; mesial lobe as wide as the lateral, and distinctly more convex, rounded or somewhat depressed on top, and having its thirteen segments usually a little thickened at their ends, but without nodes. Lateral lobes separated from the middle one by distinct furrows, somewhat flattened on the inner third, and rounding off more or less strongly to the lateral margins; pleuræ; extending straight outward for about one-fourth to one-third of their length, and then slightly deflected and curved backward to their outer ends, which are rounded, compressed, somewhat expanded, and provided with a thickened marginal ridge (not seen externally), while the anterior faces of their outer halves are strongly flattened or beveled for sliding upon each other in rolling up; each with its longitudinal furrow well defined, and placed so as to divide off, as it were, its anterior third, though this is not seen more than half way out from their inner ends, when the thorax is folded together.

Pygidium one-half to two-thirds the length of the middle of the cephalic shield, wider than long, with a more or less nearly sub-trigonal outline, the anterior margin, however, generally being so rounded as to impart a

nearly transversely suboval form to the general outline; mesial lobe well defined, depressed convex, and extending very nearly to the posterior margin, showing five or six segments, the last two being very faintly defined, while behind those there is space enough for two or three more. Lateral lobes sloping or curving off more or less rapidly, each with about five segments, only the anterior one of which has a furrow like that of each of the pleuræ.

Entire surface finely and evenly granular.

Length of cephalic shield (at its middle), 0.52 inch; greatest breadth at the posterior angle of the cheeks, 1.08 inches; length of glabella, exclusive of neck segment, 0.34 inch; breadth of glabella, 0.32 inch. Length of thorax, about 1 inch; breadth at anterior, about 0.97 inch; breadth of anterior end of mesial lobe, 0.35 inch. Length of pygidium, 0.36 inch; breadth of same, 0.50 inch.

This common, and beautiful trilobite, is regarded by many as only a variety of *Calymene Blumenbachii*, Brougniart, which may be the case, as the characters in which it differs from that species are not very striking. Its most obvious differences consist in its more finely and evenly granulated surface, and smaller sizes; the *C. Blumenbachii* having its surface marked by granulations, with tubercles, or larger granulations mingled with the smaller, and attains a rather decidedly larger size. There are also some other more or less important differences of details, such as the more produced and reflexed front margin of the head of *C. senaria*, the proportionally rather broader base of its glabella, and the more anterior position of its eyes.

Whether such differences should be regarded as being of specific, or only sub-specific importance, is, to some extent, a matter of taste, or perhaps more properly speaking, depends upon one's views in regard to the degrees, or kinds of differences, that should be considered specific. However this may be, it seems desirable, in the present state of our knowledge of these forms, to keep them separate.

Locality and position: In New York, as well as at various localities in some of the adjoining States, and Canada, this fossil occurs in the Trenton limestone, and ranges up into the Niagara group. It also has the same range in several of the Western States. At Cincinnati, Ohio, it ranges through the lower and middle portions of the Cincinnati group; and at Oxford, Lebanon, and various other localities in that State, as well as at Richmond, Madison, and numerous other places in Indiana, it occurs in the higher parts of the same series. It has also been identified in England and other foreign countries. For the use of the very fine entire specimen of this species, figured on our plate, I am indebted to D. H. Shaffer, Esq., of Cincinnati. Those showing the separate parts belong to Mr. Dyer.

FOSSILS OF THE NIAGARA AND CLINTON GROUPS.

MOLLUSCA.

BRACHIOPODA.

GENUS TRIPLESIA, Hall, 1859.

(12th Ann. Report Regents, p. 44 (=*Dicraniscus*, Meek, 1872).

Shell transversely or longitudinally sub-oval, generally more or less trilobate; hinge line straight, and provided with teeth and sockets. Ventral valve with a rather deep, rounded mesial sinus, that often terminates anteriorly in a rounded marginal projection; provided with a well-defined cardinal area, divided in the middle by a triangular fissure; beak imperforate; hinge with a strong tooth on each side of the fissure, merely supported by the thickening of the interior of the cardinal region, and apparently without any well-defined dental laminæ; muscular impressions small, situated in the bottom of the valve, and without raised margins. Dorsal valve having a more or less prominent mesial fold that imparts the usual trilobate appearance to the shell; cardinal margin not provided with an area, but having a prominent bifurcating cardinal process, on each side of which there is a brachial process, directed obliquely inward and laterally; and between the outer side of each of the latter and the cardinal edge, there is a socket for the reception of the teeth of the other valve; muscular impressions small, and placed in the bottom of the valve without raised margins. Surface nearly smooth, or only showing marks of growth, and, perhaps, sometimes, obscure radiating striæ.

At the time I proposed the name *Dicraniscus* for this type, I had only seen fragmentary specimens, which gave but a very limited knowledge of the form and general physiognomy of the exterior of the shell; though they clearly showed that it possessed quite different internal characters from any that had been described or illustrated in any of the established genera. On the contrary, the specimens on which Prof. Hall

founded the genus *Triplesia,* showed perfectly all of the external, but none of the internal characters; so that his generic description and illustrations only made known the exterior of the shell. If I had seen but a single entire specimen of our shell, or if Prof. Hall had described or illustrated the internal characters of his genus, I would certainly (especially in the latter case) have at once referred our shell to the same, if I am correctly informed in regard to the interior of *Triplesia.*

Almost immediately after the publication of my generic description, a friend who had been in correspondence with Mr. Whitfield, informed me that specimens of some of the typical species of Prof. Hall's genus *Triplesia* had recently been found in New York, showing that it possesses essentially the same internal characters as our Ohio shell. This being the case, the generic identity of the forms for which the two names were proposed would seem to be clearly established; and, as both names cannot be retained for the same genus, I now provisionally withdraw *Dicraniscus;* though I am not sure that the rules of nomenclature may not yet require it to be retained, instead of *Triplesia.*

The objection to the name *Triplesia* is, that *Triplasia* had been used by Reuss for a genus of *Foraminifera,* in 1854.* *Triplesia* and *Triplasia,* however, are not *exactly* identical; and although it is undesirable to propose a new name so near one already published for another genus, when this has inadvertently been done, I think, in general, both names should be allowed to stand, even when there is only a difference of one letter, unless that difference is due to a mere error in the orthography of one of the names, which, if correctly written, would make it exactly the same as the other. This, however, is the case with *Triplesia,* which, if correctly written, would become *Triplasia;* and, consequently, I should think, it ought not to stand, if Reuss's genus is a good one.

Prof. Hall gives the etymology of *Triplesia,* as follows: "[Gr. *τριπλασιος, triplex;* in reference to the trilobate character of several of the species.]" As *τριπλασιος* and *triplex* are not synonymous (the latter being equivalent to *τριπλεχης,* Latinized *tripleces*), there is an evident inconsistency between the name used and the character it was intended to express, though this doubtless resulted from a typographical error or a slip of the pen.

* *Triplasia* also occurs in lists of plants for an older genus of Grasses, but probably not for a good genus. At any rate, there seems scarcely any sufficient reason why the same name may not be used both in Botany and Zoology, without creating confusion, though contrary to the rules of the British and American Associations for the Advancement of Science.

TRIPLESIA ORTONI, Meek.

Plate 15, figs. 1 *a* to *k.*

Dicraniscus Ortoni, Meek, 1872; Am. Jour. Sci. and Arts, Vol. IV. (3d series), p. 280.

Shell apparently truncato-sub-oval, or sub-orbicular in general outline, being sometimes longer than wide, but more frequently the reverse, with the widest part in front of the middle, becoming quite gibbous in adult examples; hinge line generally, if not always, less than the breadth of the valves. Ventral valve less convex than the other; mesial sinus deep and wide anteriorly, but not extending quite to the beak; cardinal area rather low, sharply defined, and standing nearly at right angles to the plane of the valves, or sometimes a little arched backward; beak small, and scarcely projecting beyond the area, its point being slightly arched in some specimens. Dorsal valve moderately convex, rising into a more or less prominent mesial fold; umbo rather prominent, or at least projecting beyond that of the other valve, though the immediate and very obtuse point of its beak is incurved to the hinge line; cardinal process very long, a little curved, rounded, and rather slender below, and divided above, nearly half its length, the divisions being slender, diverging, and somewhat furrowed on their posterior sides above. Surface nearly smooth, or only showing a few sub-imbricating marks of growth near the free margins.

The specimens yet known to me are too imperfect to afford detailed measurements, though they indicate a length of one inch and a quarter, and a breadth of one inch or more.

I had examined many specimens of this shell, consisting of only the thickened rostral parts of the separated valves, showing the very long cardinal process of the dorsal valve, and the hinge and area of the ventral, before I could believe that they really belonged to the same shell. It was difficult to comprehend how so very long a cardinal process as that possessed by the dorsal valve, could be received into a ventral valve with no deeper concavity than those found in such association as to indicate that they ought to belong to the same species. It was, therefore, not until Prof. Orton found a broken specimen, with portions of the two valves united, and showing this long process in place, with relation to both valves, that I was aware that the beak of the dorsal valve is so incurved as to give this process a very oblique forward direction within the opposite valve.

I have seen no specimen with the anterior margins well enough preserved to show whether or not the mesial fold and sinus project forward beyond the margins on each side, as in the other species of the group; but so far as can be determined from the direction of the lines of growth, there would seem to be no projection of the anterior margin there. The fragments of the rostral parts, most usually found, belong to the dorsal valve. They are generally quite thick, and retain more or less of the cardinal and brachial processes. Some of them show two small, rather deep, closely approximated muscular impressions, in the bottom of the valve, with a short little ridge between them. There also seem to be one or more obscure scars on each side of these. In front of these muscular impressions, the valves seem to be quite thin.

In size and general appearance, perfect specimens of this species probably most nearly resemble *T. cuspidata,* Hall,* from the central part of the Trenton group, at Lowville, New York. It differs, however, in having a straighter and longer hinge line, and more developed cardinal area, a less elevated mesial fold, and in showing no traces of radiating striæ.

The specific name was given in honor of Prof. Edward Orton, of the Ohio Geological Survey, who discovered the specimens.

Locality and position: Near Dayton, Ohio, from the summit of the Clinton group of the Upper Silurian.

GENUS RHYNCHONELLA, Fischer, 1809.

(Mem. Soc. Imp. Mosc. II.)

RHYNCHONELLA NEGLECTA, Hall.

Plate 15, figs. 3 *a, b,* c, *d.*

Atrypa neglecta, Hall, 1852; Palæont. N. Y., Vol. II., p. 70, pl. 23, figs. 4 *a-f.*
Rhynchonella neglecta, Hall, 1859; 12th Report of Regents, p. 78.
Rhynchonella neglecta, var. scobina, Meek, 1872; Am. Jour. Sci. and Arts, Vol. IV. (3d series), p. 277.

Shell rather small, sub-trigonal, compressed, or sometimes in large specimens quite gibbous, with the mesial fold very prominent and narrow. Dorsal valve bearing on the mesial fold four simple plications, the middle two of which are more prominent and larger than the others, one of which latter occupies each slope of the fold; lateral slopes each provided with about six angular, simple plications; beak incurved.

* *Atrypa cuspidata,* Hall; Palæont. N. Y., Vol. I., p. 138, pl. XXXIII., figs. 1 *a-h.*

Ventral valve with mesial sinus corresponding to the fold of the other valve, and bearing three plications, the middle one of which is usually larger than the others; lateral slopes each with about six plications; beak small, pointed and arched, but not strongly incurved, projecting moderately beyond that of the other valve. Surface of both valves ornamented by fine marks of growth, and numerous, minute, distinct, regularly disposed granules.

Length of one of the largest and most gibbous specimens, 0.55 inch; breadth of do., 0.50 inch; convexity of same, 0.53 inch. Some other individuals of near the same length and breadth have a convexity of only 0.25 inch.

This shell agrees so closely in form, as well as in the number and arrangement of its plications, with *R. neglecta,* Hall, from the New York Niagara and Clinton groups, that I have not felt warrantable in separating it specifically. If that shell, however, has been correctly figured and described from well-preserved specimens, showing all of its finer surface markings, ours ought to be clearly distinct, as there are no surface granulations illustrated in the figures or mentioned in the descriptions of the New York species; while they are *quite distinct, and beautifully defined,* on our specimens. As the New York Niagara fossils are usually found in a good state of preservation, it is improbable that such a character would have been entirely overlooked in *R. neglecta.* Having no authentic specimens of that species at hand for comparison, however, I have merely placed our shell as a variety of the same.

NOTE.—Since the foregoing was written, I have had (through the politeness of Prof. Hart, of Cornell University,) an opportunity to examine some good specimens of *R. neglecta,* from Lockport, New York; and I find that, on protected parts of the surface, they show some remains of extremely fine granulations. This being the case, I withdraw the name *var. scobina* for the Ohio shell.

Locality and position: Clinton group of the Upper Silurian, at Dayton, Ohio.

GENUS MERISTELLA, Hall, 1860.

(Twelfth Report Regents, p. 78.)

MERISTELLA (? MERISTINA) CYLINDRICA, Hall (sp.).

Plate 15, figs. 2 *a, b,* c, *d.*

Atrypa cylindrica, Hall, 1852; Palæont. N. Y., Vol. II., p. 76, pl. 24, figs. 2 *a* to *g.*

Shell attaining a rather large size, varying from a moderately compressed, more or less broadly ovate outline, to a much more gibbous,

elongated, sub-cylindrical form, the young shell being proportionally broader and more compressed, and the adult more convex and elongated; anterior margin somewhat compressed, narrowly rounded, and a little raised along the middle; lateral margins, in the young shell, proportionally more convex in outline, and converging and rounding to the front, with usually a slight straightness or flattening of outline, and posterior convergence behind, the latter character often becoming very strongly developed in large adult examples.

Dorsal valve somewhat less convex than the other, its greatest convexity being behind the middle, while its anterior slope is sometimes slightly raised, so as to form a very obscure, or scarcely perceptible mesial ridge; or, in other examples, evenly rounded over from side to side; beak regularly incurved.

Ventral valve with its greatest convexity a little farther back than that of the dorsal, forming a regularly decreasing curve from the beak to the front; anterior slope usually showing a shallow mesial sinus (sometimes merely represented by a slight flattening) that extends to or behind the central region, with an obscurely impressed, nearly linear furrow, along its middle; beak not very prominent, abruptly pointed, and strongly incurved upon that of the other valve.

Surface usually appearing smooth, but, on closer examination, showing obscure striæ of growth, and sometimes extremely faint traces of radiating lines, near the front and lateral margins.

Length of a large, elongated, gibbous specimen (with outline of lateral margins strongly flattened), from the front to the beak of the dorsal valve, 1.25 inches; do., from front to beak of ventral valve, 1.30 inches; breadth a little in advance of the middle, 0.76 inch; convexity, 0.77 inch; same measurements of a young ovate specimen, respectively, 0.67, 0.75, 0.66, and 0.42 inch.

The specimens of this species found in Ohio are often much larger and more robust than those figured in the New York Report; but agree so closely in nearly all their characters, as to leave little room to doubt their identity with the New York shell. The largest individuals, in some cases, have the flattening of the lateral margins much more strongly defined (almost as if by accidental lateral compression, though evidently natural,) than any of those figured by Prof. Hall; which peculiarity gives them a different outline, as seen in a direct view of either valve. As there are, however, all gradations in this flattening, between these and the common forms of the *M. cylindrica,* no separation can be made on this character.

I know nothing of the internal characters of this species, beyond the fact that it has internal spires, and a strong mesial septum, or prominent ridge, in the beak of the dorsal valve.

Locality and position: Hillsboro, Ohio; Niagara group of the Upper Silurian.

GENUS TRIMERELLA, Billings, 1862.

(New Species Lower Sil. Fossils, p. 166.)

TRIMERELLA GRANDIS, Billings.

Plate 16, figs. 2 *a, b.*

Trimerella grandis, Billings, 1862; New Sp. Lower Sil. Foss., p. 166, figs. 151 *a, b;* Dall (1871), Am. Jour. Conch., Vol. VII., p. 82; Davidson and King (1872), Trimerellidæ, p. 4, extr. from Geol. Mag., Vol. IX.; Hall and Whitfield (1872), Notes on some New or Imperfectly Known Forms among the *Brachiopoda,* etc., p. 4, pl. 13, figs. 11 to 16.

Shell (as determined from internal casts) ovate, with valves moderately and nearly equally convex, and the greatest breadth in advance of the middle; lateral margins nearly straight, sub-parallel along the middle, and rounding rather abruptly into the rounded front, while the posterior lateral margins converge abruptly to the beaks. Dorsal valve with its beak apparently short and moderately incurved; interior with the two cylindrical chambers small, and short, or not usually extending back more than to points two-thirds of the length of the valve from its anterior margin. Ventral valve with beak straight, more or less abruptly pointed, and apparently projecting moderately beyond that of the other valve; internal chambers comparatively small, and of about the same length as those of the other valve. Surface and other characters unknown.

Length of internal cast, about 2.40 inches; breadth of do., 2 inches; convexity, 0.90 inch. Mr. Billings mentions seeing specimens 3 inches in length, by about 2.50 inches in breadth.

Our figures of this species on plate 16 were drawn from one of Mr. Billings's typical specimens, kindly loaned by him for comparison; but I have since received by Prof. Orton a well-defined specimen of the same shell from an Ohio locality.

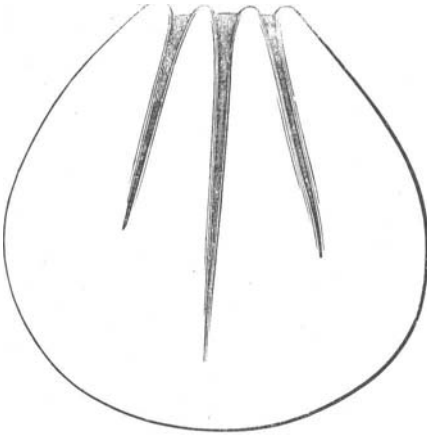
Locality and position: Mr. Billings's specimens were from Galt, New Hope and Elora, Canada, where they occur in the Guelph formation (Middle Silurian) of the Canadian Section. The Ohio specimen came from beds referred to the Niagara group of the Upper Silurian, in Ottawa county, Ohio.

TRIMERELLA OHIOENSIS, Meek.

Plate 16, figs. 1 *a, b,* c, and the annexed cuts.

Trimerella Ohioensis, Meek, 1871; Am. Jour. Sci. and Arts, Vol. I. (3d series), p. 315; Davidson and King (1872), Trimerellidæ, p. 4 (extracted from the Geologica1 Magazine, Vol. IX.).

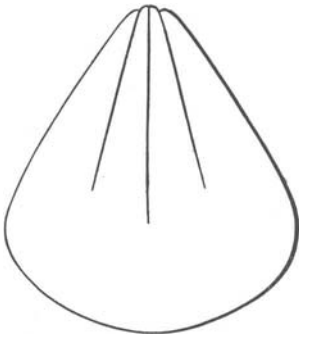
a



TRIMERELLA OHIOENSIS, Meek.

a An outline internal cast of the ventral valve, showing by comparison with figure *(a)* its broader, more rounded form, less attenuated beak, and more widely separated internal cavities.

b



TRIMERELLA ACUMINATA, Billings.

b An outline of an internal cast of the ventral valve, showing its sub-trigonal form, attenuated beak and (owing to the thinness of the partitions) the closely approximated character of casts of the internal cavities. From a Canadian specimen sent by Mr. Billings, a part of one side being restored in the figure.

Shell attaining a large size; internal cast very broad ovate, the widest part being in advance of the middle, where the breadth sometimes nearly or quite equals the length, rather distinctly convex, in large examples; anterior margin broadly rounded in outline; anterior lateral margins rounding regularly into the front, while the posterior lateral converge rapidly, with somewhat straightened or moderately convex outlines, to the beaks. Dorsal valve more convex than the other, its greatest convexity being behind the middle, thence rounding abruptly over to the umbo behind, and more gradually forward and laterally; beak (of the shell) very strongly incurved, directed downward at right angles to the plane of the valves, and apparently occupying a broad sub-trigonal sinus, or recess in the cardinal margin of the other valve; interior with mesial septum dividing the two characters, strong, extending forward usually about five-sixths the length of the valve, with the chamber on each side of it large, elongated, or extending nearly as far back as the cardinal margin, more or less obtusely pointed, and distinctly arched with the

curve of the valve. Ventral valve more flattened in the umbonal region, with beak apparently straight, moderately prominent, and rather abruptly pointed; interior with mesial septum extending as far forward as that of the other valve, and the mesial chambers long, or extending backward a little beyond the hinge margin, and nearly straight or only a little arched; while between these and each posterior lateral margin, a shallow lateral cavity extends about as far back as the mesial chambers. Margins of the two valves meeting without any upward or downward curvature around the front, but their line of junction along each posterior lateral region is broadly waved upward. Surface, as determined from moulds of the exterior in the matrix, marked by concentric striæ, which become rather strongly defined, regularly disposed, and sub-imbricating around the anterior and lateral margins.

Length of a large internal cast, 3.50 inches, with a breadth of about 2.65 inches, and a convexity of 2 inches.

At the time I first indicated this form, in the Journal of Science, I had but a very limited knowledge of Mr. Billings's *T. acuminata,* which had only been illustrated and described from a cast of the rostral part of the ventral valve. From Mr. Billings's figures, I then supposed our Ohio specimens to be allied most nearly to his *T. grandis;* though they are readily distinguishable from that species by their broader form, much longer internal chambers, and decidedly more strongly incurved beak of the dorsal valve, as shown in our figures of the two forms on plate 16. Since that time, Mr. Billings has more fully characterized his *T. acuminata,* from better specimens than those first studied by him; and he has also kindly sent to me specimens of the same from Canada. From his more extended description, and the specimens sent by him, it becomes clearly evident that our Ohio shell is decidedly more nearly related to his *T. acuminata* than to his *T. grandis.* Wishing to have our specimens as thoroughly compared with Mr. Billings's types as possible, I loaned them to him for that purpose, and he wrote back that, although closely related to his *T. acuminata,* he thinks the *T. Ohioensis* still a distinct species.

The principal differences between these two forms, so far as yet known, seem to consist in the more narrow sub-trigonal form, and the more produced and acuminate character of the beak of *T. acuminata;* which also has the casts of its internal cavities more slender, more elongated, and more closely approximated together; thus showing that the septa between them were proportionally thinner. As all these comparisons, however, have to be made from internal casts only, and some additional

collections of the Ohio form show more variation in some of these characters than I had supposed existed, I should not be surprised if farther comparisons should prove the *T. Ohioensis* to be only a more robust, broader variety of *T. acuminata*. Still, I have not yet seen sufficient reasons for uniting the two forms under one name, as the specimens thus far compared do not show an unbroken series of intermediate forms.

In order to afford the student the means of making a more satisfactory comparison, the foregoing cuts of the internal casts of the ventral valves of *T. acuminata* and *T. Ohioensis* are given. That of *T. acuminata,* is from a small Canadian specimen sent by Mr. Billings. It is a little defective on one side; but as such shells are of course symmetrical, this defect has been carefully restored from the unbroken opposite side. All of our specimens of these shells being merely rough internal casts, we have not the means of illustrating the muscular impressions.*

Locality and position: Genoa, Ottawa county, Ohio. From beds referred to the Niagara group of the Upper Silurian.

GASTEROPODA.

GENUS PLATYOSTOMA, Conrad, 1842.

(Jour. Acad. Nat. Sci. Philad., Vol. VIII., p. 275.)

PLATYOSTOMA NIAGARENSIS, *var.* TRIGONOSTOMA.

Plate 16, figs. 3 *a. b,* c.

Platyostoma Niagarensis, Hall, 1852; Palæont. N. Y., Vol. II., p. 287, pl. 60, figs. 1 *a* to *v;* Hall and Whitfield, List Fossils from Louisville, p. 10, dated June, 1872.
Platyostoma? trigonostoma, Meek, 1871; Proceed. Acad. Nat. Sci. Philad., p. 169.

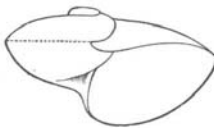
Shell strongly depressed, sub-discoidal, or lenticular, with periphery rather acutely angular; spire much depressed or scarcely rising above the inner edge of the body volution, which is more convex below than above the angle around the periphery; volutions three, very rapidly increasing in size, particularly in breadth, nearly flat, with an outward slope above; last turn large, depressed convex below, a little declining near the aperture on the inner side above; suture linear; aperture large,

* Mr. Thos. Davidson, of Brighton, England, and Prof. Wm. King, of Queen's College, Belfast, Ireland, will soon publish an elaborately illustrated paper on the family *Trimerellidæ,* made out from extensive collections of well-preserved specimens. In this paper, the muscular scars in *Trimerella* will doubtless be fully illustrated and described.

sub-trigonal, with greater breadth than height; lip extended forward on the inner side above, and thence directed very obliquely outward and backward to the marginal angle. Surface, as determined from casts, with marks of growth curving back very obliquely above and below to the angular periphery.

Height, 0.62 inch; breadth, 1.08 inches; height of aperture, 0.50 inch; breadth of do., 0.65 inch.

The specimens of this shell studied by me (without the slightest indications of accidental distortion), are so decidedly more depressed, and have the upper side of the volutions so much more flattened, and the periphery so much more angular than any of the varieties of *P. Niagarensis* illustrated by profile or lateral views among Prof. Hall's figures of that species, that I could not believe it even a strongly marked variety of the same. Since my description was published, Prof. Hall and Mr. Whitfield have regarded it as the *P. Niagarensis;* and after comparing it with a series of authentic New York specimens of that extremely variable shell, I am inclined to think it may be a variety of the same. Still, it differs, in a marked degree, in its more decidedly angular periphery, and the more flattened character of the upper side of its volutions, from any of the New York examples of *P. Niagarensis* I have seen. The annexed outline cut will illustrate its form as seen in a side view, and will also show how much it differs in outline from any of the profile figures of *P. Niagarensis* given in the Palæontology of New York, Vol. II., pl. 60; in which volume that shell is also described as being "globose."



PLATYOSTOMA NIAGARENSIS, *var.* TRIGONOSTOMA.

A profile, showing the depressed character of the spire and the angularity of the periphery, form of the aperture, etc.

Locality and position: Yellow Springs, Ohio; Niagara group of the Upper Silurian.

CEPHALOPODA.

GENUS LITUITES, Montfort, 1808.

(Conch., p. 279.)

LITUITES, ? ORTONI, Meek.

Plate 15, fig. 4.

Shell small, discoid; umbilicus comparatively large, but very shallow, the outer turn of the coil being scarcely more convex than those within; volutions three or more, slender, slightly embracing, and increasing very gradually in size, apparently scarcely wider transversely than in

their dorso-ventral diameter, evenly rounded on the sides and periphery; siphuncle unknown; septa separated on the periphery by chambers measuring less than half the dorso-ventral diameter, and generally gently arched backward on the sides; surface and outer chamber unknown.

Greatest diameter of the involuted and chambered part of the shell, 1.16 inches; dorso-ventral and transverse diameter of the outer turn, each 0.35.

As the only specimen of this species yet found does not show the outer or last chamber, and consists entirely of the chambered and involuted part, we have not the means of determining, beyond doubt, whether or not the outer or body chamber was deflected from the curve of the inner volutions. If not, of course it cannot be a true Lituite, but would most probably belong to the genus *Gyroceras,* and have to take the name *G. Ortoni.* The very slender, nearly cylindrical, and closely coiled nature of its volutions, however, are characters that seem to indicate that it belongs more properly to *Lituites* than to *Gyroceras,* in which latter group they usually increase more rapidly in size, and are generally more loosely coiled. The slender, rounded and compactly coiled nature of its volutions, gives to the shell much the general appearance of the common myriapod *Iulus,* as seen lying on one side and rolled together.

The specific name was given in honor of Prof. Edward Orton, of the Ohio Geological Survey, who discovered the only specimen of the species I have seen.

Locality and position: Niagara group, Greenville, Darke county, Ohio.

ARTICULATA.

CRUSTACEA.

GENUS LEPERDITIA, Ronault, 1851.

(Bull. Soc. Geol. Fr., 2d ser., t. VIII., p. 377.)

LEPERDITIA ALTA, Conrad (sp.).

Plate 17, figs. 2 *a, b.*

Cytherina alta (Conrad), Vanuxem, 1843; Geological Report, III. Dist. N. Y., p. 112, fig. 6.

Leperditia alta, Jones, 18—; Ann. and Mag. Nat. Hist., Vol. XVII. (2d series), p. 88, fig. —; Hall (1859), Palæont. N. Y., Vol. III., p. 373.

Carapace-valves longitudinally sub-ovate, being wider posteriorly than in front, with dorsal margin straight, the ventral forming a broad semi-

ovate curve, a little more prominent behind than in front; and the anterior and posterior margins rounded so as to connect with the dorsal border above, at very obtuse or scarcely defined angles. Left valve having its greatest convexity situated centrally with relation to the length, and considerably below the middle, where it swells out in the form of an obtuse, undefined prominence, from which the lower margin is abruptly inflected nearly or quite at right angles to the vertical plane of the valve; eye tubercle situated distinctly above the middle, and a little less than one-fourth the entire length of the valve, behind the most prominent part of the rounded front margin, sometimes accompanied by a slight furrow that curves upward and backward from its anterior side to the dorsal margin above. Surface of casts smooth, or nearly so.

Length, 0.42 inch; height, 0.26 inch; convexity (of the left valve only), 0.08 inch.

A right valve associated with the above (see fig. 2 *b*), and probably belonging to the same species, is longer in proportion to its height, and less convex near the middle of the lower side, though its lower margin is strongly inflected. It also shows scarcely any traces of an eye-tubercle in the cast.

As I have only seen internal casts of this species, I am not entirely sure that it is exactly the same as *L. alta*, though it probably is. Our figures were prepared with the intention of having them cut in lines only, and the concentric marks were merely intended to represent shading. They were afterwards added to the plate where they now appear, however, with the view of having them represented merely in outline; but the lithographer supposing the concentric lines to be surface markings, put them in so as to present a different appearance from what they would have done in a wood-cut. The figures can therefore only be relied upon as accurate outlines of the fossil, enlarged to twice the natural diameter.

Locality and position: In New York, *Leperditia alta* occurs abundantly in the subdivision known as the *Tentaculite* limestone, formerly included as a part of the Waterlime group, of the Upper Silurian. The specimens here figured are from beds referred to the Helderberg group, at Greenfield, Ohio.

GENUS ILLÆNUS, Dalman, 1826.

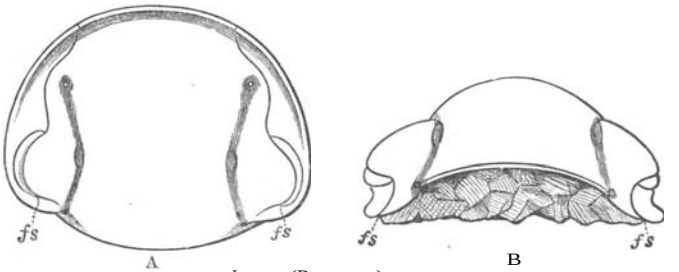
(Palæont., p. 51.)

ILLÆNUS (BUMASTUS) INSIGNIS, Hall?

Plate 15, fig. 5 *a, b, c.*

Illænus insignis, Hall; Advance sheets from Regents' Report, p. 27, dated Dec. 26, 1864; Regents' 20th Report (1868), p. 331, with wood-cuts, and on pl. 22, figures 13 and 14; also second edition of same, p. 419, with same cuts and lithographs.

Compare *Illænus (Bumastus) Worthenanus,* Winchell and Marcy, 1865; Enumeration of Fossils from the Niagara Limestone at Chicago, p. 105.



ILLÆNUS (BUMASTUS).

A–An outline of the head as seen from above, showing the form of the glabella, eyes, etc.; with the dorsal furrows terminating anteriorly and posteriorly in pits; also the facial sutures, which terminate posteriorly at the points marked *fs*.
B–A posterior view of same, showing the convexity; and the abrupt outward curve of the facial sutures behind, at the points marked *fs*.

Attaining a rather large size; general form elongate-oval, or sub-elliptic. Cephalic shield distinctly convex, or forming about one-fourth of a circle from the front to the posterior margin, transversely sub-oval in form, the widest part being behind the middle; posterior margin nearly straight, or moderately convex in outline, across between the ends of the dorsal furrows; anterior and anterior lateral margins, with a very narrow recurved rim, and a nearly regularly semicircular outline; posterior lateral margins narrowly rounded. Glabella rather strongly convex, the greatest convexity being a little behind the middle, where it rises distinctly above the eyes, and is evenly rounded over from side to side; dorsal furrows well defined in the internal cast, each starting from a minute marginal pit behind each eye-lobe, thence extending forward and inward to shallow, undefined little oval depressions nearly opposite the middle of each eye, from which they each curve outward and extend forward to and terminate in a well-defined pit near the lateral margins of the glabella, and about half way between the anterior ends of the eyes and the points where the facial sutures intersect the anterior margin; palpebral lobes rather large, larger than wide, narrowed and produced anteriorly, and moderately convex, with a more or less marked outward slope over

the eyes. Facial sutures extending forward from each eye, at first with a very slight outward curve, until they come nearly opposite, and rather close to the anterior terminal pits of the dorsal furrows, where they curve and extend obliquely inward and forward to the anterior margin, which they cut at points decidedly nearer together than the breadth across between the anterior ends of the eyes, or about equaling that between the greatest inward curves of the dorsal furrows opposite each eye; behind, these sutures start from the posterior incurved extremity of each eye, and curve very abruptly outward, so as to cut the margin almost directly behind and under the most prominent part of the same. Movable cheeks sloping off rather abruptly on each side, and each provided, in the cast, with a deep-rounded furrow around the base of each eye, and produced, attenuated, and incurved anteriorly, the widest part being opposite the anterior end of each eye. Eyes rather large, located back almost over the posterior lateral margins, strongly arched outward, or forming about one-third of a circle, very slightly oblique, their anterior ends being a little nearer together than their posterior; visual surface, as seen in the cast, very narrow in its vertical diameter, which is less than one-fourth the length, measuring around the curve.

Thorax distinctly convex, about one-third wider than long, trilobation moderately well marked in casts of the interior; mesial lobe very wide, or equaling about three times the breadth of each of the lateral, measuring over the curve of all, its greatest breadth being along the middle region, forming a broad, regular arch from side to side, so as to rise above the lateral lobes as much as the entire height of the latter; as seen from above, its ten segments present nearly straight posterior margins along most of their length, but curve rather distinctly backward at each end, as they approach the lateral lobes; lateral lobes sloping off more or less abruptly, from their inner to their outer margins; pleuræ rather wide, flattened for slipping upon each other in rolling up, and apparently obtuse at their free ends, showing a slight backward arching along the entire length of their posterior margins.

Pygidium somewhat larger than the cephalic shield, and one-sixth of its breadth wider than long, very gibbous, the greatest convexity being behind the middle, from which region it rounds down rather abruptly behind, and arches over more gradually forward, without the slightest traces of dorsal furrows; while, as seen from behind, it forms a slightly depressed or sub-semicircular arch, from side to side; general outline, as seen from above, with posterior and lateral margins forming together a deep semi-oval curve, and the anterior somewhat straightened, or gently arched forward across the central region, and curving mod-

erately backward on each side, so as to connect with the anterior lateral margins by very obtuse angles, or abruptly rounded outlines.

External surface unknown, excepting from impressions of the posterior under side of the pygidium, left in the matrix, which show this part of the surface to be marked by rather coarse concentric striæ.

Entire length, following over the convex curves of head and pygidium, 4.30 inches; do., measuring direct, with head and pygidium straightened out, about 3.80 inches; length of head (direct measurement), 1.32 inches; breadth, about 1.72 inches; length of thorax, in its natural condition, 1.05 inches; length of pygidium (direct), 1.40 inches; breadth of do., 1.70 inches.

Although I refer this form, provisionally, to Prof. Hall's species *I. insignis*, I am far from being entirely satisfied in regard to its exact identity with that form. The difficulty in making a satisfactory comparison, arises from the fact that Prof. Hall's species was founded entirely upon a separate glabella, and a detached pygidium, *supposed* (but not known) to belong to the same Trilobite. On comparing the glabella of our specimens with the figures of that of *I. insignis*, it is found to agree in most respects more closely than with that of any other form I have yet seen illustrated. It has the same convexity, nearly the same form of palpebral lobes, and the same anterior prolongation of the dorsal furrows, likewise terminating in similarly situated pits. Its facial sutures also have nearly the same direction, anteriorly at least, excepting that they are rather decidedly more convergent after passing forward beyond the terminal pits of the dorsal furrows.

This latter character makes the anterior margin of the glabella about one-fifth narrower than the distance across between the anterior terminal pits of the dorsal furrows, instead of fully equaling the same, as in the published figure *I. insignis.* Again, the outline of the posterior margin of the glabella, in the type specimen of *I. insignis*, is represented much more convex than in our specimens, thus contributing to give greater proportional length to its glabella, which, however, is also longer in front of the eyes than in the form under consideration. This straighter posterior margin of the glabella, in our specimens, also gives the eyes a position relatively farther back than in Prof. Hall's figure.* If the

* Prof. Hall's outline restoration of the movable cheeks of *I. insignis* represents them as projecting out farther laterally behind, than in the form under consideration. As this is a mere restoration, however, his figure may not be correct in that particular. It also would appear to represent the posterior termination of the facial sutures as not curving outward, as in our specimens; but this may be due to the imperfection of his specimen.

pygidium referred by Prof. Hall to *I. insignis* really belongs to the same species as the glabella figured and described by him under that name, I should think our form an entirely distinct species, since its pygidium, as will be seen by comparison, presents a strikingly different outline. In *I. insignis,* it is represented *longer than wide,* very *narrowly rounded behind,* and distinctly angular at the anterior lateral angles; while in our specimens it is *wider than long, broadly rounded behind,* and abruptly rounded, or only sub-angular anterio-laterally.

It seems to agree pretty nearly with a form described by Winchell and Marcy, under the name *I.* (*Bumastus*) *Worthenanus;* but as these authors have given no figure, I am at a loss to determine its relations to that form, which is thought by Prof. Hall to probably be identical with his *I. insignis.* If distinct from these, it might be called *I. Springfieldensis.*

As Prof. Hall cites Wauwatosa, Wisconsin, as one of the localities from which his typical specimens of *I. insignis* were obtained, I borrowed for comparison, from Dr. F. H. Day, of that place, a fine collection of the heads and pygidia of the form found there that is regarded as most nearly corresponding to Prof. Hall's figures of that species. In most of these specimens, however, the glabella agrees more nearly in form with that figured by Prof. Hall under the name *I. cuniculus,* being proportionally shorter, with the posterior margin less convex in outline, and the eyes more prominent and placed proportionally farther back, while the facial sutures are less sinuous, and not so converging anteriorly. They generally have the dorsal furrows, however, more or less defined, and terminating in pits, in front of the eyes, as in *I. insignis.*

If any of these specimens really belong to *I. insignis,* they would certainly seem to show that species to vary in the shape of the glabella, to such an extent that no well-defined and constant differences can be found in this part of the animal for the establishment of the two species *I. insignis* and *I. cuniculus.* However that may be, the specimens of pygidia sent by Dr. Day from the same locality and position, agree exactly with Prof. Hall's figure of a pygidium referred by him to *I. insignis.*

On comparing the glabella of the Ohio specimens under consideration with Prof. Hall's figure of the corresponding part of *I. insignis,* it will be seen to be proportionally shorter, to have its posterior margin much less convex in outline, and the facial sutures even more strongly sinuous and converging in front of the eyes, than represented in the figure of that species; with which, however, it agrees in having the dorsal furrows extending forward in the cast, and terminating in pits anteriorly. Yet in all of these characters, excepting its less convex posterior outline and pro-

portionally shorter form, it differs more decidedly from the figure of *I. cuniculus*.

If the pygidium figured by Prof. Hall as that of *I. insignis* really belongs to the same species as the glabella figured by him under that name, I should think our specimens almost certainly specifically distinct, as it is proportionally decidedly longer, and more narrowly rounded in outline, being very nearly or quite as long as wide, and longitudinally semi-elliptic; while in our form it is decidedly wider than long, and transversely sub-elliptic.

Thr0ugh the kindness of Prof. Marcy and Prof. Winchell, I have also had an opportunity to compare our specimens with the form described by them under the name *Illænus Worthenanus*, and thought by Prof. Hall probably to belong to his species *I. insignia*.

Locality and position: Springfield, Ohio. Niagara group of the Upper Silurian.

FOSSILS OF THE CORNIFEROUS GROUP.

MOLLUSCA.

POLYZOA.

GENUS PTILODICTYA, Lonsdale, 1829.

(Murchison's Sil. Syst., p. 130.)

PTILODICTYA (STICTOPORA) GILBERTI, Meek.

Plate 18, figs. 1 *a, b, c.*

Ptilodictya (Stictopora) Gilberti, Meek, 1871; Proceed. Acad. Nat. Sci., Philad., p. 7.

Corallum growing in thin, or much compressed, branching (or perhaps sometimes foliaceous) expansions; branches varying from about half a line to three lines in breadth, with a thickness of near half a line; non-poriferous margins sharp, with striæ well defined, and curving laterally and forward. Pores nearly circular, or slightly oval, and provided, in well-preserved specimens, with raised margins, ranged in about eight to ten longitudinal rows in a branch two and a half lines in breadth; those in adjacent rows regularly alternating so as to produce a quincuncial arrangement; five of them occupying a space of one line, measuring longitudinally, and about six, measuring obliquely, the space between the pores in the longitudinal direction being usually a little greater than
the diameter of the pores themselves; rows of pores separated by a slender, sharply raised longitudinal line. Axis forming about one-third of the thickness of the branches, and having the transverse striæ sometimes very regular, well defined, and regularly arched.

I have not seen enough of any one specimen of this species to show whether or not its branches anastomose, but as they evidently frequently

bifurcate, and send off lateral branches, it is probable that they do. It seems to be more nearly allied to *Stictopora fenestrata* of Hall, from the Chazy limestone, in the arrangement and nearly circular form of its pores, as well as in having a raised longitudinal line between each row of pores, than to any of the known Upper Silurian species. It is a much more robust species, however, with only about the same number of rows of pores, in branches of twice the breadth of those of that species, while it shows no traces of the transverse bars mentioned in the description of *S. fenestrata.* Its flattened, non-poriferous and striated margins are also much more strongly developed. Indeed, no traces of this character of the margins are represented in the published figures, or mentioned in the description of that species.

Although I am not aware that any published notice of the occurrence of this genus in the Devonian rocks has hitherto appeared, I have little hesitation in referring this species to the group, since it seems to present all the characters assigned to the same; and I have also good reason to believe the genus represented in the Lower and Upper Carboniferous. In one respect it differs from most of the species described under *Stictopora;* that is, in having the pores a little contracted and nearly circular at the aperture. In this respect, however, it appears to agree with *S. fenestrata,* the first species described under that genus; and Prof. McCoy has shown that this character occurs in British species of *Ptilodictya* of Lonsdale, of which it is now generally admitted that *Stictopora,* Hall, is only a synonym, or, at most, founded on types only sub-generically distinct.

From the same horizon as that from which the above described species was obtained, but from a different locality (Whitehouse, Lucas county), there is in the collection a foliated specimen more than two inches in breadth and 4.70 inches long, with broken margins all around. It is split in breaking the rock so as to expose one side of the strongly wrinkled and striated axis. So far as I have been able to determine from some imperfect remaining portions of the poriferous part, its pores would seem to have the same form, size and arrangement as those of the species here described. It may, therefore, possibly belong to the same species, though I am inclined to believe it will be found to be distinct. If so, it may be called *P. (Stictopora) lichenoides.* It is represented by figure 2 of our plate 18, which shows only the wrinkled surface of a piece of the axis.

Locality and position: Sylvania, Lucas county, and Marblehead. Corniferous limestone. Mr. Gilbert.

BRACHIOPODA.

GENUS RHYNCHONELLA, Fischer, 1809.

(Mem. Soc. Imp. Mosc. II.)

RHYNCHONELLA CAROLINA, Hall.

Plate 18, figs. 8 *a-e.*

Rhynchonella (Stenocisma) carolina, Hall, 1867; Palæont. N. Y., Vol. IV., p. 337, plate 34, figs. 14-19.

Shell attaining a medium size, nearly equivalve, moderately compressed, trigonoid-subovate in general outline, the breadth about equaling the length, with the widest part usually in front of the middle, from which point the straight posterior lateral margins converge to the beaks nearly at a right angle; anterior lateral margins rather narrowly rounded into the front, which is usually nearly regularly rounded in outline, or a little projecting at the termination of the sinus along the middle; anterior margins of the valves meeting each other at a rather acute angle, both at the termination of the mesial sinus and on each side; that of the ventral valve being only gently incurved, and but very slightly produced, along the middle.

Ventral valve usually a little less convex than the other; beak prominent, narrow, and but moderately curved; mesial sinus rather broad, shallow, and flat within, at the front, and rarely extending back a little beyond the middle; surface ornamented by from twenty-five to twenty-eight simple, distinct, sub-angular, radiating costæ, of which about five to seven occupy the mesial sinus, one of those on each side being usually smaller and less prominent than the others.

Dorsal valve scarcely one-fourth more convex than the other, its greatest convexity being near the middle; beak rather distinctly incurved; mesial fold broad, depressed, flattened, or rounded, and not strongly defined, or usually extending much behind the middle, occupied by about six to eight costæ, which, like those in the sinus of the other valve, are usually somewhat larger than any of the others, excepting one on each side, which is generally smaller and more depressed. Costæ of both valves well defined to the beaks, on good specimens. Finer surface markings unknown.

Length of a well-developed specimen, 1.04 inches; breadth, 1.02 inches; convexity, 0.65 inch.

Some of our specimens of this species are about one-third larger than either of those figured in the New York Palæontology, and have the beak of the ventral valve more prominent, and the posterior lateral slopes straighter. But they agree so nearly in all other respects, that I can scarcely doubt their identity with that shell, especially as it is said to occur at the same locality. Its most marked features are its compressed, sub-trigonal form, shallow and undefined sinus, and depressed, not strongly defined, mesial fold, with one of the plications on each side of both sinus and fold usually smaller and less prominent than the others. It is also peculiar in not having the anterior margin of the ventral valve much incurved, or produced, at the termination of the sinus, but so directed as to meet that of the other valve there, at the same rather acute angle as on each side of the sinus.

It resembles *Rhynchonella? laura,* Billings (=*Leiorhynchus multicostata,* Hall); though it is less nearly like Mr. Billings's typical specimen than like some of the varieties included under the latter name. Still it may be distinguished by its straighter posterior lateral slopes, more produced beak, more regular, *simple,* and more angular plications. It also seems to be a much thicker shell than any species of the group *Leiorhynchus* known to me.

Locality and position: Corniferous limestone, Columbus, Ohio. I am under obligations to Rev. Mr. Herzer, of Louisville, Ky., for the use of the best specimens of this species I have seen.

LAMELLIBRANCHIATA.

GENUS AVICULOPECTEN, McCoy, 1851.

(Ann. Mag. Nat. Hist., Vol. VII., p. 171.)

AVICULOPECTEN PARILIS, Conrad?

Plate 18, figs. 6 *a, b.*

Avicula parilis, Conrad, 1842; Jour. Acad. Nat. Sci., Philad., Vol. VIII., p. 239.
Aviculopecten Sanduskyensis, Meek, 1871; Proceed. Acad. Nat. Sci., Philad., p. 161.

Shell attaining a moderately large size, strongly compressed, oblique, very nearly equivalve; exclusive of the ears, obliquely sub-oval in outline; anterior and anterio-basal margins forming an oblique sub-semicircular curve from the anterior ear to the posterior basal margin, from which the more prominent posterior outline rounds up with a shorter curve to the posterior ear; hinge line nearly three-fourths as long as the

anterio-posterior diameter of the valves below. Beaks compressed (particularly that of the right valve) and not projecting above the hinge margin; placed distinctly in advance of the middle of the valves, and somewhat in front of the middle of the hinge margin. Ears much compressed, and rather acutely angular at their extremities; anterior one more pointed than the other, extending forward as far as the margin below, from which it is separated by a deep angular sinus, that is rather more acute in the right valve, in which this ear is a little concave on its outer surface, and defined by a linear sulcus extending obliquely from the marginal sinus to the beak. Posterior ear flattened, and somewhat longer than the other, but distinctly shorter than the prominently rounded margin below; defined by a sub-angular marginal sinus, and separated from the body of the shell, in the right valve, by its flatness and the slight swell of the rather long, straight posterior umbonal slope; while, in the left valve, there is some appearance of a slight sulcus between it and the body.

Surface ornamented by numerous unequal, slender, radiating costæ, which, on the left valve, are more sharply defined, more thread-like, and sometimes separated, near the free margins, in large specimens, by spaces two or three times their own breadth, though usually a smaller rib occupies these spaces; while, on the right valve, the costæ are all more depressed, less strongly defined, proportionally wider, and separated by narrower and more shallow furrows. Fine lines, and occasional stronger marks of growth, traverse both valves concentrically, the latter often interrupting and displacing the radiating costæ.

Anterio-posterior diameter of a specimen under medium size, 1.27 inches; height, measuring at right angles to the hinge, 1.20 inches; convexity, about 0.16 inch.

In proposing the name *Aviculopecten Sanduskyensis* for the shell here described, I remarked that, “as near as can be determined from Mr. Conrad's figure, and rather brief description of a single valve of his *Avicula parilis* (Jour. Acad. Nat. Sci., Vol. VIII., pl. 12, fig. 9), the species under consideration would seem to be somewhat nearly allied. It has nearly the same general outline and obliquity, and somewhat similar ears, though its anterior ear is proportionally shorter, and defined by an impressed line extending from the sinus up to the beak. Our shell also differs,” I continued, “in being very nearly, or quite equivalve, instead of having the right valve flat, and the left plano-convex.”

Farther comparisons, since the publication of these remarks, have led me to believe this shell most probably only a variety of the form de-

scribed by Mr. Conrad; and I therefore now place it provisionally as a synonym under his name. I am the more strengthened in this conclusion by the fact that Hall and Whitfield, after the comparison of extensive collections from this horizon in the West, have expressed the opinion that *Aviculopecten parilis* of Conrad, will probably include *A. pectiniformis* and *A. princeps* of the same author. If the species *A. parilis* varies to such an extent as to include the other two forms mentioned, it may also include that here under consideration, though I have not the necessary collections at hand to settle the question beyond doubt.

As I know nothing of the hinge or internal characters of this shell, I am not positively sure that it has the distinguishing characteristics of *Aviculopecten*, though it probably has.

Locality and position: Sandusky, Ohio. Corniferous group of the Devonian series.

GENUS LUCINA, Bruguiere, 1792.

(Encyclop. Meth. I., pl. 284.)

LUCINA (PARACYCLAS) OHIOENSIS, Meek.

Plate 18, figs. 7 *a, b.*

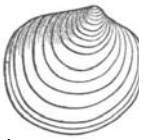
Lucina (Paracyclas) Ohioensis, Meek, 1871; Proceed. Acad. Nat. Sci., Philad., p. 6.
Compare *Posidonia lirata,* Conrad, 1838; see fig. 12, pl. II., 13th Regents' Report on State Cab. of N. Y.

Shell apparently not attaining a medium size, compressed, more or less nearly circular; beaks small, central, depressed nearly to the dorsal line, and contiguous; anterior margin rather abruptly compressed above, just in front of the beaks; hinge margin short and rounding into the posterior dorsal outline; surface ornamented with small, more or less regular, concentric undulations, most strongly defined on the umbones, and very fine lines of growth; posterior dorsal slopes of each valve marked by a strongly oblique sulcus, extending from the back part of the beaks to the upper part of the posterior margin, to which it imparts a slightly sinuous outline at its termination.

Length, 0.46 inch; height, 0.42 inch; convexity, 0.18 inch.

In proposing to name this as a new species, I mentioned the fact of its close relations to *Lucina lirata* (=*Posidonia lirata,* Conrad); but stated that "its peculiar posterior dorsal sulcus, which gives it so much the appearance of the recent *L. Jamaicensis,* is neither represented in Mr. Con-

rad's figure, nor mentioned in his description of *L. lirata*." At that time, I had no authentic specimens of Mr. Conrad's species at hand for comparison; but subsequently, through the politeness of Prof. Hartt, of Cornell University, I have had an opportunity to compare our specimens with good examples of *L. lirata* from the Hamilton group of New York, belonging to the Cornell museum. These specimens agree precisely with Mr. Conrad's figure and description, and show no traces whatever of the sulcus mentioned above.* In regard to the importance of this difference, opinions may differ, especially as the Ohio specimens seem to agree well in all other respects with those from New York. As I have yet seen but few of the Ohio specimens, however, I cannot assert, positively, that they may not vary in this character, though I have observed no evidence that they do; and, consequently, have not felt warranted in referring them to Mr. Conrad's species. Prof. Hall and Mr. Whitfield, however, regard them as not being specifically distinct from the New York form.



LUCINA LIRATA, Con. (sp.). A fac-simile of Mr. Conrad's original figure of his *Posidonia lirata.*

In order that the student may have the means of comparing the Ohio shell with Mr. Conrad's figure and description of *L. lirata,* I give the annexed wood-cut fac-simile of his figure, and the following copy of his diagnosis:

"Shell sub-orbicular, convexo-depressed; disc with about 18 concentric, angulated carinæ, and with concentric striæ. Length nearly one inch."

The identity of these Devonian shells with the existing genus *Lucina* may admit of some doubt, as their hinge and internal characters are not very well known. The form here under consideration, however, has even more exactly the *external* appearance of that genus than several foreign Devonian species that have generally been referred to it. Perhaps these ancient species may all be included under one distinct genus, for which the name *Paracyclas,* proposed by Prof. Hall, may be retained.

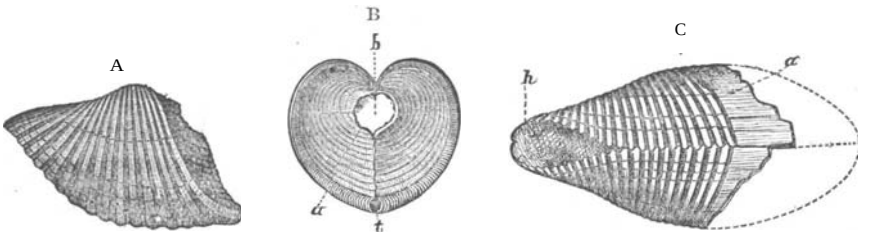
Locality and position: Dublin, Franklin county, Ohio. Corniferous division of the Devonian series.

* It may be proper to remark here, that this difference cannot be due to different conditions of preservation, since both the Ohio specimens and those from New York, now before me, are alike *well-defined casts of the exterior* surface of the shell.

GENUS CONOCARDIUM, Bronn, 1835?

(Leth. Geog., p. 91.)

CONOCARDIUM TRIGONALE, Hall.



A–Side view of a medium-sized, mature specimen, being mainly an internal cast, with the umbonal alations and the anterior beak-like appendage broken away. What appears like the anterior umbonal rib in the cut, is the evenly broken off edge of the alation, and should have had the minute cross lines running more obliquely and curved in the opposite direction.

B–Anterior view of another specimen in nearly the same condition; *b* representing the broken end of the beak-like appendage; *t*, the opening of the slender sub-cylindrical canal, passing forward from the interior, between the meeting ventral edges of the alations; and *a*, on each side, the connection of the alations with the umbonal ridges.

C–A view of the under side of another specimen, retaining a portion of the alation (marked *a*), which extended at least as far forward as indicated by the dotted lines *h*, points to the posterior hiatus.

Pleurorhynchus trigonalis, Hall, 1843; Report 4th Geol. Dist. New York, p. 172, with wood-cuts, figs. 6 *a*, *b*, on p. 171; and Regents' 12th Report (1859), p. 88; (not *P. trigonalis,* Phillips, 1836=*Conocard. trigonale,* d'Orb., 1850.*

Conocardium trigonale, Dana, 1864; Man. Geol., p. 274, fig. 457; Hall and Whitfield (excl. synon.), ad vance sheets extr. from Regents' Report, dated June, 1872.

Conocardium sub-trigonale, d'Orbigny, 1859; Prodr., Vol. I., p. 80.

Shell attaining a medium size, cordate-sub-trigonal, being sub-trigonal as seen from either side, and distinctly cordate in an anterior view, becoming quite convex in adult examples; anterior side abruptly truncated, with a forward slope from the beaks to the more or less angular anterior basal extremity, and flattened, or sometimes even a little concave, near the outer margins, so as to meet the lateral surfaces at about right angles, or less, along the prominent, angular, umbonal slopes, which extend to the anterior basal extremity, and are produced forward in the form of a peculiar thin alation, that is most extended below; dorsal margin behind the beaks nearly straight and horizontal, or a little declining and slightly concave in outline, with the edges of the valves incurved, while in front of the beaks it is more or less produced forward, in the

* *Pleurohynchus trigonalis* of Phillips, has been most generally considered identical with *C. Hibernicum,* Sowerby, though some high authorities have viewed the two names as representing two distinct species. If they are distinct, of course the specific name *trigonale* could not be used for the American form, which would, in that case, have to take d'Orbigny's name, *C. sub-trigonale.*

form of a narrow (beak-like?) extension; basal margins of the valves strongly incurved, and distinctly crenate within, nearly straight in outline, anteriorly and obliquely ascending, with a more or less convex outline posteriorly to near the hinge, below which they are widely gaping, so as to form an ovate or sub-cordate hiatus, and present a slightly sinuous outline; posterior extremity (when not broken or worn away) distinctly angular at the termination of the hinge line above; beaks moderately prominent, gibbous, and distinctly incurved nearly at right angles to the hinge, or with a very slight backward inclination. Surface ornamented by simple, regular, radiating costæ, separated by furrows of about the same size or less; costæ smaller and more crowded on the anterior flattened face of the valves than on the flanks behind the umbonal angle, and not defined on the anterior umbonal alation; crossing all of these markings, there are numerous fine, regular, crowded, concentric lines, generally much more distinct in the furrows than on the ribs between them, and more or less marked on the anterior alations; a few stronger wrinkles of growth are also usually seen at more distant intervals, especially near the lower margins of the valves, where they are more crowded together, and present a zig-zag appearance in crossing the costæ and furrows.

Length of a mature, rather short, gibbous specimen, from the anterior basal angle to the posterior extremity of the hinge, 1.32 inches; from beaks to same, 0.65 inch; height to top of umbones, 0.72 inch; convexity of the two valves, anteriorly, 0.94 inch.

This species varies more or less in general form, some examples being proportionally longer from the prominent umbonal slopes posteriorly than others which are proportionally more gibbous. In different states of preservation, the costæ and furrows between them present different appearances, being sometimes of nearly equal breadth; while in other examples, or even other parts of the same specimen, the furrows are merely linear. On well-preserved examples, the costæ are simple, but in exfoliated or worn specimens, they sometimes present a duplicated or even triplicated appearance. In some worn specimens, numerous punctures may be seen, much like those in some brachiopods, but coarser and more scattering, while others show nothing of the kind. As taken from a limestone matrix, the alations of the anterior umbonal slopes are generally broken away; and the posterior extremity is often broken or worn so as to appear more obtuse than natural, as was the case with the individual figured in Prof. Dana's Geology, as well as (apparently) that figured in Prof. Hall's report. The alations of the anterior umbonal an-

gles are most produced below, where they are sometimes an inch or more in length, in large examples; but they diminish in length (breadth, as some would understand) upward to nothing at the beaks, and consequently evidently increased with the growth of the shell; that is, they probably never increased in extent on the beaks, or at any point above the free margins, after the shell had attained any size, the additions being always made at the anterior basal angle as the valves increased in size. Broken specimens show that there was a slender, cylindrical or terete cavity extended forward in this alation along the line where its straight edges in the two valves meet below. Whether or not it terminated in an external opening, I have not been able to see, though it probably did not, as it tapers forward as the alation diminishes in thickness. It seems to have been occupied by a slender lobe or appendage of the mantle, that secreted the shelly matter forming the alation.

Notwithstanding its variations, this species may usually be readily recognized by its trigonal form, prominent and angular umbonal slopes, abruptly truncated anterior side, and (as seen in a side view) more or less angular anterior basal extremity.

Among the specimens usually referred to this species that I have seen from different localities in the West, there are two varieties, or possibly even distinct species. They appear to agree in all other characters, excepting that one is nearly always smaller, usually less gibbous, and has finer and more numerous costæ than the other. It shows about thirty costæ on each valve, behind the umbonal angle, instead of only twenty to twenty-five, as in the other variety. In Ohio, these two varieties occur at different horizons in the Corniferous group.

Locality and position: The typical specimens of this species were from the Corniferous limestone, in Erie county, New York. It also occurs in Canada, at the same horizon. I have likewise had for study a fine series of specimens from Dr. James Knapp's collection, found at probably about the same horizon at Louisville, Ky. Our Ohio specimens are from the Corniferous beds at Sandusky and Columbus. It also occurs in rocks of the same age in Indiana, and some other Western States.

CONOCARDIUM OHIOENSE, Meek.

Plate 18, fig. 9, and cut *a*, on page 204.

Conocardium Ohioense, Meek,1871; Proceed Acad. Nat. Sci., Philad., p. 9.

Conocardium trigonale (part), Hall and Whitfield; Cat. Louisville Fossils, p. 12; dated June, 1872 (not of Hall, 1843).

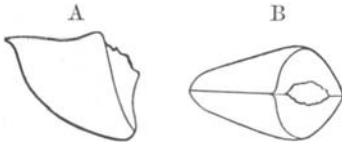
Shell rather small, longitudinally ovate-sub-trigonal, being widest and most convex anteriorly, where the valves are rather distinctly ventri-

cose; posterior side produced and abruptly contracted behind the gibbous anterior region, partly from lateral compression, and partly from the upward and backward slope of the posterior basal margin, which is slightly sinuous in outline near the extremity, and distinctly gaping, the widest part of the hiatus being above the middle; hinge line straight, or sometimes slightly declining at the posterior extremity; cardinal margins of the valves incurved; anterior-side short, though not properly truncated or flattened, abruptly contracted and a little impressed in front of the umbonal convexity, apparently provided with a slender beak-like appendage above (this part broken in the specimens); beaks projecting a little above the cardinal margin, placed in advance of the middle, and incurved with scarcely any obliquity; umbonal slopes gibbous, broadly rounded and slightly inclined backward. Surface ornamented by simple, somewhat flattened, radiated costæ, about five or six of which, on the gibbous part of each valve, are larger than a few of those immediately behind them, and separated by flattened furrows nearly or quite as wide as the costæ themselves; while on the posterior contracted portion, farther back, the costæ are proportionally wider, but more depressed, and separated by merely sharply impressed hair lines, excepting near the posterior cardinal margin, where these impressed linear furrows are represented by little *raised* lines; costæ on the anterior surface more obscure, and decidedly smaller than those on the umbones; fine regular lines and a few stronger marks of growth are also seen crossing the costæ parallel to the free margins.

Length of a specimen with the anterior attenuated appendage at the end of the hinge broken away, 0.64 inch; height, 0.43 inch; convexity, 0.37 inch.

CONOCARDIUM OHIOENSE.

A–An outline side view of a specimen with the beak-like appendage broken away—natural size.
B–A dorsal view of same species, in outline, to show the rounded ventricose character of the umbonal region, and the constriction behind the same.



CONOCARDIUM TRIGONALE.

A–An outline side view of a young specimen, being mainly an internal cast with the alation and beak-like appendage broken away—the oblique line representing the angular umbonal slope. Compare with
B–Dorsal view of same. Compare with.

This form is thought by Prof. Hall and Mr. Whitfield (see Catalogue of Fossils found at Louisville) not to be distinct from *C. trigonale*. To me, however, it seems to be readily distinguishable. It is not only always smaller, but differs materially in form, from the young of *C. trigonale* of its own size, and still more decidedly from the adult of the

same. These differences will be more readily understood by reference to the annexed outline cuts than from our figure on plate 18, which was drawn from a specimen that is a little defective at the anterior basal margin, though its marks of growth clearly show it to have the same form. From these cuts it will be seen that the shell under consideration, instead of having its anterior margin, below the extension at the anterior end of the hinge, sloping obliquely *forward,* or descending more or less nearly vertically to an anterior basal angle, has it sloping obliquely *backward* and rounding regularly into the base, without forming with the latter the slightest traces of an angular outline. I am aware that this anterior basal angle in *C. trigonale* is less produced and more blunted in young than old specimens, especially when the alation is broken away; but I have never seen a specimen that I could refer to the young of that species, with the outline of the anterior basal margin approaching that seen in the annexed cut, A. Nor do the marks of growth on well-developed specimens of that species indicate that they ever presented such an outline at any age.* An equally important difference is also observable in the umbonal slopes, which, instead of being *distinctly angular* from the beaks to the anterior basal margin, as they are even in internal casts of *C. trigonale,* are *broadly* and *regularly rounded* throughout their entire length. I cannot see how this difference can be due to differences of age and size, because it must be evident that, after the beaks were formed, and the shell had grown to any given size, additional angularity could not have been imparted to the umbonal slopes near the beaks by any farther growth of the shell; nor even any greater extension there to the alation, the additions to which were always made at the anterior basal angles of the valves, at which points the increase to the alation doubtless continued as long as the shell continued to grow. This angularity of the umbonal slopes is not only strongly defined in young specimens of *C. trigonale,* such as that represented by our outline cut, figs. A and B, but it can be traced, clearly and strongly defined, even to the points of the beaks, on all of the adult shells or internal casts of that species I have seen.

In addition to this, there is a decided constriction just behind the swell of the umbonal region in *C. Ohioense,* best seen in a dorsal view (see cut B), of which I have seen no traces in well-developed specimens of *C. trigonale,* where it would at least occur near the beaks, if it had existed in the young shell. Another difference may also be seen in the size of the costæ, or the breadth of the furrows between them, on the

* When these marks are well defined, it is always easy to determine from their curves on the umbonal region of the adult the exact outline of the young shell.

gibbous part of the umbonal region, where they are proportionally larger in *C. Ohioense* than on the corresponding parts of the umbones in the young, or mature, well-defined examples of *C. trigonale,* both of which likewise have the anterior faces of the valves decidedly more flattened than in our shell. From the roundness of its umbonal slopes, and its broadly rounded anterior basal margin, it also seems very improbable that *C. Ohioense* ever had any umbonal alation, though it possibly may have had.

Among collections from several western localities, there occur specimens of a small shell usually considered the young, or a variety, of *C. trigonale,* that agree with *C. Ohioense* in the ventricose character of the anterior region, and the distinct constriction behind the same, but differ in having the umbonal slopes slightly angular, and the anterior ventral margin a little angular and somewhat prominent in outline, instead of sloping and rounding regularly backward into the base. The fact, however, that we do find other specimens of equally small size associated with adult, well-developed *C. trigonale,* and agreeing well with that shell in the distinctly carinated character of the umbonal slopes, the produced and angular outline of the anterior basal margin, and the absence of any constriction behind the flattened backward converging (not ventricose) umbonal region, seems to render it very improbable that the other small specimens more nearly approaching the form of *C. Ohioense* are really also young individuals of *C. trigonale.* Whether or not these latter may shade by intermediate forms into *C. Ohioense,* I am not able to decide, without more specimens for comparison, but it is not improbable that such may be the case. I cannot conceive, however, how the young of *C. trigonale* could ever have had such a ventricose umbonal region, with the decided constriction seen behind it, without some indications of these peculiarities being observable near the beaks of the numerous adult specimens of that species found.

Locality and position: Corniferous limestone of the Devonian, near Columbus, Ohio.

GENUS SOLEMYA, Lamarck, 1818.

(Hist. Vol. V., p. 488.)

SOLEMYA (JANEIA) VETUSTA, Meek.

Plate 18, fig. 4.

Solemya (Janeia) vetusta, Meek, 1871; Proceed. Acad. Nat. Sci., Philad., p. 10.

Shell of medium size, transversely sub-oblong, or narrow sub-elliptic, the length being a little less than twice and a half the height; valves rather convex; anterior or longer side regularly rounded; posterior ex-

tremity more narrowly rounded; basal margin nearly or quite straight along the central region, but rounding up at the extremities, the curve being more gradual behind; beaks depressed to a level with the dorsal margin, and placed somewhat behind the middle; dorsal margin a little convex and nearly horizontal in front of the beaks, but rounding regularly into the anterior outline, and behind the beaks, slightly depressed below the horizon of the latter, though without sloping much posteriorly. Surface apparently smooth; interior showing distinct, radiating striæ below the middle of the valves, excepting near the extremities. Posterior muscular impression rather narrow, sub-oval, oblique, placed near the margin, and well defined by a slight oblique ridge along its anterio--inferior margin; anterior do., larger and faintly marked.

Length, 1.22 inches; height, 0.50 inch; convexity, 0.32 inch.

This is another type very unexpectedly found among the Corniferous specimens. So far as I am aware, no example of this group has ever before been obtained from any horizon below the Mountain limestone. Whether we regard the Carboniferous and Permian forms usually referred to *Solemya* as really belonging to that genus, or as constituting a distinct group (for which Prof. King proposed the name *Janeia*), there can be no question whatever that the shell here described belongs to the genus that includes these Carboniferous and Permian species. Specifically, it is perhaps more nearly related to *S. biarmica* of the European Permian rocks than it is to *S. Puzosiana,* de Kon., or to *P. primæva,* Phillips, from the Carboniferous. Indeed, it might even be referred to *S. biarmica* with more propriety than a Kansas Coal-measure species that has been so referred by Prof. Geinitz. Compared with the figures of the original Russian example of *S. biarmica,* figured in the Palæont. of Russia and the Ural Mountains, pl. XIX., fig. 4 *a* and 4 *b,* our shell is seen to be proportionally somewhat more depressed and longer, with the beaks a little less prominent, and farther removed from the shorter or posterior extremity. Its posterior dorsal slope, even in the internal cast, is also less oblique. In this latter character it is even less like the English and German Permian forms referred to *S. biarmica.*

I have elsewhere (Proceed. Acad. Nat. Sci., April, 1870, p. 44) expressed the opinion that these Palæozoic shells usually referred to *Solemya,* may yet have to be separated from that genus, and ranged under Prof. King's name *Janeia,* notwithstanding the fact that he subsequently abandoned his genus, under the impression that it is not distinct from *Solemya.* I still think it probable that this may have to be done.

Locality and position: Dublin, Franklin county, Ohio. Corniferous group of the Devonian.

GENUS CLINOPISTHA, Meek and Worthen, 1870.

(Proceed. Acad. Nat. Sci., Philad., p. 43.)

CLINOPISTHA ANTIQUA, Meek.

Plate 18, figs. 5 *a, b.*

Clinopistha antiqua, Meek, 1871; Proceed. Acad. Nat. Sci., Philad., p. 11.

Shell very thin, transversely sub-oval, gibbous, with flanks along the middle, near the lower margin, somewhat flattened or slightly concave; more than half as high as long; anterior or longer side regularly rounded in outline; posterior sloping above from the beaks to the narrowly rounded extremity, which is most prominent below the middle; basal margin straightened or broadly sinuous along the central region, and rather abruptly rounded up at the extremities; beaks depressed nearly or quite to the dorsal outline, and placed about half way between the middle and the posterior extremity; dorsal outline nearly horizontal and parallel to the base, in front of the beaks, but rounding regularly into the anterior margin. Surface merely showing moderately distinct lines of growth, with some obscure traces of radiating striæ, where a little worn near the base; these last mentioned markings being more distinct on the internal cast.

Length, 0.22 inch; height, 0.51 inch; convexity, 0.39 inch.

I have been much surprised to find among the collections from the Corniferous limestone a shell agreeing so exactly as this, in all its known characters, not evidently merely specific, with the type of the genus *Clinopistha,* which group I had previously supposed to be confined to the Coal-measures. It has the same short, gibbous form, thinness of substance, posterior position of the beaks and ligament, surface markings, and even the same obscure, internal, radiating striæ. Indeed, if it were not for its rather more narrowly rounded, and more protuberant, instead of slightly truncated, posterior or shorter and somewhat less gibbous beaks, and faintly sinuous base and flanks, it would scarcely be possible to distinguish it from the Coal-measure form, by any external character, excepting the white chalky texture of the shell, which is merely due to its state of preservation. The valves are a little displaced in the only good specimen I have seen, but the beaks certainly give some evidence of being slightly unequal—that is, of the left one lapping slightly upon the other, as in the typical species from the Coal-measures.

Locality and position: Same as last.

GENUS SANGUINOLITES, McCoy, 1844.

(Synop. Carb. Foss., Ireland, p. 47.)

SANGUINOLITES? SANDUSKYENSIS, Meek.

Plate 18, fig. 3.

Sanguinolites? Sanduskyensis, Meek, 1871; Proceed. Acad. Nat. Sci., Philad., p. 12.

Shell approaching a longitudinal-oblong or trapezoidal outline, moderately convex, a little more than twice as long as high, and slightly narrower anteriorly than behind; cardinal margin straight, equaling about three-fifths the entire length; basal margin nearly straight, or a little sinuous toward the front, and sub-parallel to the hinge, or slightly ascending anteriorly along its entire length, and rounding up a little more gradually into the front than behind; posterior extremity compressed, obliquely truncated above, and rather narrowly rounded to the base below; anterior side very short, sloping rather abruptly from the beaks above, and narrowly rounded at the middle; beaks depressed nearly or quite to the hinge line, compressed, and placed near the middle of the anterior third; posterior umbonal slopes not angular, or even prominently rounded. Surface only showing few irregular furrows and slight undulations of growth, most distinct below the middle of the valves.

Length, 2.70 inches; height at the posterior end of the hinge, 1.20 inches; do. under the umbones, 1.04 inches; convexity, about 0.52 inch.

I know nothing of the hinge of this shell, and merely refer it to the genus *Sanguinolites* provisionally. Indeed, until palæontologists can agree in regard to which one of the types that were originally referred to that genus is to be regarded as the typical form of the same, and something can be known in regard to the hinge and internal characters of those shells, it seems to me almost impossible to know what *Sanguinolites* is. I do not agree with those, however, who would make *Allorisma* of King a synonym of Prof. McCoy's genus, though some of the species included by him may belong to *Allorisma*.

Locality and position: Same as foregoing.

GASTEROPODA.

GENUS PLATYCERAS, Conrad, 1842.

(Jour. Acad. Nat. Sci., Philad., Vol. VIII., p. 275.)

PLATYCERAS MULTISPINOSUM, Meek.

Plate 20, figs. 7 *a, b.*

Platyceras multispinosum, Meek, 1871; Proceed. Acad. Nat. Sci., Philad., p. 17.

Shell attaining a large size, comparatively thin, depressed sub-ovate, and very oblique; apex free, stout, obliquely coiled, so as to make about one turn, beyond which the body part expands very rapidly to the aperture, making less than half of another volution; aperture proportionally very large and nearly circular; lip not sinuous or undulated, but sometimes slightly and broadly retreating behind; surface without plications or costæ, but thickly covered by numerous slender tubular spines, which leave small, depressed, smooth, undefined tubercles on the internal cast.

Length, measuring direct from the most prominent part of the spire to the anterior margin of the aperture, 3.33 inches; height to the most elevated part of the dorsal surface, when the shell is placed with its aperture downward, 1.44 inches; length and breadth of aperture, each about 2.90 inches.

This fine species differs from *P. dumosum,* Conrad, not only in its much larger size, more oblique, depressed, and more rapidly expanding form, but in having much more numerous spines. The largest specimens of that species are said to have more than one hundred spines, while that under consideration must have had more than two hundred. It likewise differs in not having its lip waved or undulated, as in Mr. Conrad's species.

It is probably more nearly related to *P. echinatum,* Hall, from the Hamilton group. No figures of that species have yet been published, but judging from the description, our shell is not only very much larger (that species being described as from one to one and a quarter inches in length, with an aperture one inch in diameter), but wants the sinuous peristome mentioned in the description of *P. echinatum*. The term “strong nodes” would also not apply to the numerous small, obscure

elevations marking the positions of the spines on internal casts of our species.

None of our specimens show the entire length of the spines, but judging from the fact that their broken ends, at a distance of 0.42 inch from their bases, only measure 0.08 inch in diameter, they would seem to have been probably shorter and more slender, as well as much more numerous, than those of *P. dumosum.* Although these spines are as completely tubular as those of the genus *Productus,* their internal cavity does not seem to have communicated with the interior of the shell, with probably the exception of those near the lip; for if that had been the case, the smoothly rounded, obscure tubercles seen on the internal cast would have shown the broken bases of the casts of the internal cavities of the spines.

Prof. Hall and Mr. Whitfield, in their list of the fossils found at Louisville, Kentucky, issued after the publication of the foregoing description and remarks, have placed this species as a synonym of *Platyceras dumosum,* Conrad. In view of the well-known variability of the species of this genus, I am willing to admit that it *may* possibly be an extreme variety of Mr. Conrad's species; though I have not yet seen the intermediate forms that would connect it with the typical examples of that shell, or with any others that could, with certainty, be identified with the same. I can only say that it differs, in a very marked degree, in size, form, and nearly all of the other characters usually regarded as specific in the genus, from the figure given by Prof. Hall in the Regents' 12th Annual Report, p. 19, as an illustration of *P. dumosum.** It is also certainly greatly larger than the maximum size of that species, as given by Prof. Hall in the 15th Report of the Regents, page 37, where *P. dumosum* is said to attain, "in its full size, a length of two and a half inches;" while specimens of the form under consideration, now before me, measure full *four inches* in length. Whatever may be thought of these differences, I think palæontologists will generally admit that the shell under consideration is, at least, as distinct from *P. dumosum* as several forms figured by Prof. Hall in the third volume of the Palæontology of New York, under different specific names, are distinct from each other.

Locality and position: Columbus, Ohio. Corniferous group of Devonian series.

* Mr. Conrad gave no figure of his type, and his description, although sufficient to distinguish it from any of the other species then known to him, is so brief that it would apply almost equally well to anyone of the several other spiniferous species now known.

PLATYCERAS DUMOSUM, *var.* ATTENUATUM.

Plate 20, figs. 2 *a, b.*

? Platyceras dumosum, Conrad, 1840; Ann. Rep. Palæont. N. Y., p. 205; Hall (1859), 13th Regents' Report, p. 19.

Platyceras attenuatum, Meek, 1871; Proceed. Acad. Nat. Sci., Philad., p. 75.

Shell attaining a moderate size, very slender and elongated. Body part more or less arched above, a little compressed behind, sub-angular on the right side, rounded over the dorsal or anterior slope, and gradually tapering backward to the small free apex, which is composed of one to one and a half contiguous volutions, and twisted to the right of the longitudinal axis of the body.* Aperture irregularly oval, or sub-triangular, and comparatively small or little expanded; lip most produced on the right anterior side, and sometimes a little retreating behind, with, at one or two other points, smaller undulations of its margin around the front. Surface of cast without longitudinal plications, folds or undulations, but showing, on internal casts, over the dorsal and anterior slope, numerous small tubercles, that evidently mark the positions of spines on the exterior. Surface markings of the shell itself unknown.

Length of the larger specimen, measuring direct from most prominent part at the curve of the spine to that of the anterior margin of the aperture, 2.10 inches; do., measuring from the apex over the dorsal curve to the same, about 3.70 inches; greatest breadth of aperture, 1.35 inches.

This shell seems to differ from all of the described spiniferous species with which I am acquainted, in being more slender, more elongated, and in having the small apex twisted nearly at right angles to the axis of the body part. These characters appear to distinguish it readily from the *typical form* of *P. dumosum,* Conr.; while, from the variety of that species that has has been described under the name *rarispinum,* it differs in never having its body even "moderately ventricose," nor in any case in contact with the apical coils, as well as in having more numerous spines, if we can judge from the number of tubercles, of which about fifty may be counted on the specimen from which the foregoing description was made out. I place it, with considerable doubt, as a variety of *P. dumosum.*

* I describe such forms, for convenience, as if placed with the aperture downward and apex directed backward toward the observer.

In general form, it resembles the more slender individuals of the non-spiniferous species *P. reflexum,* from the Oriskany Sandstone, but its body part is much straighter, while it is never so large and ventricose as in some varieties of that species.

Locality and position: Columbus, Ohio. Corniferous group.

GENUS CYCLONEMA, Hall, 1852.

(Palæont. N. Y, Vol. II., p. 89.)

CYCLONEMA CRENULATA, Meek.

Plate 19, figs. 2 *a, b,* c, *d.*

Cyclonema crenulata, Meek, 1871; Proceed. Acad. Nat. Sci., Philad., p. 79.

Shell turbinate-subtrochiform, thin; spire depressed conical; volutions four, increasing rather rapidly in size, those of the spire convex, but not rounded; last one large, convex on the upper slope to the periphery, which is rather narrowly rounded; suture well defined between the upper volutions, and somewhat canaliculate farther down; aperture ovate. Surface ornamented by sharply elevated, revolving lines or small ridges, which are beautifully and minutely crenated by the crossing of the fine, very oblique lines of growth. Of these revolving lines, from sixteen to eighteen may be counted on the body volution, and six on the next above, while those farther up appear to be quite smooth.

Length, 0.34 inch; breadth, 0.32 inch.

This species seems to be somewhat related to *C. multilira,* Hall (Fifteenth Report of Regents, p. 48, pl. 5, fig. 17), but has a decidedly more depressed form, with the volutions of its spire merely convex, instead of rounded, and its body volution narrowly, instead of regularly, rounded. It also has more revolving lines, which likewise show a delicate crenate character not represented in the figure nor mentioned in the description of *multilira.*

In general appearance, our shell more nearly resembles Mr. Conrad's original figure of his *C. bilix* (Jour. Acad. Nat. Sci., Vol. VIII., pl. XVI., fig. 10), but it is less oblique, with more convex volutions, and more numerous revolving lines.

Locality and position: Same as last.

GENUS NATICOPSIS, McCoy, 1844.

(Synop. Carb. Foss. Ireland, p. 33.)

NATICOPSIS? (ISONEMA) HUMILIS, Meek.

Plate 19, figs. 1 *a, b,* c.

Isonema humilis, Meek, 1871; Proceed. Acad. Nat. Sci., Philad., page 79.
? Naticopsis LÆVIS, Hall and Whitfield, 1872; Descrip. New. Sp. Foss., pl. 12, figs. 3, 4 and 5 (not *N. levis,* Meek, 1871).

Shell large and robust, depressed sub-turbinate, about one-fourth to near one-third wider than high; spire much depressed; volutions four, increasing rather rapidly in size, the exposed part of those of the spire gently convex; last one large, and regularly rounded, or sometimes very obtusely sub-angular around the middle of the outer side; suture well defined, without being properly channeled; aperture nearly circular a little within, but more or less angular above, at the immediate edge of the lip, where it is more oval in outline; outer lip thin, and in mature specimens slightly dilated; inner lip thickened, very distinctly flattened, and slightly spread over the imperforate umbilical region, as well as a little thickened near the top of the aperture. Surface ornamented with oblique, slightly arched lines of growth, which, on the first and second turns of the spire, are rather coarse, well defined, and present the characteristic regularity of size and arrangement, but soon become, on the succeeding turns, much finer and more crowded, as well as occasionally interrupted by irregular, stronger furrows and wrinkles of growth.

Height of a medium-sized specimen, 1.10 inches; breadth, 1.56 inches; height of aperture, measuring at the margin of the lip, to the top of the angle above, 0.95 inch; breadth about 0.87 inch.

At one time I suspected that this might possibly be the same species as *Isonema depressa,* M. and W.; that is, that it might be the adult, and *I. depressa* the young of the same species. I hardly think now, however, that this is so. It certainly shows only the same number of volutions, in individuals attaining nine or ten times the bulk of that form, and differs in being less depressed, and having more rounded and more ventricose volutions, as well as a less strongly and regularly striated surface on the upper side of the volutions. There can be no doubt, however, that it belongs to the same group.

It must have been from a rather hasty reading of my description of *Naticopsis levis,* that Hall and Whitfield referred to that species, in their list of fossils found at Louisville, the shell represented by the annexed cut, which I believe to be identical with the species here described. By reference to my description of *N. levis,* it will be seen that I distinctly described it as "sub-ovate in general outline," and gave the length of the largest specimen as 0.60 inch, with a breadth of only 0.48 inch; or, in other words, with the breadth only four-fifths the length; while the shell figured by them as *N. lævis* is decidedly *wider* than *high,* and so completely different in nearly all other respects as to leave room for doubts whether it really belongs to the same genus. Their specimen was much more nearly complete than any of those I have seen of the form under consideration, as it shows the lip entire, the whole of the broad flattened columella, and the exact outline of the aperture—in short, the whole shell; consequently, I have added an outline of their figure. Whether *exactly* identical, specifically, with the form here under consideration or not, it, beyond all question, belongs to the same group. Since seeing their figure of a specimen showing so clearly all of the characters of *Isonema,* I am led to think that group more nearly allied to *Naticopsis* than I had supposed. Still, I doubt very much whether such depressed species, differing so materially in physiognomy from the typical Carboniferous forms on which *Naticopsis* was founded, ought to be included under the same genus. If so, however, they certainly should be placed as a distinct sub-genus, which would require the name of the species *depressa* to be written *Naticopsis (Isonema) depressa.*

NATICOPSIS (ISONEMA) HUMILIS.

An outline of a figure, apparently of this species, given by Hall and Whitfield. showing the aperture and lip more completely than any of our specimens. (See Descr. New. Sp. Devonian Foss. from Iowa, pl. 12, fig. 3.)

Locality and position: Same as foregoing.

NATICOPSIS LEVIS, Meek.

Plate 19, figs. 4 *a, b.*

Naticopsis levis, Meek, 1871; Proceed. Acad. Nat. Sci., Philad., p. 76 (not *N. lævis,* Hall and Whitfield, 1872) ; Descrip. New. Sp. Fossils from Devonian rocks of Iowa, pl. 12, figs. 3, 4 and 5.

Shell apparently attaining a medium size, sub-ovate in general form, at maturity, but proportionally shorter in the young; spire moderately prominent; volutions four to four and a half, convex, increasing rather

rapidly in size; last one large, or forming near nine-tenths of the entire bulk of the shell, rounded on the sides, and a little extended below; suture well defined; aperture ovate, being regularly rounded below, and more or less angular above; columella arcuate and distinctly flattened, or a little concave below the non-perforate umbilical region, above which the inner lip is thickened. Surface only showing obscure lines of growth.

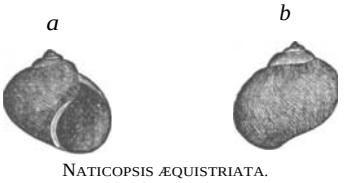
Length of the largest specimen seen, 0.60 inch; breadth, 0.48 inch; height of aperture, 0.38 inch; breadth of do., 0.27 inch.

So far as I am at present informed, this is the first Devonian species, beyond doubt known to belong to this genus, that has yet been described in this country, though it is certainly represented in rocks of that age in Europe.* Our species is even more closely allied to the typical Carboniferous forms of the genus than it is to the European Devonian species, such as *Naticopsis subcostata* and *N. margaritifera* [=*Natica subcostata* and *N. margaritifera, d' Archiac* and *de Verneuil*].

It is an interesting fact that the above-mentioned European Devonian species represent both of the sub-genera found in our Coal-measures; the first belonging to the sub-genus *Trochydornia,* and the other to the typical section of the genus.

Locality and position: Dublin, Franklin county, Ohio. Corniferous group of the Devonian.

NATICOPSIS ÆQUISTRIATA, Meek.



NATICOPSIS ÆQUISTRIATA.

a View of aperture, lip, etc., magnified about 3 diameters.

b An opposite view of same; showing the strongly curved striæ a little too fine to correspond with the size of the magnified figure.

Shell sub-globose; spire much depressed; volutions four, increasing rapidly in size, those of the spire convex, last one large and ventricose; suture well defined; aperture ovate; outer lip thin, extended forward and very oblique above, and broadly retreating or sinuous below the middle; columella narrow, arcuate, imperforate, and showing some appearance of being a little furrowed below, as if for the reception of the edge of an operculum; inner lip apparently not thickened above. Surface ornamented by fine, very regu-

* It is probable that several of the so-called Naticas of the European Silurian rocks also belong to this genus, as may be the case with some of the American Silurian species referred to *Holopea* and other genera, from the study of mere casts.

larly and closely arranged striæ of growth, which pass very obliquely backward and downward on the upper and outer side of the body volution, and then curve gracefully forward again below, so as to conform to the broad sinuosity of the outer lip.

Height, 0.17 inch; breadth, 0.18 inch.

This little shell will be at once distinguished from the young of the last, of corresponding size, with which it agrees very nearly in form, by its beautiful, very regular, well-defined, and gracefully curved striæ, as well as by its narrower columella and thin inner lip. The latter characters lead me to doubt whether it is not more properly a *Platyostoma*.

Locality and position: Same as last.

GENUS ORTHONEMA, Meek and Worthen, 1861.

(Proceed. Acad. Nat. Sci., Philad., p. 146.)

ORTHONEMA NEWBERRYI, Meek.

Plate 20, figs. 3 *a, b.*

Orthonema Newberryi, Meek, 1871; Proceed. Acad. Nat. Sci., Philad., p. 81.

Shell turreted, elongate-conical; volutions eight or nine in adult examples, compressed-convex, with a more outward slope than the general slant of the spire, the most convex part being near the lower side of each, a little above the suture; first one or two very small and depressed, and the next one or two more rapidly increasing in size than those below, thus giving a proportionally shorter and more conical appearance to young than adult specimens; suture well defined in consequence of the prominence of the lower part of each turn just above. Surface ornamented by three very slender, raised, revolving lines, one of which is placed a little below the suture, and the other two below the middle of the turns of the spire, and on the middle of the last volution; of these revolving lines, the upper two are broken up into minute, regularly arranged, projecting points, while the other is usually continuous; lines of growth minute, sharply defined, and very regularly and closely arranged, passing vertically and very nearly or quite straight across the volutions. Aperture unknown.

Length, 0.63 inch; breadth, 0.22 inch.

The general appearance of this very neat little shell, with its three slender revolving lines, two passing around the middle of its body volu-

tion and below the middle of those of the spire, at once recall to mind the genus *Murchisonia*. A moment's examination under a magnifier, however, shows that the sharply defined lines of growth pass straight across the volutions, without making the slightest flexure indicating a sinus in the lip, such as we see in *Murchisonia* and *Pleurotomaria*. It is a more slender shell than the type of the genus (*O. Salteri*, M. and W., from the Coal-measures), and has a much deeper suture, and a less angular body volution, with other differences in the details of its markings. Although nothing is known of the nature of its aperture and columella, it agrees so exactly in all its other generic characters with the genus *Orthonema*, that I have no hesitation in referring it to that genus. It is certainly not a *Murchisonia*, and differs radically in its ornamentation from *Isonema*, or any of the other palæozoic types to which the more or less similar univalves of the older rocks are usually referred.

Locality and position: Otsego, Wood county, Ohio, from the Corniferous group just above the Glass Sand. Mr. Gilbert.

GENUS TROCHONEMA, Salter, 1859.

(Canada Org. Remains, Dec. 7, p. 24.)

TROCHONEMA TRICARINATA, Meek.

Plate 19, figs. 4 *a*, *b*.

Trochonema tricarinata, Meek, 1871; Proceed. Acad. Nat. Sci., Philad., p. 82.

Shell turbinate, thin, a little wider than high; spire depressed. Volutions about five, strongly shouldered, or nearly rectangular above, the upper surface being flat, or a little concave, and extended out almost horizontally to the rectangular and carinate shoulder; below this the outer side is nearly vertically flattened to a second carina, passing around near the middle of the body whorl, exactly coincident with the suture between that and the succeeding turn, so as not to be exposed on the spire; below this second carina the under side of the body volution is flattened with a strong inward slope to a third well-defined carina, passing around the middle of the under side, and forming the margin of the umbilicus. Aperture oval-sub-pentagonal, being a little higher than wide, and somewhat angular above, at the connection of its outer lip with the return of the spire, and at the termination of each of the three revolving carina, as well as very obscurely so a little below the middle of the inner side; inner lip thin below its connection with the carina passing around the umbilicus, at which point it is very slightly thick-

ened, while above this it seems to be nearly or quite obsolete. Umbilicus rather wide, but shallow, or very rapidly contracting within. Suture well defined, without being in the slightest degree furrowed. Surface only showing very fine lines of growth, which, on the upper flattened space of the volutions, pass obliquely outward and backward, with a very slight curve, from the suture to the upper angle or shoulder, below which they pass nearly straight down the outer flattened area to the second carina, which is as far as they can be traced in the specimen studied.

Height, 0.81 inch; breadth, 0.90 inch; height of aperture, 0.54 inch; breadth of do., 0.46 inch.

This rather neat shell seems to agree exactly in all of its generic characters with the type of Mr. Salter's genus *Trochonema* (*T. umbilicata,* Hall, sp.), excepting in not even showing any tendency to have its body volution become free at the aperture, nor apparently its peritreme continuous. The first of these characters, however, seems not to be always constant in the typical species of *Trochonema;* but the fact that it *does generally* occur in the same is worthy of note; while the apparent absence of a continuous peritreme in the shell here under consideration would certainly seem to be one of more than specific importance. If so, I would suggest for it, at least as a sub-generic designation, the name *Trochonemopsis*.

Specifically, this shell will be readily distinguished from *T. umbilicata,* which it most nearly resembles, not only by its more depressed form, closely contiguous body volution, obsolete inner lip above the middle of the aperture, and more shallow umbilicus, but also by not having its suture channeled and bordered below by a fourth carina around the upper margin of each volution, as in that species.

Locality and position: Marblehead, Ohio. Corniferous group.

NOTE.—In the same matrix with the above-described shell, I have been surprised to notice numerous minute bodies that I can scarcely doubt are really the fruits of the fresh-water genus *Chara.* At any rate, they certainly seem to present all the external characters of the same. These little bodies are globose, about 0.05 of an inch in diameter, and each ornamented by nine strongly defined and very regularly disposed spiral ridges, which start on one side around a minute pit, and pass with perfect regularity spirally, so as to converge to an exactly opposite point on the other side, making each about one spiral turn in passing from side to side. If really the seeds of this fresh-water genus of plants, they must have been carried into the sea by streams, and deposited where we now find them, along with numerous marine shells.

GENUS EUOMPHALUS, Sowerby, 1814.

(Man. Conch. I., p. 97.)

EUOMPHALUS DECEWI, Billings.

Plate 19, figs. 3 *a*, *b;* and plate 20, fig. l.

Euomphalus Decewi, Billings, 1861; Canadian Journal (July), p. 358, with wood-cuts; and Devonian Fossils of Canada West, p. 94, figs. 131 and 132.

Euomphalus Conradi, Hall, 1861; 14th Regents' Report (Aug.), page 107.

Shell attaining a large size, discoid in form, the upper side being moderately concave, or nearly or quite flat, and the lower broadly and deeply concave; periphery flattened-convex, and nearly vertical to the plane of the shell, or somewhat oblique. Volutions about three, irregularly sub-quadrangular, increasing regularly and gradually in size from the apex, and coiled more or less nearly (but never exactly) in the same plane, obtusely angular around the upper outer side, and thence flattened, with a more or less inward slope above, to the inner side; lower side of volutions prominent and obtusely angular at its connection with the periphery, from which point it slopes strongly inward, usually with a concave face, into the large umbilicus; aperture, like the section of the volutions, irregularly quadrangular, the inner side being much narrower, and the oblique lower side wider, than any of the others. Surface ornamented by distinct lines of growth, and sometimes, on the upper and outer sides of the volutions, by little regular ridges, both of which curve strongly backward to the angle around at the meeting of the upper and outer sides, where they make a short backward arch in crossing a slightly concave, undefined band, somewhat like that seen on *Pleurotomaria;* thus indicating a wide, deep notch in the lip at the termination of the upper angle of the volutions. A similar but less strongly defined backward curve of these markings also occurs on the outer surface of the whorls, at the lower angle.

Greatest transverse diameter of a large specimen, about 4.30 inches; height of same near the aperture, 1.66 inches.

I have had no opportunity to compare this Ohio shell with either Canadian or New York specimens of Mr. Billings's species, but it agrees so nearly in size and form with the characters of that shell, as defined by Mr. Billings and Prof. Hall, that I can scarcely doubt its identity with the same. There are, however, a few characters presented by our specimens that are not mentioned in either of the descriptions alluded to above. These are the tendency of the marks of growth to assume the

appearance of little ridges and furrows on the upper and outer surfaces of the whorls; and the presence of a slightly impressed pleurotomoid band around the upper angle of the same. Of course, if these do not exist in *P. Decewi,* our shell would belong to a distinct species at least, or possibly even have to be referred to a different group. It is probable, however, that the surface markings are variable, and that the band-like depression may have been accidentally obscured in the specimens of *E. Decewi* hitherto found.

Locality and position: The typical specimens of *E. Decewi* were found in the county of Haldinand, Canada West; and those for which Prof. Hall proposed the name *E. Conradi* came from various localities in Central and Western New York. Our fig. 1, plate 20, represents a specimen from Kelley's Island, Lake Erie, and the larger one on plate 19 was taken from a bowlder found in Defiance county, Ohio, and belongs to James Ralston, Esq., of Defiance, Ohio. Its horizon seems to be always in the Corniferous limestone of the Devonian.

GENUS XENOPHORA, Fischer, 1806.

(Museum Demidovianum, p. 213.)

XENOPHORA? (PSEUDOPHORUS) ANTIQUA, Meek.

Plate 17, figs. 1 *a, b,* c, *d, e.**

Trochita antiqua, Meek, 1871; Proceed. Acad. Nat. Sci., Philad., p. 82.

Shell strongly depressed-sub-trochiform, about three times as wide as high; under side flattened, and provided with a broad, shallow, eccentric umbilical impression; volutions two and a half to three, a little convex, with a gentle outward slope above, and an acutely angular periphery at the connection of the upper slope of the whorls and the base; suture rather obscure; aperture transversely rhombic, nearly three times as wide as high, with acutely angular outer and inner extremities; upper side of lip very oblique, and extended far forward beyond that below, which latter seems to be nearly straight. Surface of upper side ornamented by rather distinct lines, or small ridges of growth, which cross the volutions very obliquely, with strong backward curves, as they approach the periphery, parallel to the margin of the lip.

Breadth, 2.12 inches; height, about 0.66 inch.

* It was by mistake that this species was figured on this plate as if from the Waterlime horizon.

The specimens of this shell yet found are very imperfect, but its form and general appearance are so peculiar that there can scarcely be any difficulty in identifying it.

Although it has a broad concavity occupying the whole under side, this concavity does not seem to extend up into the very short spire, as a proper umbilicus. It is almost certainly not a true *Trochita,* because the broad under side does not have the character of a mere spiral lamina within the margin, but is really the lower side of the body volution. It seems to be more nearly related to *Xenophora,* Fischer (=*Phorus,* Montfort), or *Onustus,* Humphrey; but differs from both in not having the habit of attaching foreign bodies around its periphery, as well as in wanting the distinct umbilicus of the latter. It will probably be found to represent an undescribed group, which might be called *Pseudophorus.*

Locality and position: Monclova, Lucas county, Ohio. Corniferous group of the Devonian. It was by an oversight that the figures of this species were placed on plate 17.

GENUS BELLEROPHON, Montfort, 1808.

(Syst. Class. Moll., p. 50.)

BELLEROPHON NEWBERRYI, Meek.

Plate 20, fig. 5.

Bellerophon Newberryi, Meek, 1871; Proceed. Acad. Nat. Sci., Philad., p. 77.

Shell scarcely attaining a medium size, sub-globose in general form, and without umbilical openings, their position being occupied by a callus of the lip on each side; body volution moderately expanded at the aperture, which is rather large, transversely sub-reniform or sub-cordate, being nearly twice as wide transversely as the anterio-posterior diameter; lip apparently with a small sinus or notch in front, and rounded in outline on each side, very thin, excepting in the umbilical regions, between which it is thinly spread a little over that part of the return of the spire indenting the inner or posterior side of the aperture. Dorsal band rather narrow, not elevated above the surface of the rounded dorsum, and merely defined by a slight furrow along each side.* Surface ornamented by distinct, very regularly disposed little transverse costæ, or coarse raised lines, most strongly defined on the dorsal side, where they

* In one of the smaller specimens the band is a little raised, so as to form a slight ridge.

curve a little backward near the band, and more abruptly in crossing the latter; while they become finer, more crowded, and again curve backward in approaching the umbilical region, where they become obsolete on each side, while they diminish to mere lines of growth, or die out, on the expanded part of the lip near the aperture. Extremely faint traces of minute revolving lines are also sometimes seen on well-preserved specimens.

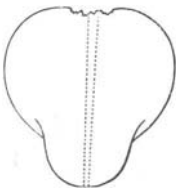
Greatest anterio-posterior diameter of a mature specimen, 0.70 inch; transverse diameter of aperture, 0.72 inch.

In first publishing a description of this species, I remarked that, "in its surface markings, it seems to agree with *B. patulus,* Hall;" but mentioned certain characters in which it differs from Prof. Hall's figure and description of that species: such, for instance, as its much less expanded lip, not "overlapping the volutions on the posterior side," as is said to be the case with that species; want of an open umbilicus, etc.

Since the publication of my description, Prof. Hall and Mr. Whitfield have expressed the opinion, in their list of fossils found at Louisville, Ky., that the Ohio shell is not distinct from *B. patulus,* Hall.

BELLEROPHON PATULUS.

A fac-simile of Prof. Hall's original figure, showing the great expansion of the lip.



BELLEROPHON NEWBERRYI.

An outline, showing the much less expanded character of its lip, etc. Dorsal band not *seen* to extend as far forward as the dotted lines indicate.

At the time I first studied the specimens of *B. Newberryi,* and prepared the published description of that shell, I had no New York specimens of *B. patulus* for comparison, and consequently had to rely upon memory and Prof. Hall's figure and descriptions for the characters of that species. The annexed cut is an exact copy of his figure, and I have also added, for comparison, the cut representing, in outline, the same view of *B. Newberryi,* natural size, taken from a different specimen from that figured on plate 20.

Prof Hall's original description of *B. patulus* reads as follows: "Shell slightly umbilicated, aperture suddenly and broadly dilated, nearly smooth or with faint undulating striæ, which become strong and slightly

arched in receding from the margin. The striæ become very strong and sharply arched upon the first volution."

In a more extended description of this shell, published in the 15th Report of the Regents, p. 57, he repeats that it has a small umbilicus, and that its volutions are rounded, "the last one near the aperture abruptly and widely dilated, *overlapping the volution on the posterior side*." He farther states that "nearly all the specimens examined are more strongly striated on the back of the volution above the expansion than the one figured in the Geological Report of the Fourth District, but in other respects," he continues, "there is no important difference." He gives the transverse diameter of the aperture as a little more than one and five-eighths inches by one and a quarter inches in length, and adds that "another specimen has a diameter of aperture of nearly two inches."

Since publishing the description of *B. Newberryi,* I have, through the kindness of Prof. Hartt, of Cornell University, had an opportunity to make a direct comparison of our specimens of the same with authentic examples of *B. patulus* (belonging to the Cornell museum), from the Hamilton group of New York. None of these borrowed specimens have the expanded part of the lip entire all around, but they retain enough of it to show that it spreads out as greatly as represented in Prof. Hall's figure, while they agree perfectly in all other respects with his figure and description.

On comparing these specimens with those of our Ohio shell, I find that, as originally stated by me, and as may be seen by the annexed cuts and our figure on plate 20, the two forms not only differ in the very much greater expansion and backward extension of the lip in the New York shell, but also in the presence of a decided, open and deeply penetrating, though small, umbilicus in the same;* while in the Ohio form there is no proper open umbilicus at all, its place being occupied on each side by a callus formed by a thickening of the lip, which does not project backward beyond these points. Even when this callus is removed, there is no such decided, deeply penetrating umbilicus seen as occurs in the New York species, but only a mere minute indentation. A critical comparison of the specimens before me also shows that there are other well-marked differences. For instance, the greater expansion of the shell, although much more strongly marked at the aperture in *B. patulus,* is not entirely confined to that part, but even the involuted portion also expands more rapidly, laterally, than in *B. Newberryi;* while in the lat-

* It measures 0.10 to 0.12 inch in diameter, with abruptly inflected walls, in the New York specimens before me.

ter, these body volutions show a decidedly greater proportional dorso-ventral diameter, thus giving them a much more rounded dorsal and lateral outline.* Again, on several of the better preserved specimens of the Ohio shell, there is a narrow, well-defined dorsal band, margined on each side by an impressed line, exactly as represented in our figure 5 of plate 20; while no traces of any such band are seen on any of those of the New York species before me, all of which merely show the transverse lines to make a backward curve in crossing the middle of the dorsum, without giving origin to a band.

Whether this band continues well defined forward to the anterior margin of the lip, or even upon the expansion, in the Ohio shell, I am unable to say from observation, none of our specimens having the surface well preserved there, though it probably does, nearly as indicated by the dotted lines in the outline cut. The specimen from which that figure was drawn has the margin of the lip defective around the left side, and at the middle of the front; but its outline can be clearly seen around the right side; and as these shells are exactly symmetrical, the general outline of the lip, with the exception of the little break at the middle of the front, can be relied upon as natural in the cut, especially as it agrees with that of the specimen from which figure 5 of plate 20 was drawn, in which the outline can be traced nearly all around. I should also remark here, that since the figure on plate 20 was drawn and the annexed cut was prepared, a more careful examination of the specimen figured on plate 20 has nearly satisfied me that there is a decided little notch at the middle of the lip in front, entirely unlike the broad, faint sinuosity shown in Prof. Hall's figure of *B. patulus*.

From the foregoing remarks it will be seen that, in reviewing the subject, with the aid of New York specimens of *B. patulus* for comparison, I have seen no reason to modify my original conclusion, that *B. Newberryi* is specifically distinct from *B. patulus;* though I do not thereby mean to assert that the latter species may not also occur in the Western States.

Locality and position: Dublin, Franklin county, Ohio. Corniferous group.

* Measurements of the involuted turns of the two species show that the dorso-ventral diameter of those of *B. Newberryi* is *constantly* one-fourth to one-third greater than those of *B. patulus*, at all points where the transverse diameters of the two are exactly equal.

BELLEROPHON PROPINQUUS, Meek.

Plate 20, figs. 4 *a, b.*

Bellerophon propinquus, Meek, 1871; Proceed. Acad. Nat. Sci., Philad., p. 78.

This species, so far as its characters are known, agrees so nearly with the last, in form and size, that it may be sufficiently characterized by pointing out the few characters in which it differs. In the first place, its transverse lines are distinctly finer, more crowded, and less regularly arranged; while it has a small umbilical perforation not entirely closed by the thickened lip on each side, as we see in that species. Again, its dorsal band is always distinctly elevated, very narrow, and furrowed along the middle, so as to present a biangular appearance, while the transverse lines bend back more strongly in approaching this band than in *B. Newberryi,* and do not impart the crenated or sub-imbricated appearance in crossing the band seen on this part of that species. It is likewise destitute of the very fine obscure revolving striæ of the *B. Newberryi,* and seems to have its aperture somewhat less expanded, though none of the specimens I have yet seen are in a condition to show the expansion of the aperture satisfactorily.

Locality and position: Same as last.

GENUS PLEUROTOMARIA, Defrance, 1826.

(Dict. Sci. Nat., p. 381, Vol. XLI.)

PLEUROTOMARIA LUCINA, Hall?

Plate 20, fig. 6.

Euomphalus? rotundatus, Hall, 1843; Geol. Rep. 4th Dist. N. Y., p. 172, fig. 4 (not *Pleurotomaria rotundata,* Munster, 1841?).

Pleurotomaria Lucina, Hall, 1862; Regents' 15th State Cab. Report, p. 42; pl. 5, fig. 12.

Shell turbinate, very thin; spire moderately prominent; volutions three, increasing rather rapidly in size, all regularly rounded, last one comparatively large and ventricose; suture deep; aperture apparently circular; axis imperforate. Surface elegantly cancellated by regular, equal, rather strong thread-like revolving and transverse lines, the latter of which curve backward a little near the spiral band, which is narrow, a little convex along the middle, and crenated by the crossing of the slightly curved transverse lines, so as to present the appearance of the edge of a finely milled coin; a space just below the band, of the same

breadth as the latter, being without revolving lines, gives the band the appearance of having twice its true breadth.*

Height, 1 inch; breadth, 0.97 inch.

This shell agrees so nearly in form and proportions, as well as in its ornamentation, with Prof. Hall's figure of the species described by him under the name *P. Lucina,* that I have concluded to refer it provisionally to the same. Still I do so with considerable doubt, because if his figures and descriptions are *strictly accurate,* our shell would be clearly distinct, for the following reasons: In the first place, its spiral band is really not more than half the proportional breadth of that seen on Prof. Hall's figure, and differs in having a ridge along the middle, distinctly crenated by the crossing of the transverse lines; while it also passes around so as to be seen on the volutions of the spire, a little above the suture. In the figure, however, of *P. Lucina,* referred to, it is represented as being not only flat and much wider, but as *not appearing on the volutions of the spire, above the suture,* at all; which latter character would place it in the separate group for which Deslonchamps has proposed the name *Cryptotæna.* Again, a cast figured in the Report on the 4th Geological District of New York (p. 173), under the name *Euomphalus rotundatus,* and now regarded by Prof. Hall as belonging to his *P. Lucina,* is there described as having the "umbilicus large"; while in the description of the shell of this species, in the Regents' Report cited, the under side of the body volution is also said to be "depressed into the umbilicus." Yet in our specimen of the shell here under consideration, there is not even *a minute umbilical perforation.* It is true, an internal cast would show a small perforation left by the columella, but this could not be properly described as a *large* umbilicus.

If I were sure that Prof. Hall's figure is correct in the characters mentioned, particularly in not having the spiral band exposed on the volutions of the spire, I should certainly regard our shell as belonging to an entirely distinct species; but as the figure may not be exact in these characters, I am left in doubt in regard to the identity of our shell with *P. Lucina.* Should it be distinct, however, it might be designated as *P. hyphantes,* in allusion to its beautiful textile style of sculpturing.

Locality and position: Dublin, Franklin county, Ohio. Corniferous group of the Devonian system.

* This flat space just below the band is represented proportionally too broad in our figure, so that it has too much the appearance of being itself the band, which passes around immediately above, and, from its narrowness, might be overlooked.

GENUS CONULARIA, Miller, 1818, M.S.

(Sowerby Man. Conch. III., p. 108.)

CONULARIA ELEGANTULA, Meek.

Plate 23, fig. 4.

Conularia elegantula, Meek, 1871; Proceed. Acad. Nat. Sci., Philad., p. 85.

Shell presenting the usual quadrangular pyramidal form, with a divergence of the sides from the rather pointed apex, forming an angle of about eighteen degrees; each of the four lateral angles slightly rounded and distinctly furrowed; sides equal, nearly flat, and without any well-defined longitudinal mesial furrows. Surface ornamented by numerous very small, closely arranged transverse lines, that arch gently forward or toward the aperture, and sometimes become slightly interrupted and alternating along the middle of each side, while in other instances they are merely a little deflected and continuous across this slight impression or imaginary line. These lines attain their largest size, and are separated by spaces of their own breadth, at about 0.70 inch from the apex, and beyond this become gradually smaller and more crowded toward the aperture. When largest and widest apart, they number about seven in one-tenth of an inch. They are all crenulated, there being fourteen of the crenulations in a length of one-tenth of an inch. Furrows between the transverse lines, marked by very fine striæ running in the direction of the longitudinal axis of the shell, and much smaller and more crowded than the crenulations *on* the striæ.

Length of a specimen, apparently nearly entire, 1.70 inches; breadth, about 0.59 inch.

This species is related to *C. byblis* of White (Proc. Bost. Soc. N. H., Feb'y, 1862, p. 22), and *C. multicostata,* M. and W. (Proceed. Acad. Nat. Sci., Philad., Dec'r, 1865, p. 252), from the Waverly group of Iowa and Ohio. It differs, however, in having its transverse lines smaller and more crowded, there being about seventy of them to the inch, at the point where they are largest and widest apart, and one hundred in the same space near the larger end of the shell; while in both of the Waverly species mentioned, only forty-five to fifty occur in an inch. The crenulations of the transverse striæ are also smaller and more crowded in the species under consideration, there being usually fourteen of them in the tenth of an inch, which would give one hundred and forty to the inch; while, according to Prof. Winchell's measurements, they are so

much larger and more distant in *C. byblis,* that sixty to seventy-five of them would occupy the same space. The obtusely rounded and smooth apex mentioned in Dr. White's description, if natural, would be another very important distinction; but I suspect, from the appearance of some of the specimens of species of this genus figured by Prof. Barrande, that this is due to the removal of the apex by some accident, so as to expose one of the smooth septa within.*

Compared with *C. Niagarensis,* Hall, the species under consideration evidently differs in being much more gradually tapering, and has the transverse lines much smaller and more crowded toward the larger end of the shell. In form it agrees more nearly with *C. simplex* of Barrande, which, however, has the furrows between the transverse lines smooth, and these lines not becoming smaller and more crowded towards the aperture from a point six to seven-tenths of an inch from the apex.

Locality and position: Delaware, Ohio. Corniferous division of the Devonian.

CEPHALOPODA.

GENUS CYRTOCERATITES, Goldfuss, 1830?

CYRTOCERATITES OHIOENSIS, Meek.

Plate 23, figs. 2 and 2 *b.*

Cyrtoceras Ohioense, Meek, 1871; Proceed. Acad. Nat. Sci., Philad., p. 86.

Shell long, slender, and gently arched, very gradually tapering; section a little oval, or nearly circular, the dorso-ventral diameter being slightly greater than the transverse. Septa distant from each other, on the outer or convex (ventral) side of the curve, slightly more than one-sixth, and, on the inner side, about one-seventh the dorso-ventral diameter. Siphuncle situated near the outer side of the curve, but not exactly marginal. Surface ornamented by small, somewhat irregular annular ridges and striæ, that curve a little backward in crossing the ventral side. Rather distinct, raised lines also mark the surface longitudinally, so as to form, with the annular markings, a somewhat cancellated appearance.

* Since seeing these figures of Prof. Barrande's, I am led to think it probable that *C. byblis,* White, and *C. multicostata,* M. and W., may belong to one species, the supposed obtusely rounded, smooth apex of *C. byblis* being the principal character that led to the supposition that *C. multicostata* was quite distinct. A comparison of specimens, however, might show other distinctions.

Length of a specimen incomplete at both ends and septate throughout (excepting about one inch of the anterior end), 6.50 inches, measuring along the convex side of the curve; dorso-ventral diameter at the posterior end, 1.33 inches; transverse diameter at the same place, 1.27 inches. The increase in size is such that the same measurements at a point three inches farther forward are respectively 1.56 and 1.50 inches; while from this point to the broken anterior end, which includes only about one inch of the body chamber, the shell diminishes a little in both diameters, but apparently more in the transverse than the dorso-ventral, though this may be in part due to accidental lateral pressure.

This species seems to be related to *Cyrtoceras eugenium,* Hall (Regents' 15th Rep., p. 70, pl. 9, figs. 1, 2 and 3), but evidently not only attained a larger size, but differs in having its dorso-ventral diameter a little greater than the transverse, instead of the reverse. It also differs in being marked with distinct longitudinal raised lines, as well as in tapering somewhat, from the central region forward, and in having its septa more closely arranged. In form it agrees less nearly with several of the Bohemian species figured by Dr. Barrande; but it differs from all of these in its surface markings, while from his *C. pugio,* which has somewhat similar sculpturing, it differs in being a little more curved, and without transverse undulations.

The entire shell could scarcely have been less than twelve or fourteen inches in length, and probably curved so as to form about one-fourth of a circle.

Locality and position: Dublin, Franklin county, Ohio. Corniferous group of the Devonian series.

GENUS GYROCERATITES, Meyer, 1831.

(Nov. Act. Acad. Caes. Leop. XV., 2, p. 72.)

GYROCERATITES (?TROCHOCERAS) OHIOENSIS, Meek.

Plate 22.

Gyroceras (Trochoceras?) Ohioense, Meek, 1871; Proceed. Acad. Nat. Sci., Philad., p, 87.

Shell attaining a large size, oval-sub-discoid, composed of three or four rather rapidly enlarging whorls, the under ones of which are closely contiguous, while the last one seems to become a little free at the aperture; umbilicus large and of moderate depth. Volutions rounded, sub-quadrangular, with the transverse diameter somewhat greater than the

dorso-ventral, rather broadly flattened on the periphery, and compressed convex on the sides, which round off gradually into the umbilicus, and more abruptly to the periphery, excepting in young shells, which have the sides of the volutions more flattened, and rounding as abruptly into the umbilicus as to the flattened outer side. Septa moderately distant, or separated by spaces which measure, on the middle of each side, about one-third the dorso-ventral diameter of the volution at the same point; all curving gracefully backward as they cross the sides, and forward as they pass from the sides to the flattened periphery, in crossing which they again make another, but stronger backward curve. Body-chamber large, or occupying more than half the outer volution. Surface (of cast) ornamented by small transverse ridges, of which about thirty may be counted to a side of each volution, the outer half only of which they occupy, without passing over or upon the periphery; while on the inner volutions they are sometimes so short as to assume rather the aspect of transversely elongated nodes. Siphuncle, aperture and finer surface markings unknown.

Greatest diameter across the disc of a specimen with a part of the outer volution broken away, about 9 inches; dorso-ventral diameter of outer volution at the point where it is broken off, 3.63 inches; thickness, or transverse diameter of same at same point, about 3.90 inches.

Owing to the fact that the only two specimens of this species I have seen are both in such a condition as to show clearly only one side (the upper side, if it is a *Trochoceras*), I am in some little doubt whether it is a *Gyroceras* or a *Trochoceras.* From the depth of the concavity of this side, however, I can scarcely doubt that the volutions are really coiled in the same plane as in *Gyroceras* and *Nautilus.* The contiguous character of its volutions (excepting, apparently, the last one near the aperture) is, however, rather against its being a *Gyroceras,* though the inner turns are sometimes in contact in species apparently belonging to that genus. If the last turn really does become free, as seems to be the case, this character would be equally against the probability of its being a *Nautilus;* but as the specimens are not in a condition quite to remove all doubts on this point, it is barely possible that this shell may be found to belong to some of the sections of that group, though I can scarcely think so.

I know of no described species of *Gyroceras* so nearly allied to this, specifically, as to require a close comparison.

Locality and position: Delaware, Ohio, and in Marion county of the same State. Corniferous limestone of the Upper Helderberg series (Devonian).

GYROCERATITES (? NAUTILUS) INELEGANS, Meek.

Plate 21.

Gyroceras (*Nautilus?*) *inelegans,* Meek; Proceed. Acad. Nat. Sci., Philad., p. 89.

Shell attaining a large size, sub-discoidal. Volutions about two and a half to three, increasing rapidly in size, having a somewhat greater dorso-ventral than transverse diameter, being moderately compressed on each side, narrowly rounded over the periphery, and rounding regularly into the umbilicus, which is of moderate depth, and distinctly narrower than the dorso-ventral diameter of the outer whorl. First turn apparently slightly embraced by the second, which seems to become free towards the aperture. Septa rather distant, deeply concave on their anterior faces, and crossing the sides and periphery with very slight backward curves; all separated from each other on the periphery by spaces equaling about half the dorsa-ventral diameter at the point of measurement. Body-chamber large, or forming half of the outer volution; aperture not expanded; lip sinuous on the outer side. Surface of cast sometimes showing on the inner volutions some very faint traces of rather distant transverse ridges, which become nearly or quite obsolete on the outer turn. Siphuncle and finer surface markings unknown.

Greatest diameter across the disc of a specimen a little compressed by accidental pressure, 9 inches; dorso-ventral diameter of last turn near the aperture, 4.10 inches; transverse diameter of same, 3.50 inches.

This is another form in regard to the generic characters of which I am in doubt. Its more rapidly expanding volutions, more rounded periphery, proportionally narrower umbilicus, and closely contiguous or even slightly embraced inner turn, give it a much more Nautiloid look than the last, and I should scarcely hesitate to refer it to the genus *Nautilus,* if it were not for the fact that the outer volution seems to be a little detached at the aperture. Still this may possibly be due to compression.

Locality and position: Corniferous group of the Devonian, Marion county, Ohio.

ARTICULATA.

CRUSTACEA.

GENUS PROETUS, Steininger, 1831.

(Mem. Soc. Geol. France, Vol. I., p. 355.)

PROETUS PLANIMARGINATUS, Meek.

Plate 23, figs. 3 *a, b.*

Proetus planimarginatus, Meek, 1871; Proceed. Acad. Nat. Sci., Philad., p. 89.

Pygidium depressed, semi-elliptic, the length and breadth being nearly as five to seven; anterior margin very gently arcuate or convex in outline; posterior somewhat narrowly rounded; lateral margins diverging forward, with slightly convex outlines, to the anterior lateral angles which are not truncated. Mesial lobe rather depressed, but rounded and well defined, narrow, or only a little more than half as wide at its anterior end as the lateral lobes, tapering gradually, with straight sides, to its posterior extremity, which terminates, at a distance of about half the breadth of the anterior end, within the margin; provided with about twelve or thirteen nearly straight segments, most of which are well defined. Lateral lobes gently convex, sloping gradually from near the middle to the lateral and posterior margins, which are horizontally flattened, but not thickened; segments eight or nine, not extending upon the flattened margin, and each divided its entire length by so broad a furrow (flat within) that only a very narrow anterior and posterior margin is left projecting, and merely separated from that of the contiguous segment by a faint linear depression; thus presenting the appearance of narrow ribs or segments, longitudinally marked by faint linear furrows, and separated from each other by broad flattened depressions. Surface apparently nearly smooth. Other parts unknown.

Length of pygidium, 0.64 inch; breadth, 0.94 inch; height of lateral lobes, 0.13 inch; do., to top of mesial lobe at its anterior end, 0.23 inch.

The pygidium of this species seems to present much the same general outline as the corresponding part of *P. Haldemani,* Hall, from the Hamilton group; but it has a proportionally narrower mesial lobe (which scarcely equals one-fourth the entire anterior breadth, instead of one--third), and a smaller number of segments in the lateral lobes. It also differs in having a distinctly flattened, instead of a thickened, border.

If I have correctly understood the nature of the segments of its lateral lobes, they are also very different from those of *P. Haldemani*, being provided with wide flattened longitudinal furrows. These furrows are so wide and strongly defined, that I have been in some doubt whether they ought not rather to be regarded as the divisions between the segments, than as the furrows of the segments themselves. On tracing them inward, however, to the mesial lobe, they are found to be abruptly narrowed and curved slightly forward, as they approach the latter, so as to seem to correspond to the furrows *on* the segments, rather than to depressions *between* them.

None of the specimens show much of the surface, but as far as it can be seen, it seems to be smooth, and to coincide exactly with the smallest elevations and depressions of the internal cast, from which the foregoing description was drawn up.

Locality and position: Upper part of the Corniferous group, Sylvania, Lucas county, Ohio. Devonian. Mr. Gilbert's collection.

GENUS DALMANITES, Barrande, 1852.

(Silur. Syst., Boh. I., expl., pl. 21, etc.)

DALMANITES OHIOENSIS, Meek.

Plate 23, fig. 1.

Dalmanites Ohioensis, Meek, 1871; Proceed. Acad. Nat. Sci., Philad., p. 91.
Compare *D. Helena,* Hall, 1862; Regents' 15th Report, p. 89.

Pygidium large, depressed, semi-elliptic in general outline, nearly straight or gently convex in outline on the anterior margin, with the lateral angles a little rounded; posterior extremity somewhat raised and truncated, with the lateral angles of the truncated margin produced into two rather short, distinctly converging spines. Mesial lobe narrow, or only equaling half the breadth of each lateral lobe at the anterior ends, depressed and gradually tapering to the posterior end, which terminates, very near the truncated posterior margin, while it is rather distinctly separated by the furrow on each side from the lateral lobes; segments about eighteen, passing straight across, and separated by well-defined furrows, that are narrower than the segments themselves, which are not furrowed. Lateral lobes most convex along somewhat within the middle, where they are nearly or quite as high as the mesial lobe, toward which they slope slightly on the inner side, while beyond the middle they slope off gradually to the lateral margins, which are very narrow,

not thickened above, and curve outward nearly horizontally; segments about fifteen, widening slightly outward, and separated by deep, well-defined furrows, extending very nearly to the lateral margins; the larger ones showing faint traces of a slender, longitudinal furrow along the middle, while all, excepting a few of the smallest posterior ones, are produced beyond the lateral margins in the form of slender, sharp, rounded spines, that curve a little backward and upward. Surface nearly or quite smooth. Thorax and cephalic shield unknown.

Length of pygidium, 1.70 inches; breadth, 2.70 inches; height, or convexity, 0.25 inch; breadth of posterior truncation, 0.45 inch; length of longest spines projecting from lateral margins, 0.38 inch.

This trilobite seems to be closely allied to *D. myrmecophorus* (=*Asaphus myrmecophorus*), Green, to which I was at one time inclined to refer it. A careful comparison, however, with the descriptions of that species given by Green, and subsequently by Prof. Hall, seems to show that our fossil cannot be properly considered identical. In the first place, it differs in having the mesial lobe only just half as wide as each of the lateral (measuring both at their anterior ends), instead of only about one-third as wide (see dimensions *D. myrmecophorus*, given in 15th Regents' Report, p.88). Again, it shows no traces whatever of nodes or spines (excepting the marginal spines) on any of the segments either of the mesial or lateral lobes; while in Green's species the segments of the lateral lobes are described, in the Regents' Report above cited, and also by Green, as being marked by one or two rows of nodes, and those of the mesial lobe are described in the Regents' Report as being marked each by three spines. Our species also shows a faintly impressed mesial line along each segment of the lateral lobes, not mentioned either by Hall or Green in describing *D. myrmecophorus.*

Green gives the number of segments in the middle lobe of the pygidium as fourteen, and in each lateral lobe as thirteen; while in apparently a larger specimen (three inches in length) Prof. Hall counted twenty-four segments in the axis, and twenty in each lateral lobe; from which we may infer that the number of segments varied somewhat with the size of the specimen in that species.

Although nothing is known of the cephalic shield of this species, or, I believe, of that described by Green, I have little or no hesitation in expressing the opinion that at least the form here under consideration possessed the peculiar perforated or digitated extension of its anterior margin seen in *D. selenurus,* and hence that it belongs to Mr. Conrad's sub-genus *Odontocephalus.*

Another specimen in the collection from the same locality and position as that from which the foregoing description was made out, consisting of a rude cast of the pygidium, shows the same proportional breadth of the mesial and lateral lobes, and apparently about the same number of segments, but differs in being proportionally longer, its length being to its breadth as about 8 to 11, instead of about 8 to 13. It also differs in having the spines on each side of the truncated posterior extremity distinctly larger than in the form above described, and directed straight backward, as in *D. selenurus,* instead of converging, as in the last. The spines along its lateral margins, however, are, on the contrary, proportionally decidedly smaller. This, I suspect, belongs to a distinct species, but as the specimen is too eroded to show its surface characters clearly, I have preferred to refer it doubtfully, for the present, to the same.*

Locality and position: Marblehead, Ohio. Corniferous group of the Devonian.

* Since the publication of the foregoing description and remarks, Hall and Whitfield have referred this form, in their list of the Louisville fossils, to *D. Helena,* Hall, described in the Regents' 15th Report, p. 89. I have no other means of forming an opinion in regard to the relations of our specimens to Prof. Hall's species (which has not yet been figured), than by comparison with his published description of the same; and I can only say that if his description is *accurate,* our trilobite certainly *ought* to be a distinct species. He describes the form and proportions of the pygidium of his species so as to conform pretty nearly with ours, but *distinctly states* that it has the "lateral lobes marked by 18 or 19 ribs, *which terminate in a narrow, thickened, somewhat undulating border*." Not a word is said about the border showing any indications of being armed with slender, sharp, produced marginal spines, such as are seen on the form under consideration. Again, he describes the surface of his species as "granulose; *ribs marked by two rows of nodes or short spines*." Our figure was drawn from a good gutta-percha cast, made in a well-defined natural mould of the external surface of the pygidium, in a compact limestone matrix; and I am sure that there are no traces of the two rows of nodes or spines mentioned on the ribs of *D. Helena,* to be seen in this mould of the exterior, where they ought to be well marked, if they existed.

LIST OF FOSSILS

DESCRIBED IN THE PRECEDING REPORT.

FOSSILS OF THE CINCINNATI GROUP.

RADIATA.

ECHINODERMATA.

CRINOIDEA.

GENUS HETEROCRINUS, Hall.

Heterocrinus constrictus.....Hall.
— exilis.....Hall?
— simplex.....Hall.
— juvenis.....Hall.
— heterodactylus.....Hall?
— laxus.....Hall.
— subcrassus.....M. and W.

GENUS ANOMALOCRINUS, Meek and Worthen.

Anomalocrinus incurvus.....M. and W.

GENUS POTERIOCRINITES, Miller.

Poteriocrinites (Dendrocrinus) Cincinnatiensis.....Meek.
— polydactylus.....Shumard.
— posticus.....Hall.
— Dyeri.....Meek.
— caduceus.....Hall.
— Casei.....Meek.

GENUS GLYPTOCRINUS, Hall.

Glyptocrinus decadactylus.....Hall.
— Dyeri.....Meek.
— Dyeri var. sub-globosus.....Meek.
— Nealli.....Hall.
— parvus.....Hall.
— Baeri.....Hall.

CYSTOIDEA.

GENUS LEPOCRINITES, Conrad.

Lepocrinites Moorei ..... Meek.

GENUS ANOMALOCYSTITES, Hall.

Anomalocystites (Ateleocystites) balanoides ..... Meek.

GENUS LICHENOCRINUS, Hall.

Lichenocrinus Dyeri ..... Hall.
— crateriformis ..... Hall.

GENUS HEMICYSTITES, Hall.

Hemicystites stellatus ..... Hall.
— (Cystaster) granulatus ..... Hall.

GENUS AGELACRINITES, Vanuxem.

Agelacrinites (Lepidodiscus) Cincinnatiensis ..... Roemer.
— pileus ..... Hall.
— vorticellata ..... Hall.

ASTEROIDEA.

GENUS PALÆASTER, Hall.

Palæaster? Dyeri ..... Hall.
— granulosus ..... Hall?
— ? Jamesii ..... Dana.
— incomptus ..... Meek.
— Shaefferi ..... Hall.

GENUS STENASTER, Billings.

Stenaster grandis ..... Meek.

OPHINROIDEA.

? GENUS PROTASTER, Forbes.

Protaster granuliferus ..... Meek

MOLLUSCA.

POLYZOA.

GENUS PTILODICTYA, Lonsdale.

Ptilodictya (Stictopora) Shafferi ..... Meek.

BRACHIOPODA.

GENUS LEPTÆNA, Dalman.

Leptæna sericea ..... Sowerby?

GENUS STROPHOMENA, Rafinesque.

Strophomena rhomboidalis ..... Wilckens.
— nutans ..... James.
— planumbona ..... Hall.

Strophomena plicata.....James.
— planoconvexa.....Hall.
— filitexta.....Hall.
— sulcata.....DeVerneuil.
— sinuata.....James.
— alternata.....Emmons.
— alternata, var. nasuta.....Conrad.
— alternata, var. alternistriata.....Hall.
— alternata, var. loxorhytis.....Meek.
— alternata, var. fracta.....Meek.

GENUS ORTHIS, Dalman.

Orthis retrorsa.....Salter?
— subquadrata.....Hall.
— occidentalis.....Hall.
— insculpta.....Hall.
— borealis.....Billings.
— bellula.....James.
— ? ella.....Hall.
— fissicosta.....Hall.
— plicatella.....Hall.
— triplicatella.....Meek.
— emacerata.....Hall.
— emacerata, var. multisecta.....James.
— (Platystrophia) biforata.....Schlotheim.
— (Platystrophia) lynx.....Von Buch.
— (Platystrophia) laticosta.....James.
— (Platystrophia) dentata.....Pander?
— (Platystrophia) acutilirata.....Conrad.

GENUS RHYNCHONELLA, Fischer.

Rhynchonella dentata.....Hall.
— capax.....Conrad.

GENUS ZYGOSPIRA, Hall.

Zygospira modesta.....Say.
— Cincinnatiensis.....James.
— Headi.....Billings.

GENUS RETZIA, King.

Retzia (Trematospira) granulifera.....Meek

GENUS PHOLIDOPS, Hall.

Pholidops Cincinnatiensis.....Hall

LAMELLIBRANCHIATA.

GENUS AMBONYCHIA, Hall.

Ambonychia costata.....James.
— (Megaptera) alata.....Meek.
— (Megaptera) Casei.....M. and W.?

GENUS CYPRICARDITES, Conrad.

Cypricardites Sterlingensis ..... M. and W.
— ? carinata ..... Meek.

GENUS MEGAMBONIA, Hall.

Megambonia Jamesii ..... Meek.

GENUS CLIDOPHORUS, Hall.

Clidophorus (Nuculites) fabula ..... Hall.

GENUS TELLINOMYA, Hall.

Tellinomya? obliqua ..... Hall.

GENUS ANODONTOPSIS, McCoy.

Anodontopsis? Milleri ..... Meek,
— (Modiolopsis?) unionides ..... Meek.

GENUS SEDGWICKIA, McCoy.

Sedgwickia (Grammysia?) neglecta ..... Meek.
— ? fragilis ..... Meek.
— ? compressa ..... Meek.

GENUS CARDIOMORPHA, DeKonninck.

Cardimorpha? obliquata ..... Meek.

GASTEROPODA.

GENUS CYRTOLITES, Conrad.

Cyrtolites (Microceras) inornatus ..... Hall.
— ornatus ..... Conrad.
— Dyeri ..... Hall.
— ? costatus ..... James.

GENUS CYCLONEMA, Hall.

Cyclonema bilix ..... Conrad.

GENUS CYCLORA, Hall.

Cyclora minuta ..... Hall.
— ? parvula ..... Hall.

GENUS PLEUROTOMARIA, Defrance.

Pleurotomaria (Scalites?) tropidophora ..... Meek.

CEPHALOPODA.

GENUS ORTHOCERAS, Auct.

Orthoceras Ortoni ..... Meek.

GENUS TROCHOCERAS, Barrande.

Trochoceras? Baeri ..... M. and W.

ARTICULATA.

CRUSTACEA.

GENUS CYTHERE, Muller.

Cythere Cincinnatiensis ..... Meek.

GENUS ASAPHUS, Brongniart.

Asaphus (Isotelus) megistos .....Locke ?

GENUS PROETUS, Steininger.

Proetus Spurlocki .....Meek.

GENUS CERAURUS, Green.

Ceraurus Icarus .....Billings.

GENUS ACIDASPIS, Murchison.

Acidaspis crosotus.....Locke ?
— Cincinnatiensis .....Meek.
— ceralepta .....Anthnoy ?

GENUS DALMANITES, Barrande.

Dalmanites Carleyi.....Meek.

GENUS CALYMENE, Brongniart.

Calymene senaria .....Conrad.

FOSSILS OF THE NIAGARA AND CLINTON GROUPS.

MOLLUSCA.

BRACHIOPODA.

GENUS TRIPLESIA, Hall.

Triplesia Ortoni.....Meek.

GENUS RHYNCHONELLA, Fischer.

Rhynchonella neglecta .....Hall.

GENUS MERISTELLA, Hall.

Meristella (Meristina ?) cylindrica.....Hall.

GENUS TRIMERELLA, Billings.

Trimerella grandis.....Billings.
— Ohioensis .....Meek.

G ASTEROPODA.

GENUS PLATYOSTOMA, Conrad.

Platyostoma Niagarensis, *var*.....

CEPHALOPODA.

GENUS LITUITES, Montfort.

Lituites Ortoni.....Meek

ARTICULATA.

CRUSTACEA.

GENUS LEPERDITIA, Ronault.

Leperditia alta.....Conrad.

GENUS ILLÆNUS, Dalman.

Illænus (Bumastus) insignis.....Hall.

FOSSILS OF THE CORNIFEROUS GROUP.

MOLLUSCA.

POLYZOA.

GENUS PTILODICTYA, Lonsdale.

Ptilodictya Gilberti.....Meek.
— lichenoides?.....Meek.

BRACHIOPODA.

GENUS RHYNCHONELLA, Fischer.

Rhynchonella carolina.....Hall

LAMELLIBRANCHIATA.

GENUS AVICULOPECTEN, McCoy.

Aviculopecten parilis.....Conr.

GENUS LUCINA, Bruguiere.

Lucina (Paracyclas) Ohioensis.....Meek.

GENUS CONOCARDIUM, Bronn.

Conocardium trigonale.....Hall.
— Ohioense.....Meek.

GENUS SOLEMYA, Lamarck.

Solemya (Janeia) vetusta.....Meek.

GENUS CLINOPISTHA, Meek and Worthen.

Clinopistha antiqua.....Meek

GENUS SANGUINOLITES, McCoy.

Sanguinolites? Sanduskyensis ..... Meek.

GASTEROPODA.

GENUS PLATYCERAS, Conrad.

Platyceras multispinosum ..... Meek.
— dumosum, var. attenuatum ..... Meek.

GENUS CYCLONEMA, Hall.

Cyclonema crenulata ..... Meek.

GENUS NATICOPSIS, McCoy.

Naticopsis (Isonema) humilis ..... Meek.
— (Isonema) levis ..... Meek.
— æquistriata ..... Meek.

GENUS ORTHONEMA, Meek and Worthen.

Orthonema Newberryi ..... Meek.

GENUS TROCHONEMA, Salter.

Trochonema tricarinata ..... Meek.

GENUS EUOMPHALUS, Sowerby.

Euomphalus Decewi ..... Billings.

GENUS XENOPHORA, Fischer.

Xenophora (Pseudophorus) antiqua ..... Meek.

GENUS BELLEROPHON, Montfort.

Bellerophon Newberryi ..... Meek.
— propinquus ..... Meek.

GENUS PLEUROTOMARIA, Defrance.

Pleurotomaria Lucina ..... Hall?

GENUS CONULARIA, Miller.

Conularia elegantula ..... Meek.

CEPHALOPODA.

GENUS CYRTOCERATITES, Goldfuss.

Cyrtoceratites Ohioensis ..... Meek.

GENUS GYROCERATITES, Meyer.

Gyroceratites (Trochoceras) Ohioensis ..... Meek.
— (? Nautilus) inelegans ..... Meek.

ARTICULATA.

CRUSTACEA.

GENUS PROETUS, Steininger.

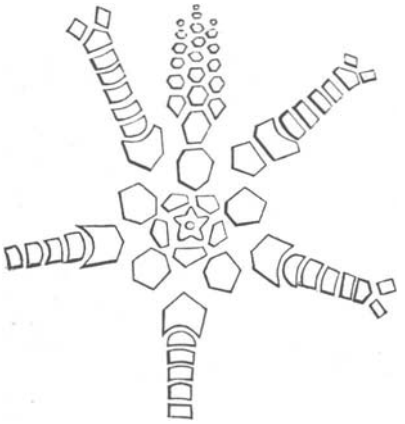
Proetus planimarginatus ..... Meek.

GENUS DALMANITES, Barrande.

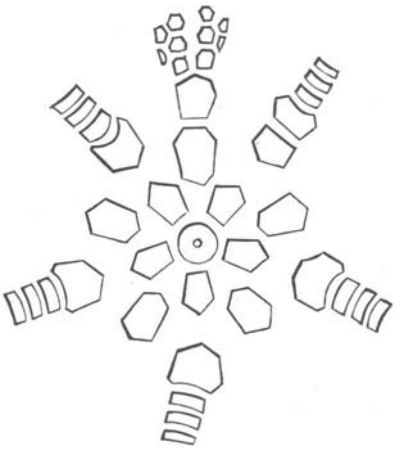
Dalmanites Ohioensis ..... Meek.

NOTE.—The sudden and severe illness of Mr. Meek prevented him from supervising the printing of his report, and occasioned the omission of the wood-cuts of the accompanying diagrams from the places they were intended to occupy in the text. The references given with them to the pages on which the species they represent are described, it is hoped will enable those who are interested in the study of this group of fossils to make some intelligent use of them, notwithstanding their removal from their proper places. It is but just, also, to say, that the typographical errors in Mr. Meek's report would have been eliminated if the proofs could have been submitted to him for correction. Under the circumstances, I am sure they will be pardoned, and that palæontologists will regret, not so much the trifling inaccuracies of Mr. Meek's text, as the sad cause which has produced them. J. S. N.

DIAGRAMS OF CRINOIDS.

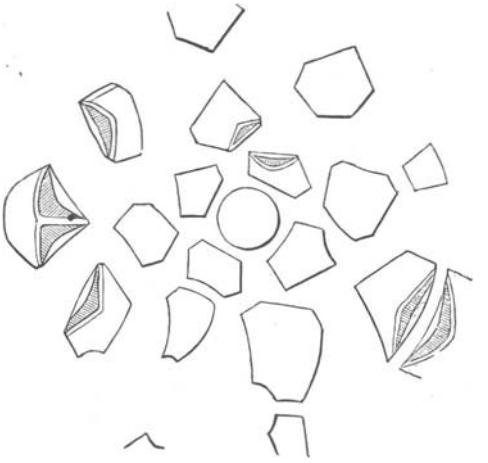


DENDROCRINUS CASEI.
p.28.

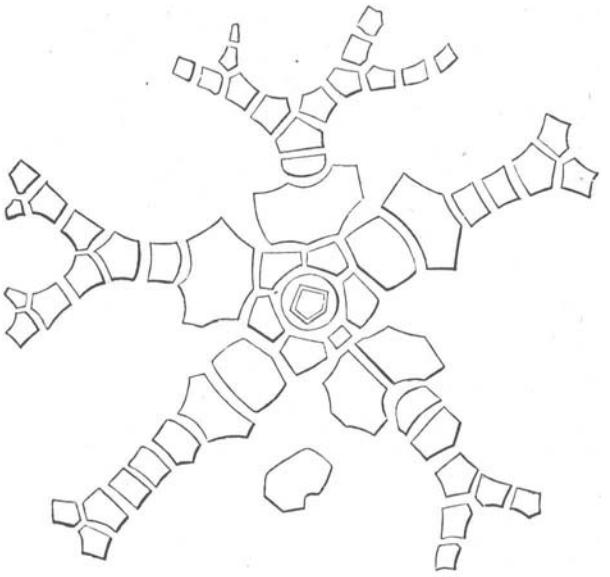


POTERIOCRINUS CADUCEUS.
p.26

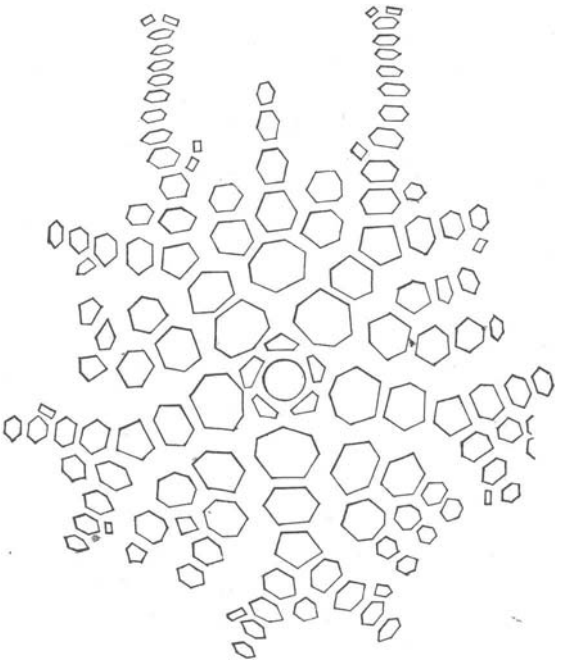
HETEROCRINUS SIMPLEX.
p.7.



LEPOCRINITES MOOREI.
p.39.



ANOMALOCRINUS INCURVUS.
p. 17.



GLYPTOCRINUS DYERI.
p.32.

PLATE I.

PAGE

Fig. 1. HETEROCRINUS HETERODACTYLUS?..... 12

1 *a*. Posterior view of body, arms, and a considerable portion of the column. Natural size. Dr. C. A. Miller's collection.

1 *b*. Same view of same enlarged, but with only a part of the column drawn.

Fig. 2. HETEROCRINUS HETERODACTYLUS? (variety)..... 14

2 *a*. Another specimen, apparently a variety of the same as fig. 1, showing posterior side of body, arms, and part of the column. Mr. Dyer's collection.

2 *b*. Same, magnified.

Fig. 3. HETEROCRINUS JUVENIS 10

3 *a*. A side view of body, arms, and a part of the column, natural size. Mr. Bean's collection.

3 *b*. A posterior view of a specimen consisting mainly of the body and a piece of the column; also showing first anal piece at (*a*), magnified a little more than 2 diameters. Mr. O'Neall's collection

3 *c*. One of the discs of the column, magnified about 2½ diameters, and showing the little cavities for the reception of the five minute, intercalated sub-basal pieces.

Fig. 4. HETEROCRINUS SIMPLEX 7

4 *a*. An oblique posterior view of a specimen consisting of the body and arms, and showing anal plate at (*a*). Nat. size.

4 *b*. Another view of same specimen.

Fig. 5. HETEROCRINUS SIMPLEX 9

5 *a*. Side view of body, arms, and a portion of the column of an individual that seems to have had the upper part of its arms broken away during the life of the animal, and subsequently restored. Mr. Dyer's collection. Nat. size

5 *b*. Same magnified.

Fig. 6. HETEROCRINUS SIMPLEX, *var*..... 9

6 *a*. Side view of body and arms, with a portion of column. Nat. size.

6 *b*. Posterior view of same, showing anal pieces at (*a*.)

Fig. 7. HETEROCRINUS SIMPLEX, *var*. GRANDIS 9

7 *a*. Side view of body, arms, pinnulæ, and a portion of the column. Nat size.

7 *b*. A side view of a part of one of the arms magnified.

7 *c*. Dorsal view of same.

Fig. 8. HETEROCRINUS LAXUS 14

8 *a*. Posterior view of body and arms; showing also the anal plates at (*a*). Nat. size. Type specimen from Mr. Dyer's collection.

b. Anterior view of same.

Fig. 9. HETEROCRINUS SUBCRASSUS..... 15

9 *a*. Side view of body and arms, with a piece of the column. Nat. size. Mr. O'Neall's collection.

9 *b*. Posterior view of same, showing anal series of pieces at (*a*).

Fig. 10. HETEROCRINUS CONSTRICTUS..... 3

10 *a*. Side view of body and portions of the arms. Nat. size. Type specimen from Mr. Dyer's collection.

10 *b*. Posterior view of same, showing anal piece.

Fig. 11. HETEROCRINUS CONSTRICTUS, *var*. COMPACTUS 4

A side view of body, arms, and a part of the column. Mr. Dyer's collection.

Fig. 12. HETEROCRINUS EXILIS, *var*. EXIGUUS 5

Posterior view of body, arms and a part of column; also showing anal plates at (*a*). Mr. Dyer's collection.

1.

Geological Survey of Ohio.

LOWER SILURIAN. (Cincinnati group.) PLATE 1.

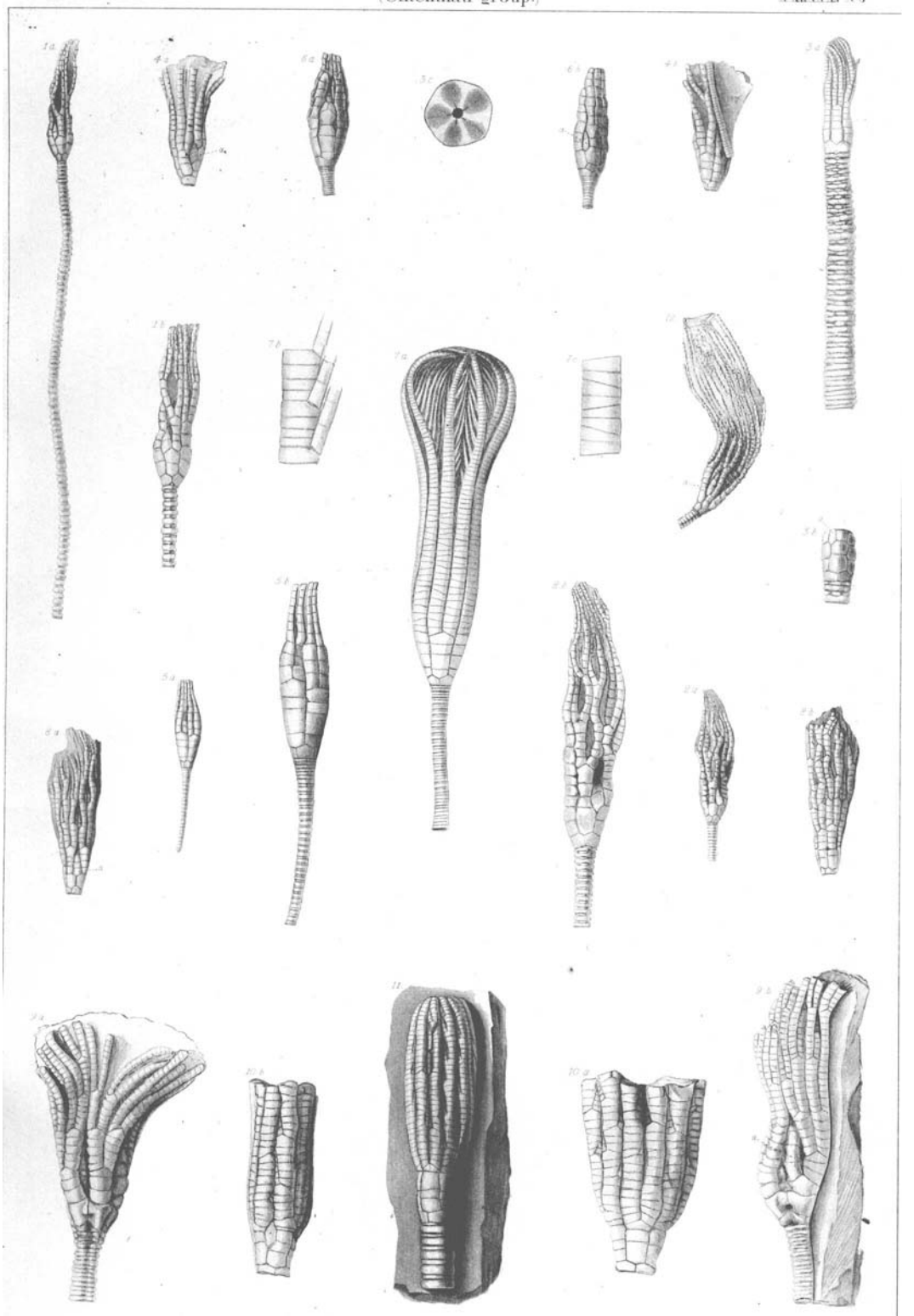


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PLATE II.

PAGE.

Fig. 1. GLYPTOCRINUS BAERI 37

1 *a*. A side view of the body and arms, with their pinnulæ; all somewhat flattened by pressure.

1 *b*. Another specimen, consisting of the arms and pinnulæ only, as seen spread out in the matrix. Both originals in Dr. Baer's collection.

Fig. 2. GLYPTOCRINUS DYERI 32

2 *a*. A posterior view of a specimen consisting of the body and portions of the arms. Mr. Dyer's collection.

2 *b*. A side view of another specimen, consisting of body, arms and pinnulæ. Mr. Dyer's collection.

2 *c*. A posterior view of body and lower part of arms. *G. Dyeri, var. sub-globosus.*

Fig. 3. GLYPTOCRINUS O'NEALLI 34

3 *a*. Side view of body, arms, pinnulæ, and a portion of the column. Mr. O'Neall's collection.

3 *b*. Posterior view of another specimen, showing body and arms, anal series of plates, etc. Mr. O'Neall's collection.

3 *c*. Same view of another specimen, with the arms broken away so as to expose the vault, composed of minute pieces; also the very small anal opening at (*o*). Mr. O'Neall's collection.

Fig. 4. GLYPTOCRINUS PARVUS ..... 36.....

4 *d*. Side view of body, arms, pinnulæ, and a few segments of columns. [The body is somewhat crushed in the specimen, and the arrangement of the pieces may not therefore be in all respects exactly represented.] Mr. Dyer's collection.

4 *b*. A similar view of another specimen in Mr. Dyer's collection.

Fig. 5. GLYPTOCRINUS DECADACTYLUS 30

5 *a*. A side view of body and the lower parts of the arms of an unusually large, fine specimen, belonging to Mr. Dyer's collection *

5 *b*. A posterior view of another similar but smaller specimen in Mr. Dyer's collection.

Fig. 6. ANOMALOCRINUS INCURVUS 17

6 *a*. A posterior view of body, parts of the arms, and a few joints of the column, showing the anal piece (*a*), and an abnormal sixth basal piece (*b*). Mr. Miller's collection.

6 *b*. Anterior view of same.

6 *c*. An end view of the column, near the body, magnified about 2½ diameters, to show that it is composed of an aggregation of numerous minute calcareous particles. The large central cavity is filled with crystalline calcareous matter, and may be larger than natural, in consequence of the solution of the surrounding part, or other accidental removal of the same.

6 *d*. The root, or expanded part of the base of the column, as it grew attached to a mass of rock, composed of comminuted shells, etc. [This specimen is not positively known to belong to this species, but from its peculiar structure, it is believed to be the root of the same.] Mr. Dyer's collection.

6 *e*. A part of the column of the above, from just above the root, magnified about 2½ diameters, to show its complex structure as seen in a side view.

6 *f*. An end view of the column, at 0.43 inch above the root, 6 *d*.

---

* This fine specimen, by some unknown agency, disappeared from the collections borrowed from C. B. Dyer, Esq., of Cincinnati. A liberal reward will be paid for its delivery to that gentleman, or for any information by which it can be recovered. It can be readily identified by the figure here given, wherever it may be.

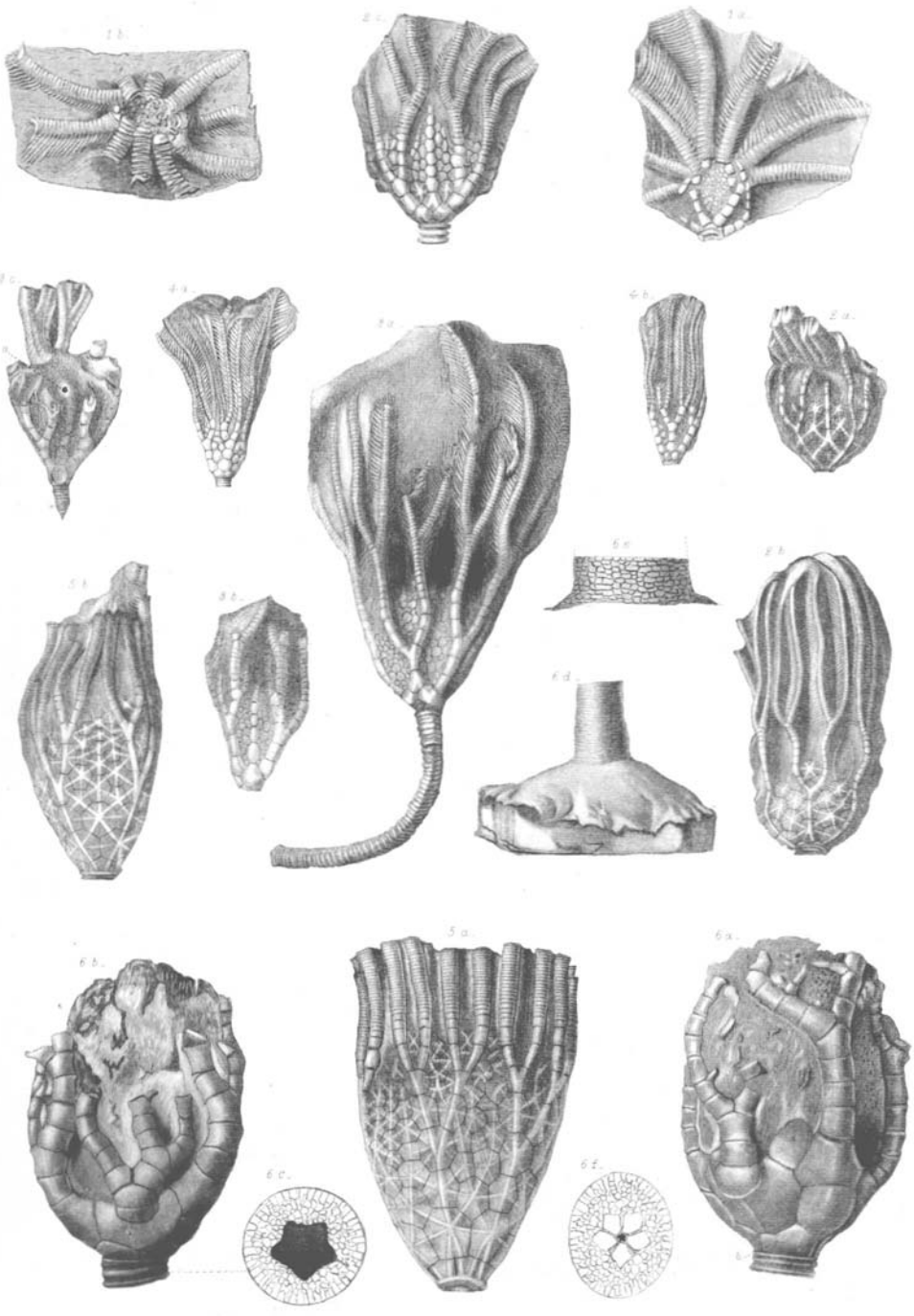

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PLATE III.

PAGE.

Fig. 1. LICHENOCRINUS CRATERIFORMIS 51

1 *a*. Upper side of disc, with the long appendage removed. Mag. 3 diameters. Mr. Dyer's collection.

1 *b*. A smaller individual growing on the middle of the glabella of a trilobite, and having a part of the plates and appendage of the upper side removed, so as to expose some of the internal radiating lamellæ. Mag. 2 diameters. Mr. Dyer's collection.

1 *c*. Upper side of a large specimen, showing disc plates and the broken end of the long central appendage. Mag. 2 diameters. Mr. Dyer's collection.

1 *d*. The flat under side of same specimen, as seen separated from the body upon which it grew, in such a manner as to leave the thin basal layer attached to the station, and thus expose numerous radiating striæ, and a small central opening (the latter apparently due to some accident). Mag. 2 diameters. Mr. Dyer's collection.

1 *e*. A side view of same specimen. Mag. 2 diameters. Mr. Dyer's collection.

1 *f*. A basal layer or platform attached to its original station, and showing its upper or inner structure, as exposed by the removal of the disc plates and internal lamellæ. Natural size. Mr. Dyer's collection.

1 *g*. Same, magnified 2 diameters. Mr. Dyer's collection.

1 *h*. Another basal layer, exposing its inner surface in the same way, with a smaller central circumscribed space. Mag. 2 diameters. Mr. Dyer's collection.

1 *i*. The circumscribed central area, magnified 6 diameters, to show that the radiating lines corresponding to the lamellæ of the interior are arranged in cycles, like the septa of a coral; five at equal distances apart, reaching the center, with three slightly shorter ones between each two of the longest, and another still shorter series intercalated regularly between the others. Mr. Dyer's collection.

1 *j*. A specimen, with the under or attached side separated from the body on which it grew, so as to expose its under surface, which is quite smooth, but shows, when moistened and examined under a magnifier, traces of the inner rays through its translucent substance. It also has one edge (the upper one in the drawing) folded upon itself in such a manner as to expose some of the disc plates of the upper side; but as the plates are curved and not broken along the folded edge, nor the sutures gaping there, this folding of the edge could not have resulted from flexibility of the disc, but seems to be a deformity produced during the growth of the animal. Mag. 3 diameters. Mr. Dyer's collection.

1 *k*. A slab of rock with two of the small discs placed, one partly upon or against the other, and showing the long appendage of each tapering off to an extremely attenuated extremity. Natural size. Mr. Dyer's collection.

1 *l*. Another larger individual growing on the shell of an *Orthis testudinaria*, and showing nearly three inches of its column-like appendage broken at its free end. Nat. size. Mr. James's collection.

1 *m*. A portion of the lower sub-pentagonal part of the long appendage of same, magnified 3 diameters, to show the alternately interlocking arrangement of its pieces there.

1 *n*. An end view of same, showing section of internal canal.

1 *o*. A piece of same farther up, where the pieces become nearly opposite.

1 *p*. The body and a part of the base of the appendage of the same specimen enlarged three diameters, to show how exactly it conforms to the inequalities of the surface of the shell upon which it grew.

1 *q*. Two smaller individuals growing on the shell of an *Orthis testudinaria*. Mag. a little more than 2 diameters.

1 *r*. Two others, growing on same species of *Orthis*, one of them with the upper side of the disc weathered so as to expose the edges of the lamellæ within. Nat. size. Mr. Dyer's collection.

1 *s*. Two individuals with the plates of the upper side partly removed so as to show the lamellæ within. Nat. size. Mr. Dyer's collection.

1 *t*. The same magnified two diameters.

Fig. 2. LICHENOCRINUS DYERI 51

A specimen showing the upper side of the disc, with its numerous very small pieces, and the base of its appendage in the middle. Nat. size. Mr. Dyer's collection.

Fig. 3. 46

3 *a*. A fragment having the structure and appearance of the column-like appendage of *L. Dyeri*, and showing its smaller end tapering rather abruptly to a blunt point. Mr. Dyer's collection. Nat. size.

3 *b*. A portion of same, magnified 3½ diameters.

Fig. 4. LEPOCRINITES MOOREI 39

4 *a*. Side view of body and a part of column. Nat. size. Mr. Moore's collection.

4 *b*. Another view of same, showing the anal opening, etc.

Fig. 5. AGELACRINITES PILEUS? 56

5 *a*. View of upper side. Nat. size. Mr. Dyer's collection.

Fig. 6. AGELACRINITES CINCINNATIENSIS 55

6 *a*. View of upper side. Nat. size.

6 *b*. Same, enlarged 2 diameters. Mr. Dyer's collection.

Fig. 7. AGELACRINITES VORTICELLATA 57

7 *a*. View of upper side. Nat. size.

7 *b*. Same, enlarged 2 diameters. Mr. Dyer's collection.

Fig. 8. HEMICYSTITES STELLATUS 52

8 *a*. Upper surface. Nat. size.

8 b. Same, enlarged 2 diameters. Mr. Dyer's collection.

Fig. 9. HEMICYSTITES GRANULATUS 54

9 *a*. Side view. Nat. size.

9 *b*. Same, enlarged 2 diameters. Mr. Dyer's collection.

Geological Survey of Ohio.

LOWER SILURIAN. (Cincinnati group.) PLATE 8.

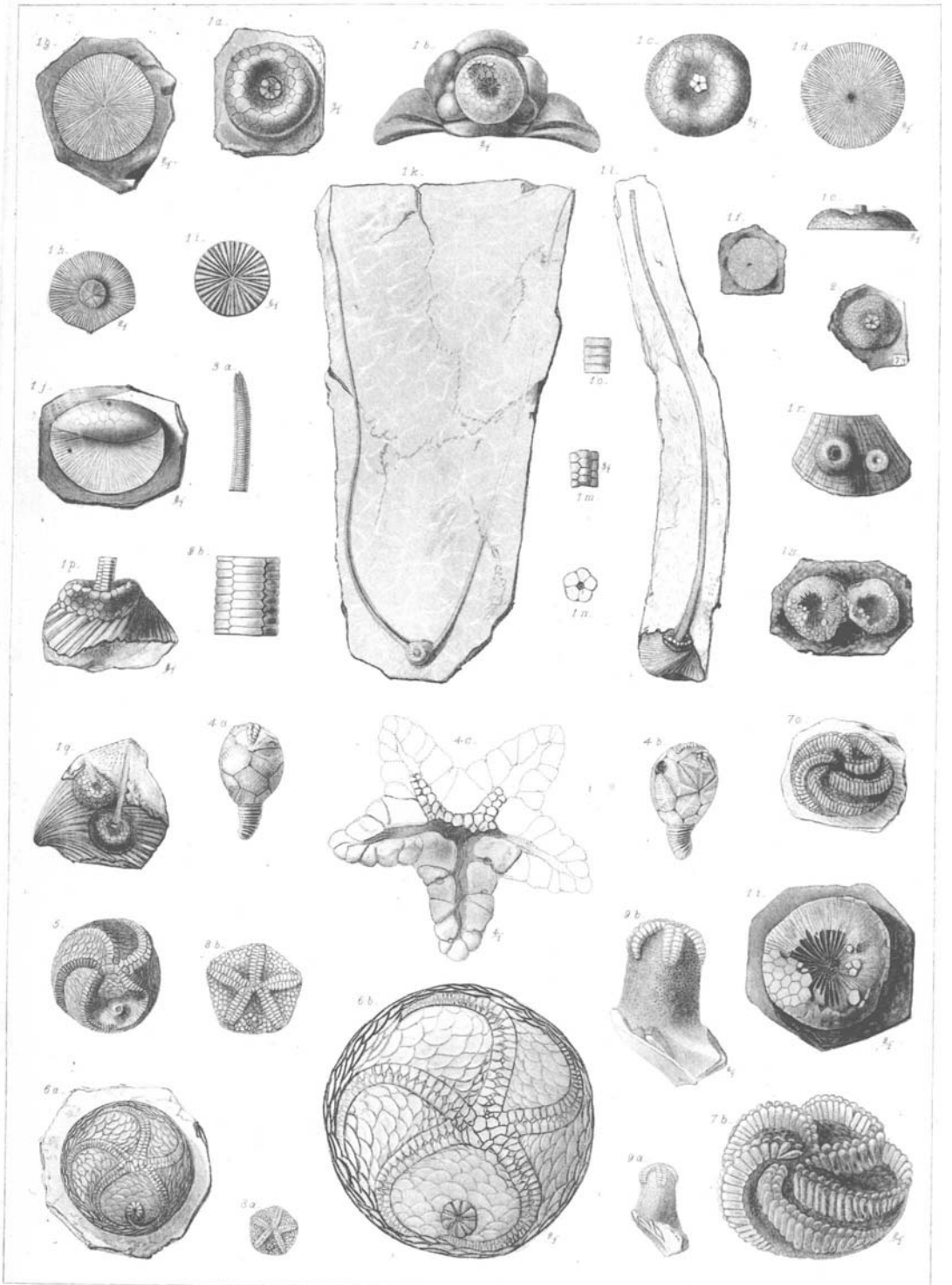

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PLATE III. *bis.*

PAGE.

Fig. 1. POTERIOCRINITES (DENDROCRINUS) CADUCEUS 26

1 *a*. A lateral view of body, a part of the column, and the arms, excepting their more slender subdivisions. Nat. size. Mr. O'Neall's collection.
1 *b*. A part of the column of same, magnified 2 diameters.
1 *c*. Portion of slender subdivisions of the arms, magnified about 4 diameters.
1 *d*. Posterior view of body and portions of the arms, with also a few segments of the column attached. Mr. O'Neall's collection.

Fig. 2. POTERIOCRINITES (DENDROCRINUS) CASEI 28

2 *a*. A specimen showing the anterior side of the body, with portions of some of the arms, and a piece of the column attached. The large ventral prolongation is also imperfectly seen, like arms above, composed of small pieces, marked with little ridges arranged zig-zag. Mr. Case's collection.
2 *b*. An end view of the column of same, showing its distinctly pentagonal form.
2 *c*. A posterior view of a young individual, showing body, arms, and a short piece of the column. Mr. Dyer's collection.

Fig. 3. POTERIOCRINITES (DENDROCRINUS) DYERI..... 24

3 *a*. Lateral view of body, arms, and a portion of the column. Mr. Dyer's collection.
3 *b*. A similar view of a smaller specimen, with the body plates somewhat deranged by pressure. Mr. Dyer's collection.

Fig. 4. POTERIOCRINITES (DENDROCRINUS) POSTICUS..... 22

4 *a*. Posterior view of one of the type specimens, showing body, portions of some of the arms, and a part of the ventral prolongation. Mr. Dyer's collection.
4 *b*. Same view of another one of the type specimens, showing rather more of the arms. Mr. Dyer's collection.
4 *c*. An anterior view of same.

Fig. 5. POTERIOCRINITES (DENDROCRINUS) CINCINNATIENSIS..... 20

5 *a*. A posterior view of body, most of the arms, and a part of the column, of type specimen. Mr. Dyer's collection.
5 *b*. Same view of another smaller specimen, with arms removed.

Fig. 6. ANOMALOCYSTITES BALANOIDES 41

6 *a*. An anterior view of the lower part of the body only. Mr. Dyer's collection.
6 *b*. Side view of same.
6 *c*. A posterior view of same, showing the deeply sinuous character of the basal pieces, and some remains of the extremely thin segments of the very thick upper end of the column.

Fig. 7. STENASTER GRANDIS 66

7 *a*. Dorsal view of a specimen with two of the rays folded over upon the disc, so as to show thin ventral sides; one of the others curved and compressed laterally, and the other two with their extremities broken away. Mrs. Haines's collection.
7 *b*. A piece of one of the rays enlarged; under side view.
7 *c*. A piece of same, dorsal side, more highly magnified.

Fig. 8. PROTASTER GRANULIFERUS 68

8 *a*. A ventral view of a specimen consisting of a part of the disc and the inner ends of the rays, magnified about 2 diameters.
8 *b*. A small portion of the integument of the dorsal side of the disc, magnified to show its minutely granular structure.

Fig. 9. POTERIOCRINITES (DENDROCRINUS) POLYDACTYLUS..... 22

A posterior view of the body and arms, with a piece of the column attached.

Geological Survey of Ohio.

LOWER SILURIAN. (Cincinnati group.) PLATE 3 bis.

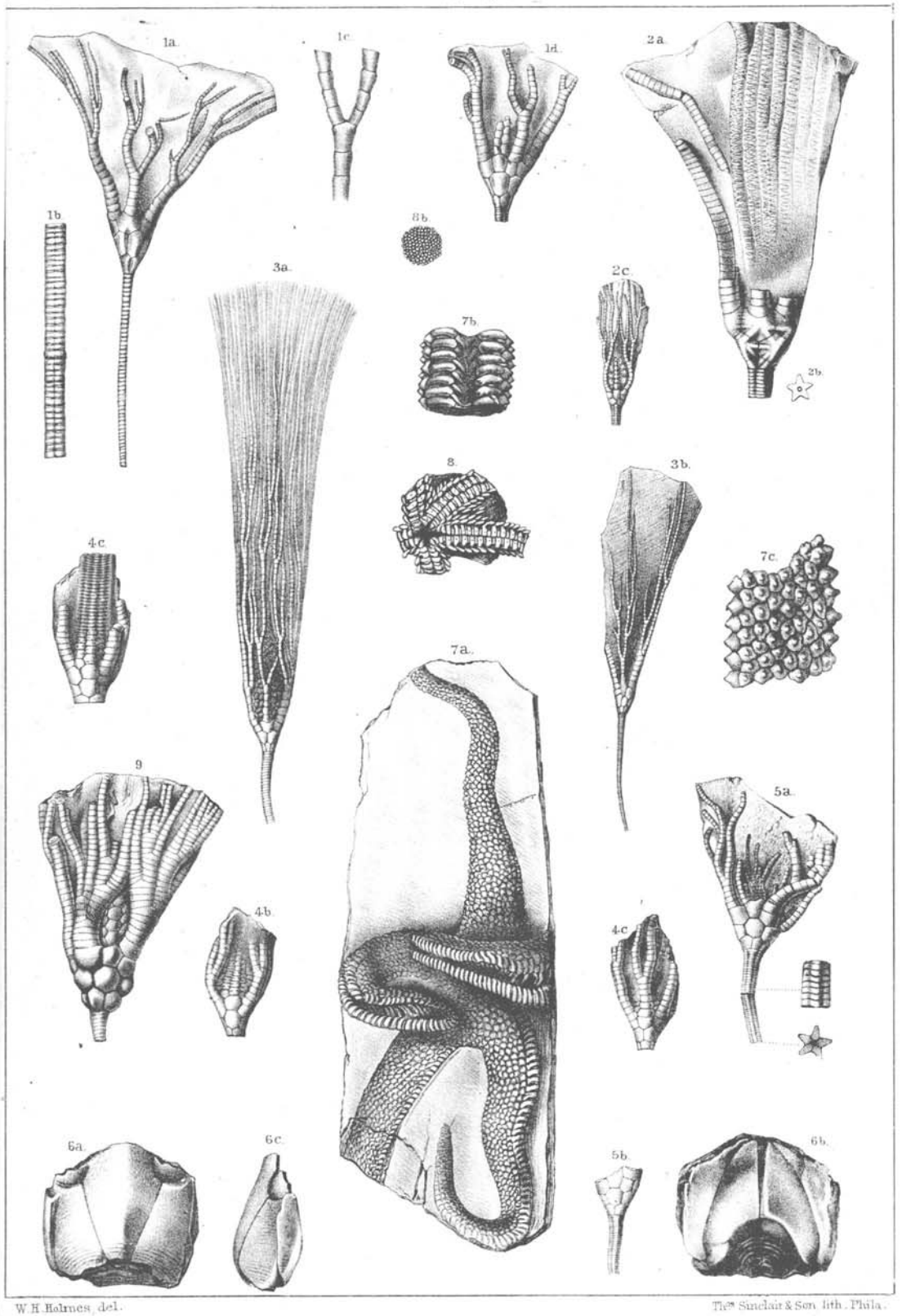

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PLATE IV.

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Fig. 1. PALÆASTER SHAEFFERI 66

An outline view of the ventral side, from plate IX., fig. 2, of 20th Ann. Regents' Report, N. Y.

Fig. 2. PALÆASTER DYERI 58

2 *a*. A view of the ventral side of a specimen consisting of a part of the disc, and portions of the rays, showing some of the marginal and adambulacral pieces, with their spines, and at one place a few dorsal pieces of one of the rays brought into view by distortion; the whole being much obscured by adhering shaly matter. The ambulacral canals are doubtless made to appear narrower than natural, at the broken end of the lower ray, by accidental pressure. Mr. Dyer's collection.

2 *b*. A part of the under side of one of the rays, showing the marginal and adambulacral pieces with some of their spines, all magnified 2 diameters.

2 *c*. A part of the dorsal side of one of the rays, showing the angular forms, and loose arrangement of the dorsal pieces, as magnified nearly 2 diameters.

2 *d*. Two of the spines of the marginal and adambulacral pieces, magnified 3 diameters.

2 *e*. The madreporiform piece, magnified 2 diameters.

2 *f*. Two of the very small dorsal spines, magnified 3 diameters.

Fig. 3. PALÆASTER GRANULOSUS ?..... 60

3 *a*. Ventral side of a specimen showing two and a part of a third ray, and, less distinctly, a portion of the disc. The ranges of pieces outside of the marginal rows belong to the dorsal series, being here brought into view by accidental pressure. Mr. Dyer's collection.

3 *b*. A part of one of the rays, showing the marginal, adambulacral, and ambulacral pieces, all in their relative positions, and magnified about 2 diameters.

3 *c*. Dorsal side of a piece of one of the rays, near its middle, showing the arrangement and form of the dorsal pieces, as seen magnified about 2½ diameters.

Fig. 4. PALÆASTER JAMESII..... 62

View of the ventral side. This specimen has the appearance of having the marginal pieces removed, so as to expose the inner side of the dorsal pieces. This, however, may be owing to some peculiar character of the fossil, or due to some other accidental cause. The oral pieces are not clearly seen, and may not have exactly the characters represented. Mr. James's collection.

Fig. 5. PALÆASTER INCOMPTUS..... 64

5 *a*. Dorsal side of a compressed specimen, with the pieces somewhat displaced.

5 *b*. The madreporiform body of same, magnified about 5 diameters.

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LOWER SILURIAN. (Cincinnati group.) PLATE 4.

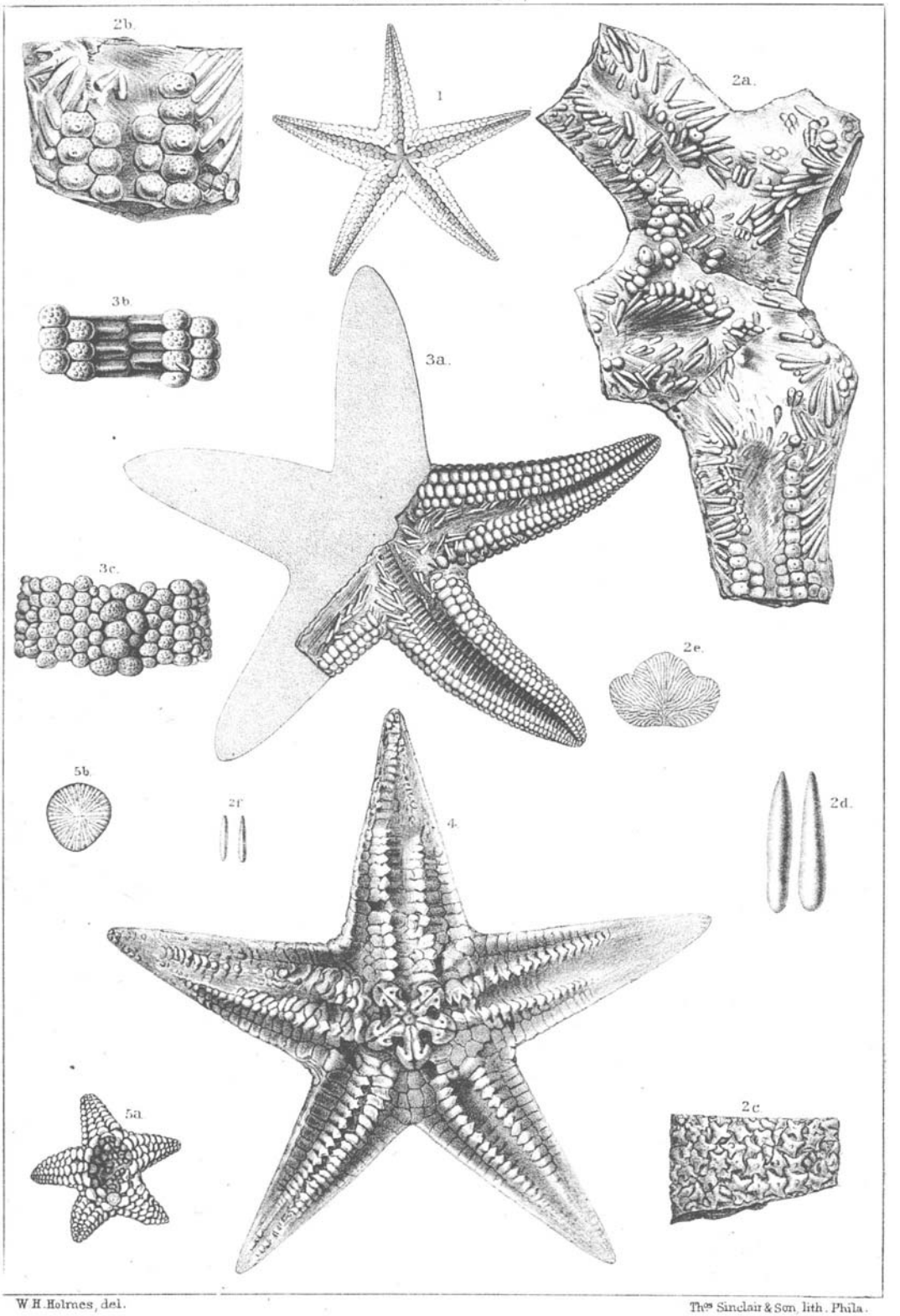

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PLATE V.

PAGE.

Fig. 1. PTILODICTYA SHAFFERI 69

1 *a*. Parts of the stems and branches. Natural size. Mr. Shaffer's collection.
1 *b*. Same magnified about 2½ diameters.
1 *c*. A part of one of the branches, magnified about 12 diameters, to show the oval form of the pores, and the striated interspaces.

Fig. 2. PHOLIDOPS CINCINNATIENSIS 130

2 *a*. A view from above, magnified about 3 diameters. Mr. James's collection.
2 *b*. Profile of same, magnified as above.
2 *c*. Cross lines showing the natural size of the specimen.

Fig. 3. LEPTÆNA SERICEA? 70

3 *a*. Dorsal view, magnified 1½ diameters.
3 *b*. Interior of ventral valve, magnified 1½ diameters, showing muscular impressions, etc.
3 *c*. Interior of dorsal valve, magnified 1½ diameters, to show muscular impressions and cardinal and brachial processes.
3 *d*. Surface striæ, magnified.
3 *e*. Section of the two valves united.
3 *f*. A dorsal view of the variety *rugosa*, magnified as above, showing cardinal area, and the oblique wrinkles near the hinge line.
3 *g*. Interior of dorsal valve of same, showing cardinal and brachial processes, muscular impressions, etc., as magnified 1½ diameters.
3 *h*. Section of the united valves.

Fig. 4. STROPHOMENA SULCATA 85

4 *a*. A dorsal view of a rather small specimen.
4 *b*. A ventral view of a larger individual.
4 *c*. Cardinal view of same, showing area, pseudo-deltidium, perforation of beak, etc.
4 *d*. Anterior view of same, showing mesial sinus and fold.
4 *e*. Surface striæ, magnified.

Fig. 5. STROPHOMENA SINUATA 87

5 *a*. Dorsal view.
5 *b*. Ventral view.
5 *c*. Cardinal view, showing area, false deltidium, and the minute perforation of the beak.
5 *d*. An anterior view, showing the much fainter sinus and fold than are seen in the last, as represented by fig. 4 *d*.
5 *e*. Surface striæ, magnified.
5 *f*. An imperfect specimen, showing cardinal process, and socket ridges of the interior of the dorsal valve.
5 *g*. Another, showing hinge teeth, and the cavity for the reception of the muscles, dental ridges, etc., of ventral valve.

Fig. 6. STROPHOMENA RHOMBOIDALIS, VAR. TENUISTRIATA 75

6 *a*. Ventral view.
6 *b*. Dorsal view.
6 *c*. Interior of dorsal valve, showing the short cardinal process, muscular scars, etc.
6 *d*. Section of the two valves united.
6 *e*. Surface striæ, magnified.

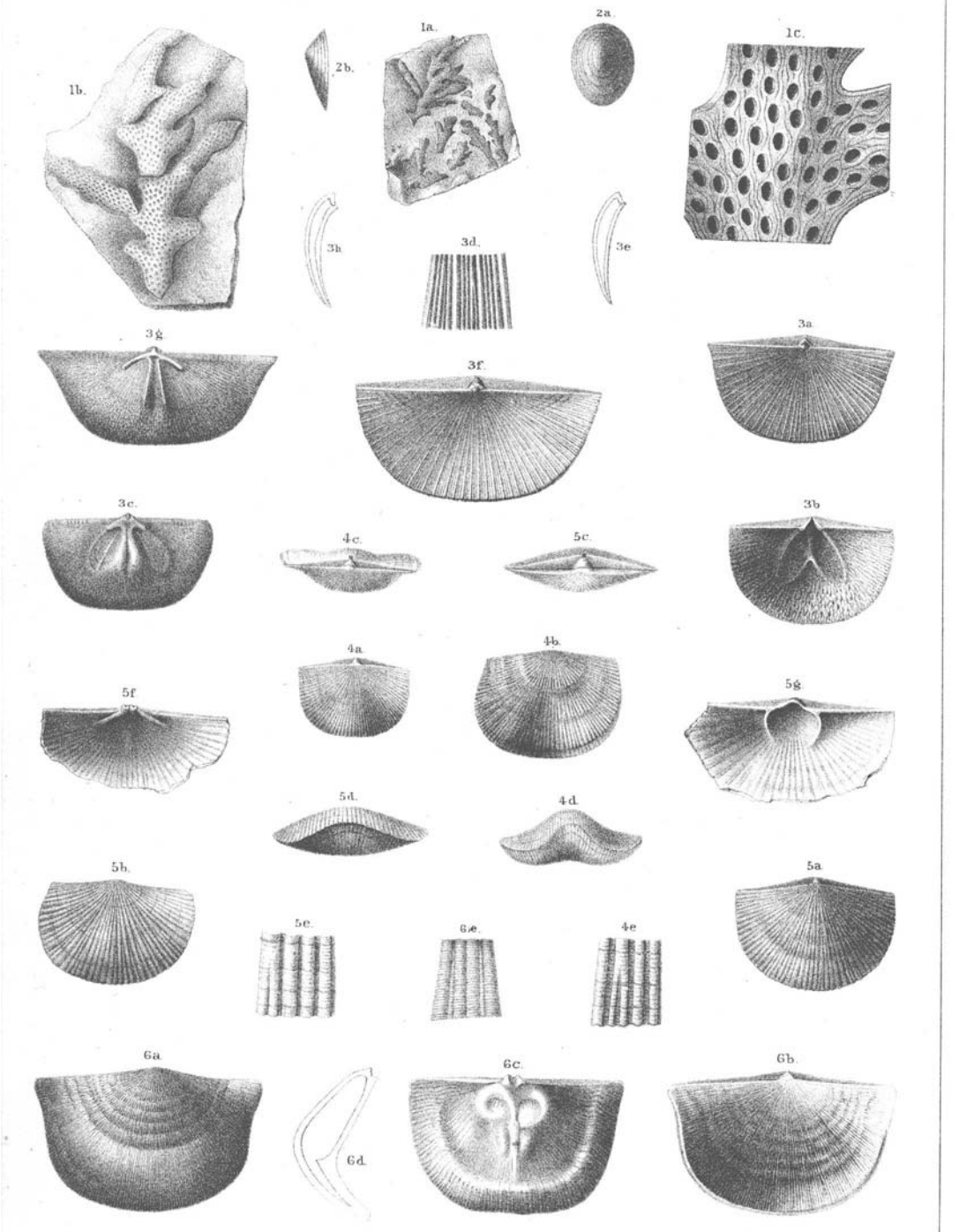

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PLATE VI.

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Fig. 1. STROPHOMENA NUTANS 77

1 *a*. View of dorsal side.
1 *b*. Ventral view.
1 *c*. Interior ventral valve, showing the cavity for the muscular attachments, hinge teeth, area, and pseudo-deltidium, as well as the thickened, wrinkled, and geniculated zone around the front and lateral margins.
1 *d*. Interior of dorsal valve, showing cardinal process, sockets, and obscure muscular markings.
1 *e*. Magnified surface markings.
1 *f*. Section of the two valves united.

Fig. 2. STROPHOMENA PLANO-CONVEXA 82

2 *a*. Ventral view.
2 *b*. Dorsal view.
2 *c*. Posterior view, showing area, pseudo-deltidium, and minute perforation of beak.
2 *d*. Interior ventral valve, showing muscular cavity, hinge teeth, area, pseudo-deltidium, etc.
2 *e*. Section of the two valves united.
2 *f*. Interior of dorsal valve, showing the very small bipartite cardinal processes, oblique socket ridges, and obscure radiating ridges without well-defined muscular scars in the bottom of the valve.
2 *g*. Surface markings, magnified.

Fig. 3. STROPHOMENA PLANUMBONA 79

3 *a*. View of ventral side.
3 *b*. Dorsal view.
3 *c*. Interior of ventral valve, showing muscular cavity, hinge teeth, and thickened and wrinkled anterior and lateral margins.
3 *d* Interior of dorsal valve, showing the bifid cardinal process, muscular scars, etc.
3 *e*. Section of the two valves united.
3 *f*. Posterior view of the united valves, showing area, pseudo-deltidium, etc.
3 *g*. Surface striæ, magnified.

Fig. 4. STROPHOMENA PLICATA 81

4 *a*. Ventral view.
4 *b*. Dorsal view.
4 *c*. Posterior view, showing area, pseudo-deltidium, etc.
4 *d*. A lateral or profile view of same.
4 *e*. Interior of a dorsal valve, showing the short bifid cardinal process, sockets and oblique socket ridges, and obscurely some of the internal markings. Externally this specimen shows the characteristic oblique wrinkles.
4 *f*. Interior of ventral valve, with hinge teeth, muscular cavity, and cardinal area, with its pseudo-deltidium.
4 *g*. Section of the two valves united.
4 *h*. Surface markings, magnified.

Fig. 5. STROPHOMENA FILITEXTA 83

5 *a*. Ventral view.
5 *b*. A dorsal view of another specimen.
5 *c*. Interior of a ventral valve, showing the large, deep, very strongly defined muscular cavity, hinge teeth, etc.
5 *d*. Interior of a dorsal valve, showing the bifid cardinal process and socket ridges, with four strong ridges, and three linear ones between them, in the bottom of the valve, the whole of which is much roughened by little asperities.
5 *e*. Surface markings, magnified.

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LOWER SILURIAN. (Cincinnati group.) PLATE 6.

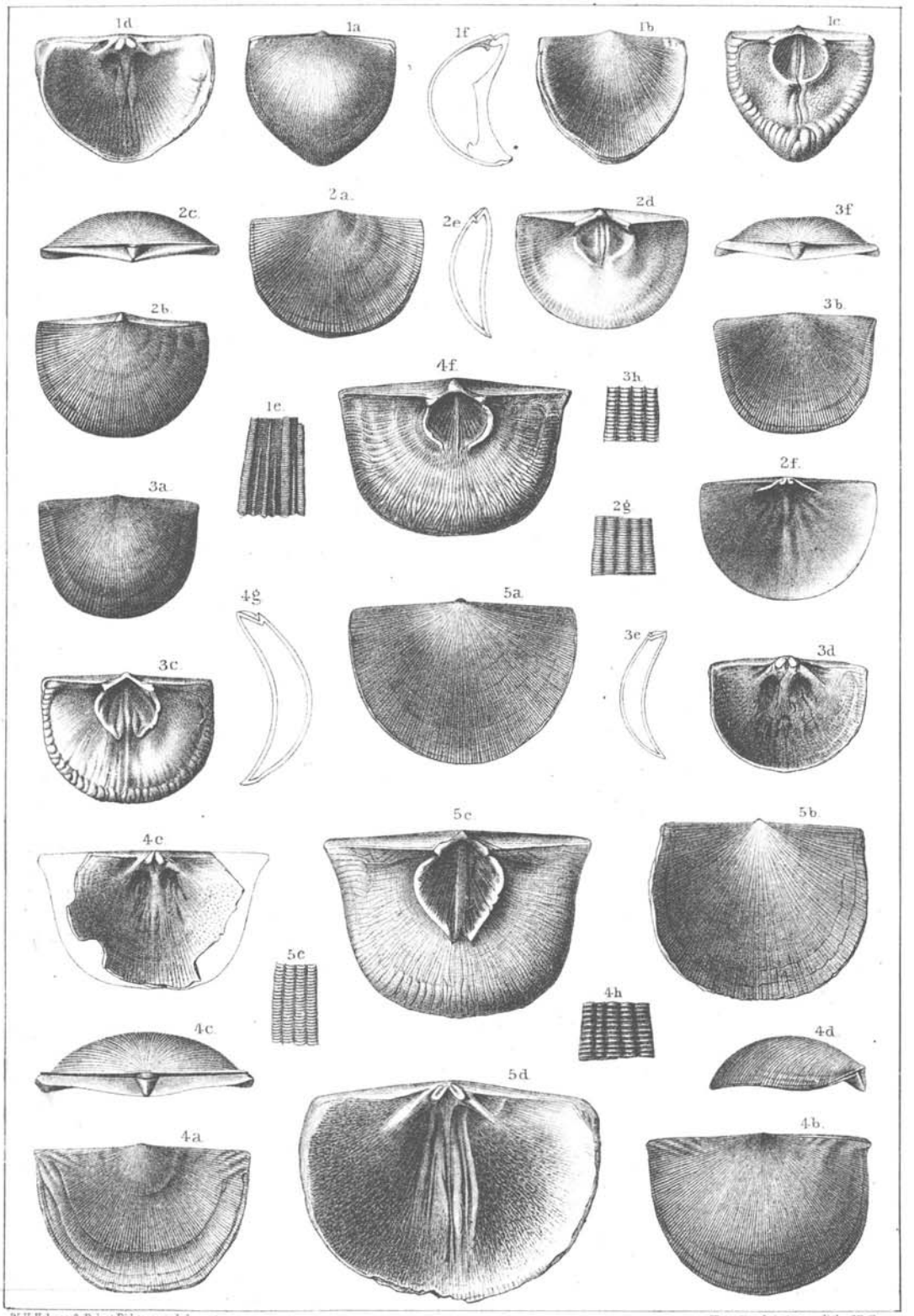

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PLATE VII.

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Fig. 1. STROPHOMENA ALTERNATA 88

1 *a*. Ventral view of a rather long specimen.
1 *b*. Dorsal view of same, showing area, false deltidium.
1 *c*. Internal view of ventral valve, showing muscular impressions, hinge teeth, etc.
1 *d*. Interior of dorsal valve, showing muscular impressions, the bifid cardinal process, and a somewhat thickened and wrinkled ridge around near the anterior and lateral margins.
1 *e*. A section of the two valves.
1 *f*. Surface striæ magnified to show how several small ones usually occur between each two larger.
1 *g*. Some of the striæ much more magnified, to show the small, crowded lines of growth. The surface markings of the other varieties differ but little from this.

Fig. 2. STROPHOMENA ALTERNATA, *var.* NASUTA 90

2 *a*. A ventral view.
2 *b*. A section of same specimen, to show the strong deflection of the valves.
2 *c*. Ventral view of a smaller specimen, with the nasute character more strongly defined. Mr. Dyer's collection.

Fig. 3. STROPHOMENA ALTERNATA, *var.* FRACTA 91

3 *a*. A dorsal view of a large specimen.
3 *b*. Ventral view of another individual of more elongated form, showing a second growth around the anterior and anterior-lateral margins, often seen in this variety.
3 *c*. Interior view of same, showing hinge and muscular impressions.
3 *d*. Interior of ventral valve of a smaller specimen, showing the bifid cardinal process, and the muscular scars more remote from the same than in the other varieties.
3 *e*. Section of the two valves, showing their depressed form.

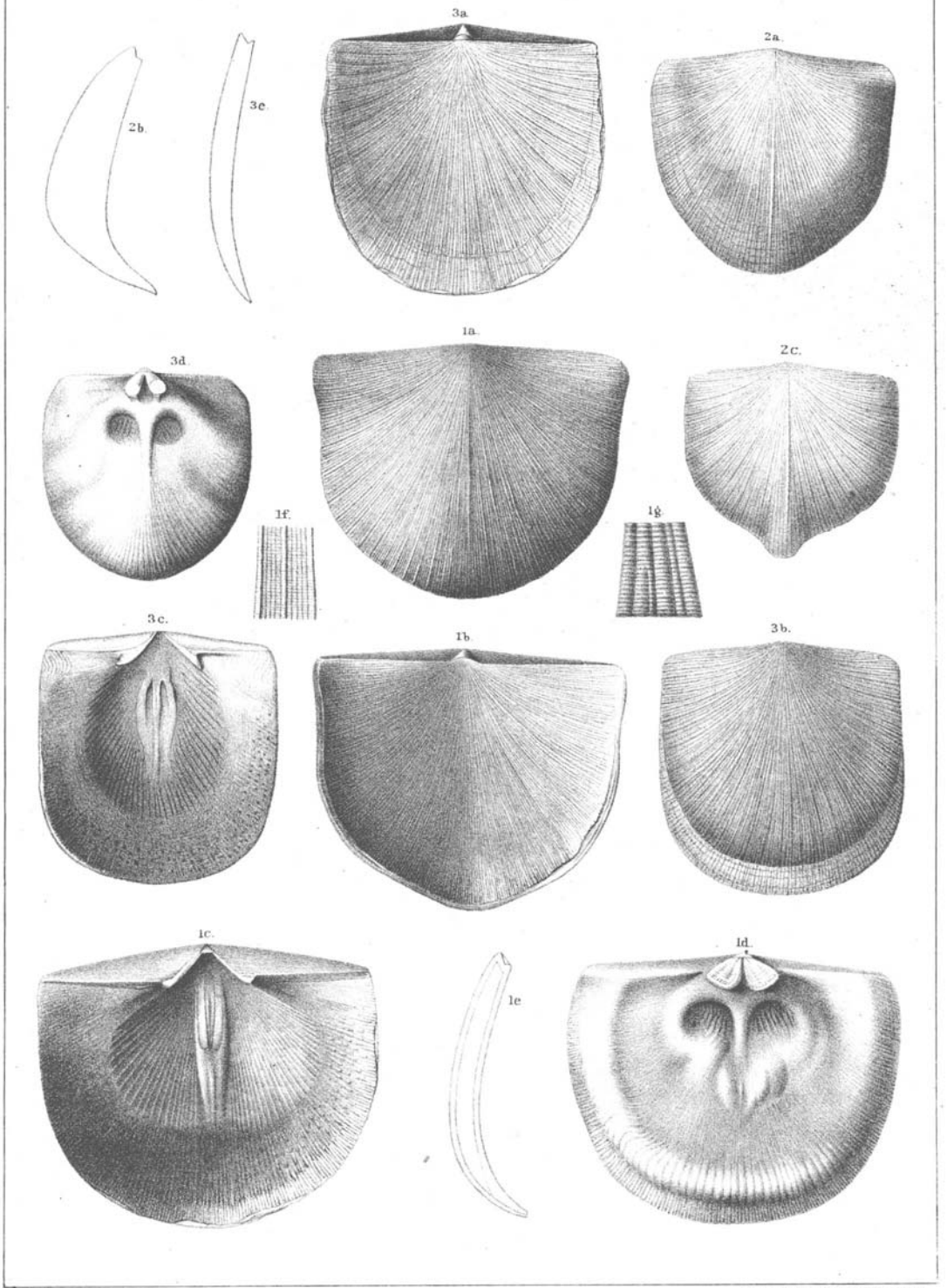

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PLATE VIII.

PAGE.

Fig. 1. ORTHIS EMACERATA 109

1 *a*. A dorsal view of a medium-sized specimen of the same form as one of the typical examples.
1 *b*. A profile view of same.
1 *c* A posterior view of same.
1 *d* A ventral view of a more transverse specimen, agreeing with the other typical example.

Fig. 2. ORTHIS EMACERATA 109

2 *a*. Dorsal view of a larger specimen, differing in form.
2 *b*. A ventral view of same.
2 *c* An internal view of ventral valve, showing muscular impressions, hinge teeth, etc.
2 *d*. Interior of dorsal valve showing muscular scars and cardinal and brachial processes.
2 *e* Profile of the specimen represented by fig. 2 *a*.
2 *f*. Cardinal or posterior view of same.
2 *g*. Surface striæ much magnified, to show the minute lines of growth as seen crossing the furrows between the striæ.

Fig. 3. ORTHIS EMACERATA *var.* MULTISECTA 112

3 *a*. Ventral view.
3 *b*. A cardinal view of same.
3 *c* Interior of dorsal valve, showing muscular impressions, cardinal and brachial processes.
3 *d*. Surface striæ magnified, to show minute cross striæ in furrows

Fig. 4. ORTHIS BOREALIS 101

4 *a*. Dorsal view.
4 *b*. Profile of same
4 *c*. Anterior view of same.
4 *d*. Ventral view of a smaller specimen.
4 *e*. Dorsal view of same.
4 *f*. A cardinal or posterior view.

Fig. 5. ORTHIS BELLULA 103

5 *a* A dorsal view. Natural size.
5 *b*. Same, magnified 2 diameters.
5 *c*. Ventral view, magnified.
5 *d*. Cardinal or posterior view, magnified.
5 *e*. Anterior view, magnified.
5 *f*. Surface striæ, magnified.

Fig. 6. ORTHIS FISSICOSTA 106

6 *a*. Ventral view.
6 *b*. A dorsal view of same.
6 *c*. Cardinal view of same.
6 *d*. Surface striæ and minute cross lines of growth, magnified.
6 *e*. Profile view of the specimen represented by fig. 6 *a*.
6 *f*. An internal view of a dorsal valve of a smaller specimen, showing hinge, with cardinal and brachial processes, without any visible muscular scars.
6 *g* An internal view of a ventral valve of a specimen with the cardinal margin broken away, showing an obscurely defined muscular cavity.
6 *h*. Interior of a ventral valve, showing small hinge teeth and an obscurely defined muscular cavity.

Fig. 7. ORTHIS PLICATELLA 108

7 *a*. Ventral view.
7 *b*. Dorsal view of same.
7 *c*. Interior of a dorsal valve, showing cardinal and brachial processes, without any muscular scars.
7 *d*. A profile view.
7 *e*. An anterior view.
7 *f*. A cardinal view.
7 *g*. Surface markings enlarged to show transverse striæ between the ribs, and minute traces of longitudinal striæ upon and between the same.
7 *h*. A ventral view of a specimen nearly intermediate between typical form of this species and the following variety.
7 *i*. A dorsal view of same.
7 *j*. Interior of dorsal valve of same, showing cardinal and brachial processes.

Fig. 8. ORTHIS PLICATELLA, *var.* TRIPLICATELLA 109

8 *a*. A dorsal view.
8 *b*. A ventral view.
8 *c*. Cardinal view, to show the very low area, as compared with figs. 7 *f* and 6 *c*.
8 *d*. Profile of same.
8 *e*. Surface markings, magnified.

Fig. 9. ORTHIS? ELLA 105

9 *a*. A dorsal view.
9 *b*. Profile.
9 *c*. Cardinal view, showing the very restricted character of the area.
9 *d*. Anterior view of same.

Geological Survey of Ohio.

LOWER SILURIAN. (Cincinnati group.) PLATE 8.

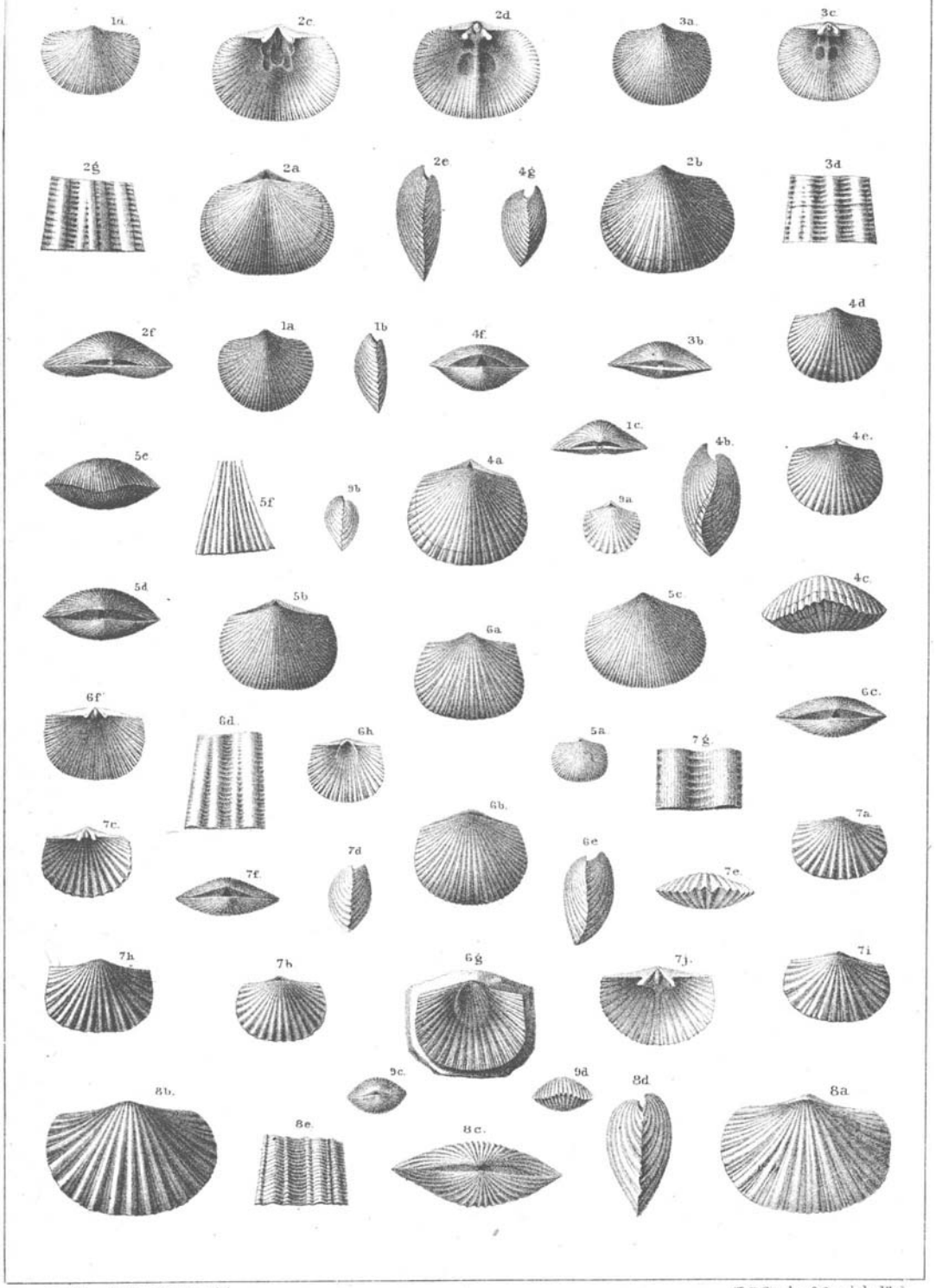

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PLATE IX.

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Fig. 1. ORTHIS INSCULPTA 99

1 *a*. Dorsal view.
1 *b*. Ventral view of same.
1 *c*. Interior of dorsal valve, showing cardinal and brachial processes, muscular impressions and vascular markings. Mr. Dyer's collection.
1 *d*. Interior of ventral valve, showing muscular and other internal markings, hinge teeth, etc.
1 *e*. Same view of another specimen differing somewhat in these details.
1 *f*. A cardinal or posterior view, showing the cardinal area, foramen, etc.
1 *g*. Profile of same.
1 *h*. Surface markings, magnified.

Fig. 2. ORTHIS SUBQUADRATA 94

2 *a*. Dorsal view. (*b*, by mistake on the plate.)
2 *b*. Ventral view of same. (Right-hand side of the plate.)
2 *c*. Interior of dorsal valve, showing cardinal and brachial processes, muscular scars, etc.
2 *d*. Interior of ventral valve, showing muscular impressions, hinge teeth, and vascular markings.
2 *e*. Surface markings, magnified.
2 *f*. A cardinal or posterior view.
2 *g*. A part of the cardinal margin, magnified to show the markings on the cardinal process, etc.

Fig. 3. ORTHIS OCCIDENTALIS 96

3 *a*. A dorsal view.
3 *b*. Ventral view.
3 *c*. An anterior view.
3 *d*. A profile or lateral view.
3 *e*. Posterior or cardinal view, showing the high area and foramen.
3 *f*. Interior of the ventral valve, showing muscular scars, hinge teeth, etc.
3 *g*. Surface markings, magnified.
3 *h*. Interior of dorsal valve, showing muscular impressions, and cardinal and brachial processes.

Fig. 4. ORTHIS SINUATA 96

4 *a*. Dorsal view of a large specimen.
4 *b*. Ventral view of same.
4 *c*. Profile of same.
4 *d*. Anterior view of same.
4 *e*. Interior of dorsal valve showing cardinal and brachial process, muscular scars, etc.
4 *f*. Interior of ventral valve, showing muscular impressions, hinge teeth, etc.
4 *g*. Surface markings, magnified.

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LOWER SILURIAN. (Cincinnati group.) PLATE D.

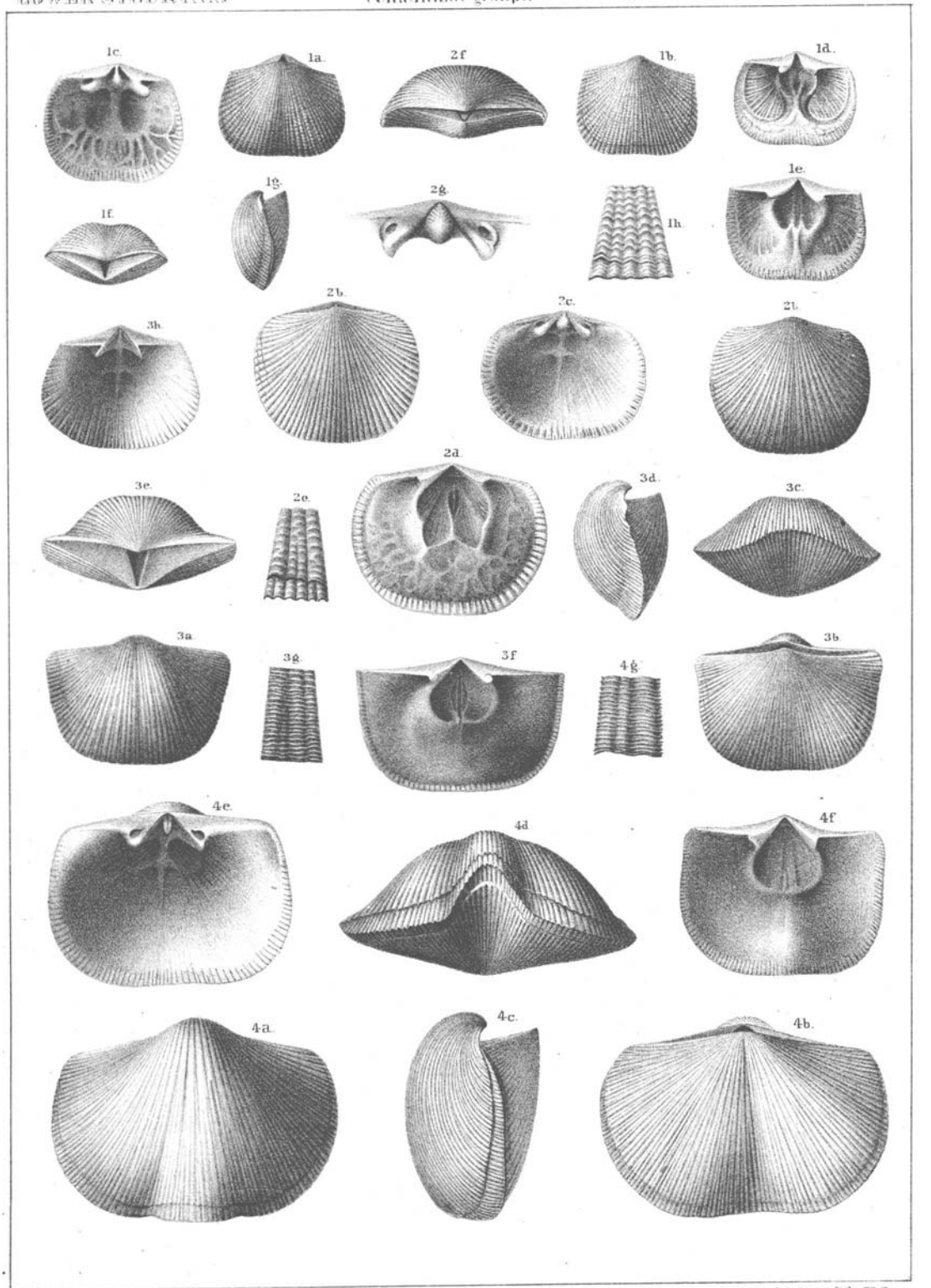

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PLATE X.

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Fig. 1. ORTHIS (PLATYSTROPHIA) BIFORATA, *var.* LYNX 114

1 *a*. Dorsal view of a medium-sized adult specimen.
1 *b*. Anterior view of same. (This figure should have been drawn with the dorsal valve above, for ready comparison with the same view of the other varieties on this plate.)
1 *c*. Ventral view of same.
1 *d*. A posterior view, showing the double area, foramen, etc.
1 *e*. An internal view of the ventral valve, showing the area, foramen, hinge teeth, and the deep cavity for the muscular scars.

Fig. 2. ORTHIS (PLATYSTR.) BIFORATA, *var.* OF YOUNG..... 117

2 *a*. Dorsal view.
2 *b*. Anterior view of same, showing the very prominent mesial fold and deep sinus.
2 *c*. Posterior view of same.
2 *d*. Ventral view of same.

Fig. 3. ORTHIS (PLATYSTR.) BIFORATA, *var.* DENTATA?..... 117

3 *a*. Dorsal view of a specimen with two plications on the mesial fold and one in the sinus.
3 *b*. A ventral view of same.
3 *c*. Anterior view of same, showing the prominent mesial fold and deep sinus.
3 *d*. A ventral view of another specimen, with a second smaller plication in the sinus and a third on the fold.

Fig. 4. ORTHIS (PLATYSTR.) BIFORATA, *var.* LATICOSTA..... 116

4 *a*. A dorsal view.
4 *b*. Ventral view of same.
4 *c*. Anterior view, showing the prominent mesial fold and deep, wide sinus.
4 *d*. Interior of a ventral valve.
4 *e*. Interior of dorsal valve, showing the obscure muscular scars, very small linear cardinal process, and the tooth-like brachial processes.
4 *f*. The minute granular surface markings, magnified.

Fig. 5. ORTHIS (PLATYSTR.) BIFORATA, *var.* ACUTILIRATA..... 119

5 *a*. Ventral view of a rather large adult specimen.
5 *b*. Posterior view of same, showing the cardinal area and strongly incurved beak of each valve.
5 *c*. Anterior view of same.*
5 *d*. A dorsal view of a more transverse specimen.
5 *e*. Interior of ventral valve, showing the deep cavity for the muscular scars, cardinal area, foramen, and hinge teeth, with a slight thickening and subcrenate appearance of the hinge margin near the teeth. (This latter character may not be normal, as it is not seen in some other specimens.)
5 *f*. A less transverse individual; dorsal view.
5 *g*. Surface granules, magnified. (These granules occur on all of the other varieties, in well-preserved examples.)

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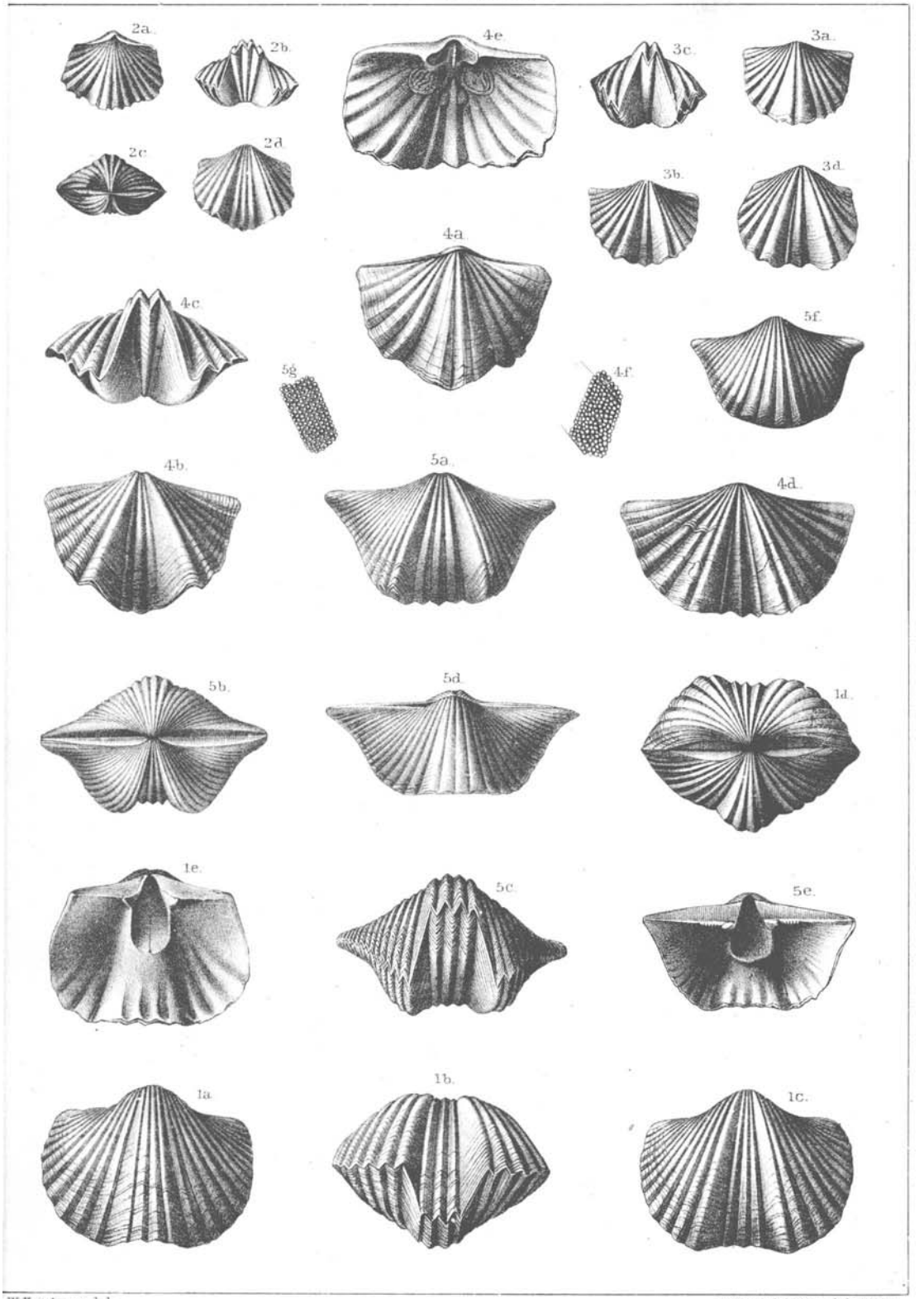
* It may perhaps not be superfluous to inform students, that in comparing this figure and figs 2 *b*, 3 *c*, and 4 *c*, with 1 *b*, that the latter was inadvertently drawn in a different posture from the others, its sinuated valve being turned upward, instead of the reverse.



W.H. Holmes del. Thos Sinclair & Son, lith. Phila.

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PLATE XI.

PAGE.

Fig. 1. ZYGOSPIRA HEADI 127

1 *a*. Profile view.
1 *b*. Dorsal view.
1 *c*. Front view.
1 *d*. Ventral view.

Fig. 2. RHYNCHONELLA CAPAX 123

2 *a*. Dorsal view of an adult, rather gibbous specimen.
2 *b*. Front view of same.
2 *c*. Ventral view of same.
2 *d*. Lateral or profile view of a large gibbous specimen.
2 *e*. Interior of ventral valve, showing hinge teeth, and the deep angular cavity for the muscular impressions seen in the bottom of the valve; also the deep rostral cavity.
2 *f*. Interior of dorsal valve, showing the short, closely set apophyses, with the sockets for the reception of the teeth of the other valve, just outside of them. A mesial ridge is seen in the bottom, but no muscular scars have been observed.

Fig. 3. RHYNCHONELLA DENTATA 121

3 *a*. Dorsal view of a specimen with the usual number of muscular plications (two) on the mesial fold.
3 *b*. Lateral view of same.
3 *c*. Ventral view of same, showing the single plication in the sinus.
3 *d*. Dorsal view of another specimen having a rudimentary plication somewhat raised on each side of the usual two forming the mesial fold.

Fig. 4. ZYGOSPIRA MODESTA 125

4 *a*. Ventral view of an adult specimen.
4 *b*. Profile of same.
4 *c*. An anterior view of same.
4 *d*. Dorsal view.

Fig. 5. ZYGOSPIRA CINCINNATIENSIS 126

5 *a*. Dorsal view.
5 *b*. Ventral view.
5 *c*. An anterior view.

Fig. 6. RETZIA (TREMATOSPIRA) GRANULIFERA 128

6 *a*. Ventral view. Nat. size
6 *b*. Dorsal view of same.
6 *c*. Profile view of same.
6 *d*. Dorsal view, magnified
6 *e*. A part of two of the plications more highly magnified, to show the surface granulations, with numerous much smaller punctures

Fig. 7. ORTHIS RETRORSA ? 92

7 *a*. Dorsal view.
7 *b*. Ventral view, showing the area strongly inclined forward, and the foramen, with the beak and area of the dorsal valve
7 *c*. A profile view of the same specimen.
7 *d*. Interior of ventral valve of a larger individual, showing the very strongly defined cavity for the muscular scars, and the complex vascular markings. Mr Dyer's collection.
7 *e*. Interior of same valve of a smaller individual, showing same parts, but presenting differences in the form of the cavity for the muscular scars and vascular markings, that seem scarcely compatible with specific identity.
7 *f*. Surface markings, magnified.

Fig. 8. AMBONYCHIA (MEGAPTERA) CASEI ? 133

An external view of right valve, with a part of the alation broken away.

Fig. 9. AMBONYCHIA (MEGAPTERA) ALATA 131

A right valve, with a part of the wing removed. Mr. James's collection.

Fig. 10. CLIDOPHORUS' (NUCULITES) FABULA 138

10 *a*. A left? side view of an internal cast, magnified 10 diameters
10 *b*. Opposite view of same.

Fig. 11. TELLINOMYA OBLIQUA ? 139

11 *a* and *b*. Right and dorsal views of an internal cast, magnified 10 diameters.
11 *c*. Dorsal view of same.

Fig. 12. CYPRICARDITES STERLINGENSIS ? 133

A right and dorsal views of an internal cast, showing some remains of impressions of posterior hinge teeth at (*t*) of fig. 12 *a*.

Geological Survey of Ohio.

LOWER SILURIAN. (Cincinnati group.) PLATE. II.

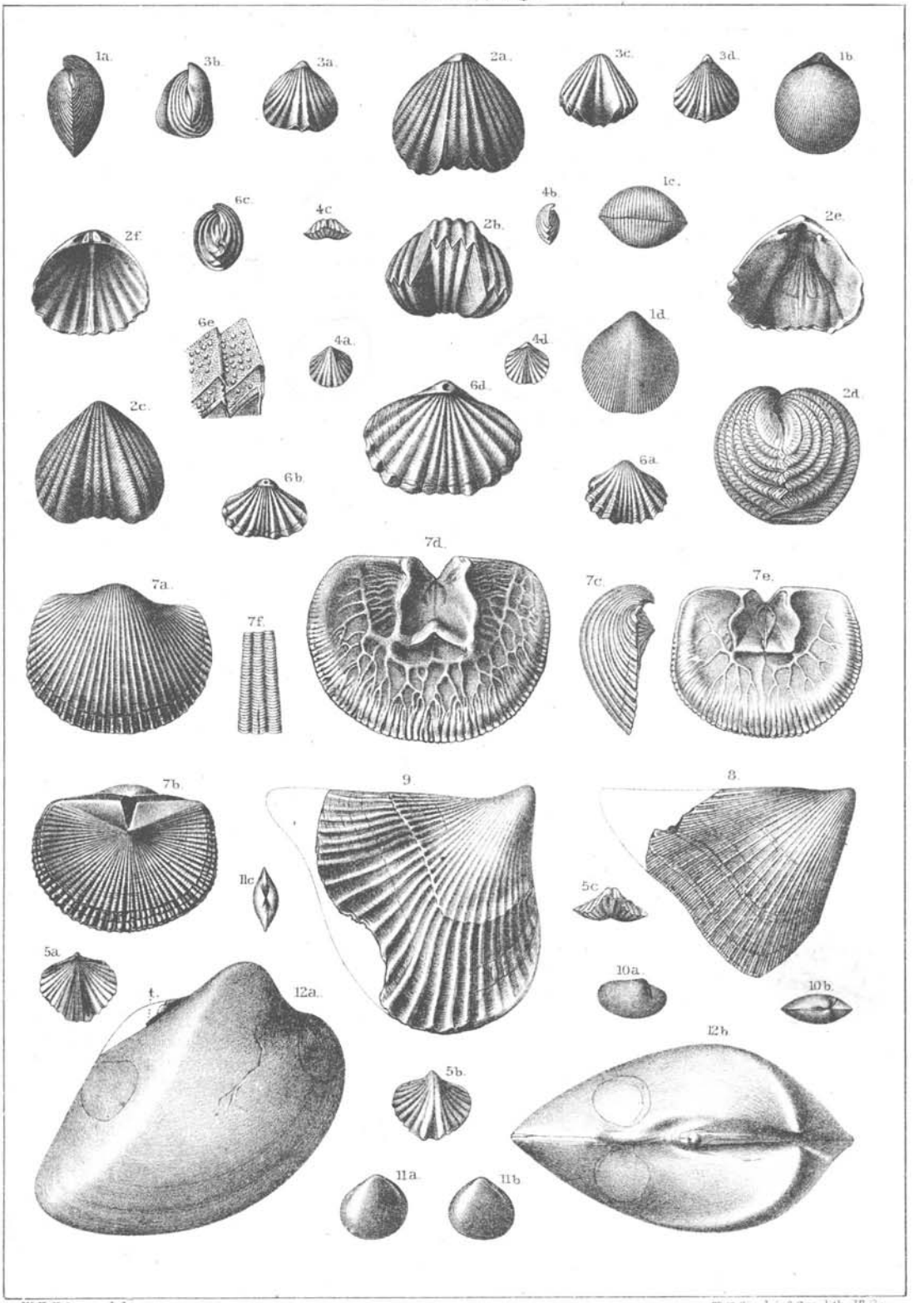

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PLATE XII.

PAGE.

Fig. 1. ANODONTOPSIS MILLERI..... 140

1 *a*. Left side view of a medium-sized specimen. Nat. size.
1 *b*. Dorsal view of same
1 *c*. Hinge and interior of left valve of a large specimen, with some of the anterior margin broken away. Mr. Dyer's collection.
1 *d*. Hinge of right valve, with both extremities br ken away. A little magnified.

Fig. 2. ANODONTOPSIS UNIONOIDES..... 141

2 *a*. Dorsal view. Mr. Miller's collection.
2 *b*. Right side view of same specimen.

Fig. 3. SEDGWICKIA ? FRAGILIS 143

3 *a*. Left side view. Nat. size. Mr. James's collection.
3 *b*. Dorsal view of same. Nat. size.

Fig. 4. CARDIOMORPHA ? OBLIQUATA 146

4 *a*. Left side view. Mr. Dyer's collection.
4 *b*. Posterior profile view of same Both natural size.

Fig. 5. AMBONYCHIA COSTATA..... 130

5 *a*. Left side view. Nat size. Mr. James's collection.
5 *b*. An anterior profile vi• w.
5 *c*. Surface costæ somewhat enlarged, to show the small lines of growth.

Fig 6. CYPRICARDITES ? CARINATA 135

6 *a*. An anterior view. Nat. size. Mr. Dyer's collection.
6 *b*. A left side view of same. Nat. size. Mr. Dyer's collection.

Fig. 7. SEDGWICKIA ? COMPRESSA 144

7 *a*. A left ? side view. Nat. size. Mr. James's collection.
7 *b*. Dorsal view of same. Nat. size. Mr. James's collection.

Fig. 8. SEDGWICKIA (? GRAMMYSIA) NEGLECTA 142

A right side view. Nat. size. Mr. James's collection.

Fig. 9. MEGAMBONIA JAMESI..... 136

9 *a*. A left side view of an imperfect cast. Nat. size. Mr. James's collection.
9 *b* An anterior view of same.

Fig. 10. AMBONYCHIA (MEGAPTERA) ALATA..... 131

A right side view of an imperfect specimen. Nat. size Mr. James's collection.

Geological Survey of Ohio.

LOWER SILURIAN. (Cincinnati group.) PLATE 12.

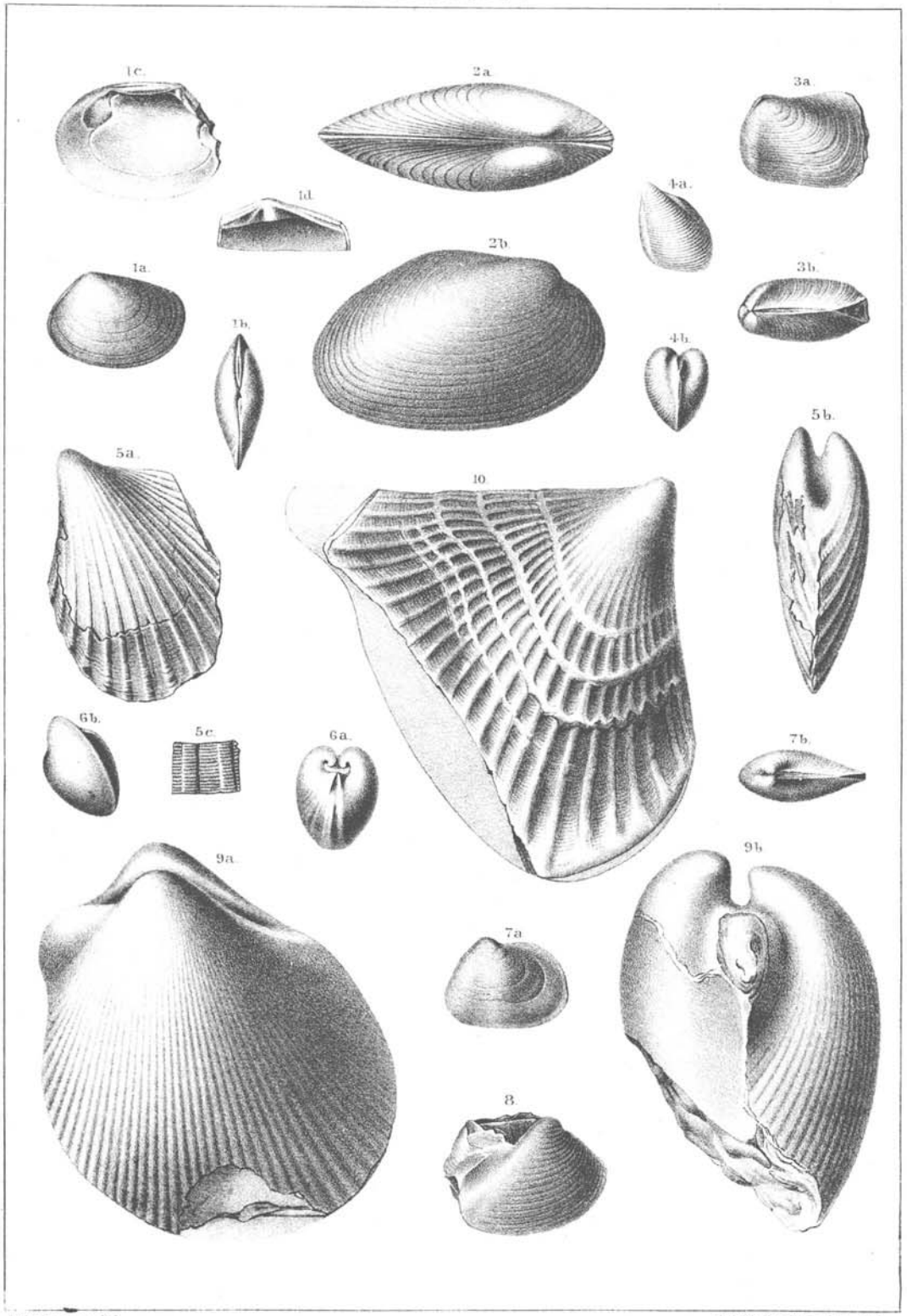

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PLATE XIII.

PAGE.

Fig. 1. CYRTOLITES COSTATUS 150

1 *a*. A side view of a specimen with the shell partly removed, so as to expose the internal cast embedded in the matrix.
1 *b*. Enlargement of a part of the surface, to show the minute transverse striæ between the revolving costæ.
1 *c*. Outline profile, to show the form of a section of the volution near the aperture. Mr. James's collection.
1 *d*. A side view of another specimen, somewhat flattened by lateral pressure, and diff ring from the other in having no large cross ribs. This n ay possibly be distinct from the other. Found by Mr. Klippart.
1 *e*. An enlargement of surface markings of same.

Fig. 2. CYRTOLITES DYERI 149

2 *a*. Side view. Natural size.
2 *b*. Profile view. Natural size.
2 *c*. Side view of same, enlarged to show surface markings.
2 *d*. Side view of another specimen with slightly wider volutions, and somewhat different surface markings.
2 *e*. A profile outline of same. Mr. Dyer's collection.

Fig. 3. CYRTOLITES ORNATUS 148

3 *a*. A side view, natural size, of a gutta-percha cast taken from a natural mould. Mr. James's collection.
3 *b*. Enlarged surface markings of same.

Fig. 4. CYRTOLITES (MICROCERAS) INORNATUS..... 147

4 *a*. Side view. Mag. 6 diameters.
4 *b*. Profile view. Mag. 6 diameters.

Fig. 5. CYCLONEMA BILIX..... 151

5 *a*. A side view of the typical form of the species.
5 *b*. Enlargement of surface markings of same.
5 *c*. A ventricose variety, with marks of growth very obscure.
5 *e*. Variety *lata*, possibly a distinct species.
5 *f*. Another view of same.
5 *g*. A much elongated variety.

Fig. 6. PLEUROTOMARIA (SCALITES?) TROPIDOPHORA..... 154

6 *a*. A side view of a specimen enlarged 2 diameters.
6 *b*. An opposite view of same.
6 *c*.

Fig. 7. CYCLORA MINUTA..... 152

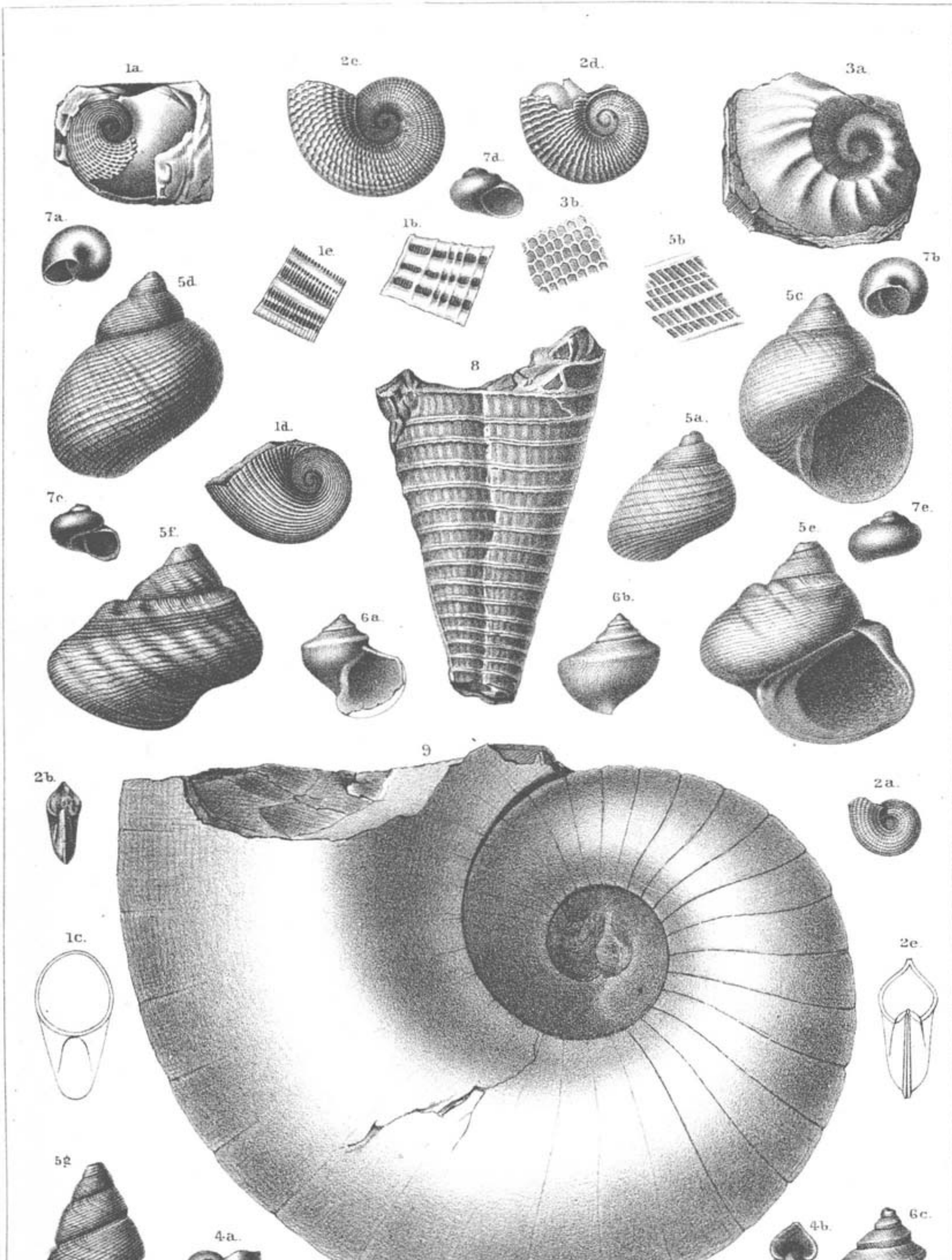
7 *a*. View of under side. Magnified 6 diameters.
7 *b*. Same view of another specimen, with lip more spreading near umbilicus. Magnified 6 diameters.
7 *c*. Side and aperture view. Magnified as above.
7 *d*. Same view of another specimen.
7 *e*. An opposite view of same.

Fig. 8. ORTHOCERAS ORTONI 155

A side view of an imperfect specimen, somewhat flattened by accidental pressure. Mr. Dyer's collection.

Fig. 9. TROCHOCERAS? BAERI 157

A side view of an imperfect specimen. Dr. Baer's collection.



W. H. Holmes, del. A. J. Ibbotson.

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PLATE XIV.

PAGE.

Fig. 1. CYTHERE CINCINNATIENSIS 158

1 *a*. A side view. Magnified about 3½ diameters. Mr. Dyer's collection.
1 *b*. A dorsal view of same specimen.
1 *c*. A lateral view of a large specimen. Magnified 3 diameters. Mr. Dyer's collection.
1 *d*. A dorsal view of same.

Fig. 2. DALMANITES CARLEYI 170

2 *a*. Cephalic shield. Nat. size. Mr. James's collection.
2 *b*. Same, magnified.
2 *c*. The visual surface of one of the eyes, magnified.
2 *d*. Pygidium, probably of the same species, found associated.

Fig. 3. ACIDASPIS CINCINNATIENSIS 167

Pygidium and a part of one of the thoracic segments. Drawn natural size. Mr. Dyer's collection.

Fig. 4. ACIDASPIS 169

A right movable cheek, inside view. Nat. size. Probably belongs to *A. Cincinnatiensis*.

Fig. 5. ACIDASPIS 169

A left movable cheek, apparently of another species, from a higher position in the series. Mr. O'Neall's collection.

Figs. 6 and 7. ACIDASPIS 169

Fig. 6 represents a glabella with the fixed cheeks, nat. size; and fig. 7 the same parts, with the fixed cheeks mainly broken away. These may belong to two species. Both nat. size. Mr. James's collection.

Figs. 8 and 9. ACIDASPIS CERALEPTA? 169

Fig. 8. A pygidium apparently without digitations between the two spines.
Fig. 9 differs in having 6 digitations between the two spines. These may belong to distinct species, but they seem to be the same as those for which the above specific name was proposed by Mr. Anthony. Both are drawn natural size. Mr. James's collection.

Fig. 10. ACIDASPIS CROSOTUS 165

10 *a*. A nearly perfect specimen, magnified about 4 diameters. It has the extremities of the pleuræ broken away, and does not show the margins of the cheeks, the supposed outlines of which are indicated by dotted lines, without any attempt to show the digitations of the margins. Dr. Miller's collection.
10 *b*. A mould of the exterior of another specimen, apparently of this species. Magnified about 4 diameters. Mr. James's collection.

Fig. 11. CERAURUS ICARUS 162

11 *a*. A large, nearly perfect specimen. Mrs. Haines's collection.
11 *b*. A lateral view of a nearly entire specimen of smaller size, rolled up. Mr. James's collection.
11 *c*. A view from above of the cephalic shield of same.

Fig. 12. PROETUS SPURLOCKI 161

A specimen with the cephalic shield injured by abrasion and pressure, and slipped slightly backward so as partly to hide one or more of the thoracic segments. Magnified 3 diameters. Mr. Dyer's collection.

Fig. 13. ASAPHUS (ISOTELUS) MEGISTOS? 159

A young, entire specimen.

Fig. 14. CALYMENE SENARIA 173

14 *a*. A view of cephalic shield and a part of the thorax of an unusually fine, perfect specimen. Mr. Shaffer's collection.
14 *b*. A lateral view of same.
14 *c*. An anterior view of same; also showing the pygidium, and the posterior part of thorax.
14 *d*. A specimen showing an inside view of the labrum or hypostome, in place, with an inner view of the rostral shield, and on each side of the latter a little of the margin of the cheeks. All magnified 2 diameters. Mr. Dyer's collection.
14 *e*. An outside view of the labrum. Magnified 2 diameters. Mr. Dyer's collection.
14 *f*. An internal view of two of the body segments, nearly natural size, to show the curious inflected margins of the free ends of the pleuræ, as seen from below.

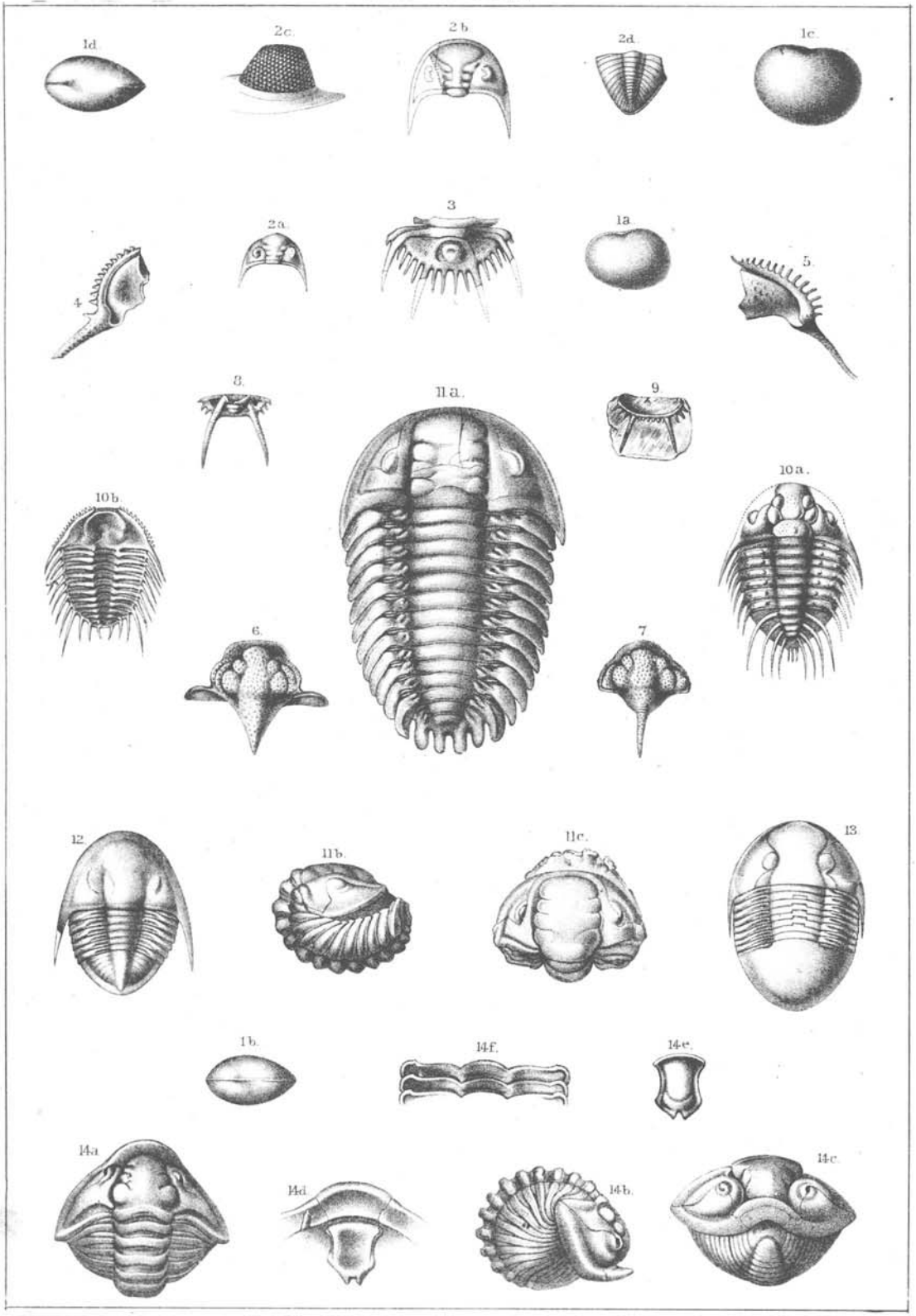

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PLATE XV.

PAGE.

Fig. 1. TRIPLESIA ORTONI 178

1 *a*. A dorsal view of a specimen with the anterior part of the valves broken away.
1 *b*. A side view of the same.
1 *c*. A dorsal valve, with the anterior and portions of the lateral margins broken away.
1 *d*. A posterior view of a portion of the two valves somewhat compressed accidentally, showing the area and small foramen of the ventral valve.
1 *e*. A lateral view of an imperfect specimen.
1 *f*. Interior of an imperfect ventral valve, showing the hinge teeth, foramen, etc.
1 *g*. A fragment of the dorsal valve, turned up so as to show the full length of the bifid cardinal process.
1 *h*. A side view of the same, turned as the curvature of the beak would direct the cardinal process.
1 *i*. An inner view of the same part of another specimen, with the cardinal process partly broken away, and the remains of the brachial processes seen on each side.
1 *j*. A part of the ventral valve, including the beak and most of the area, turned so as to show the projection of the hinge teeth beyond the hinge line.
1 *k* An ideal section of the two valves united, showing how the long cardinal process projects within the cavity of the ventral valve.

Fig. 2. MERISTELLA (MERISTINA?) CYLINDRICA 180

2 *a* View of ventral valve of a large specimen, much flattened on each side.
2 *b*. Dorsal view of same
2 *c*. Lateral view of same.
2 *d*. A dorsal view of a smaller specimen, less flattened on each side.

Fig. 3. RHYNCHONELLA NEGLECTA?..... 179

3 *a*. Ventral view of a large gibbous specimen.
3 *b*. Dorsal view of same.
3 *c*. Lateral view of same.
3 *d*. Granulations of the surface, magnified.

Fig. 4. LITUITES? ORTONI 186

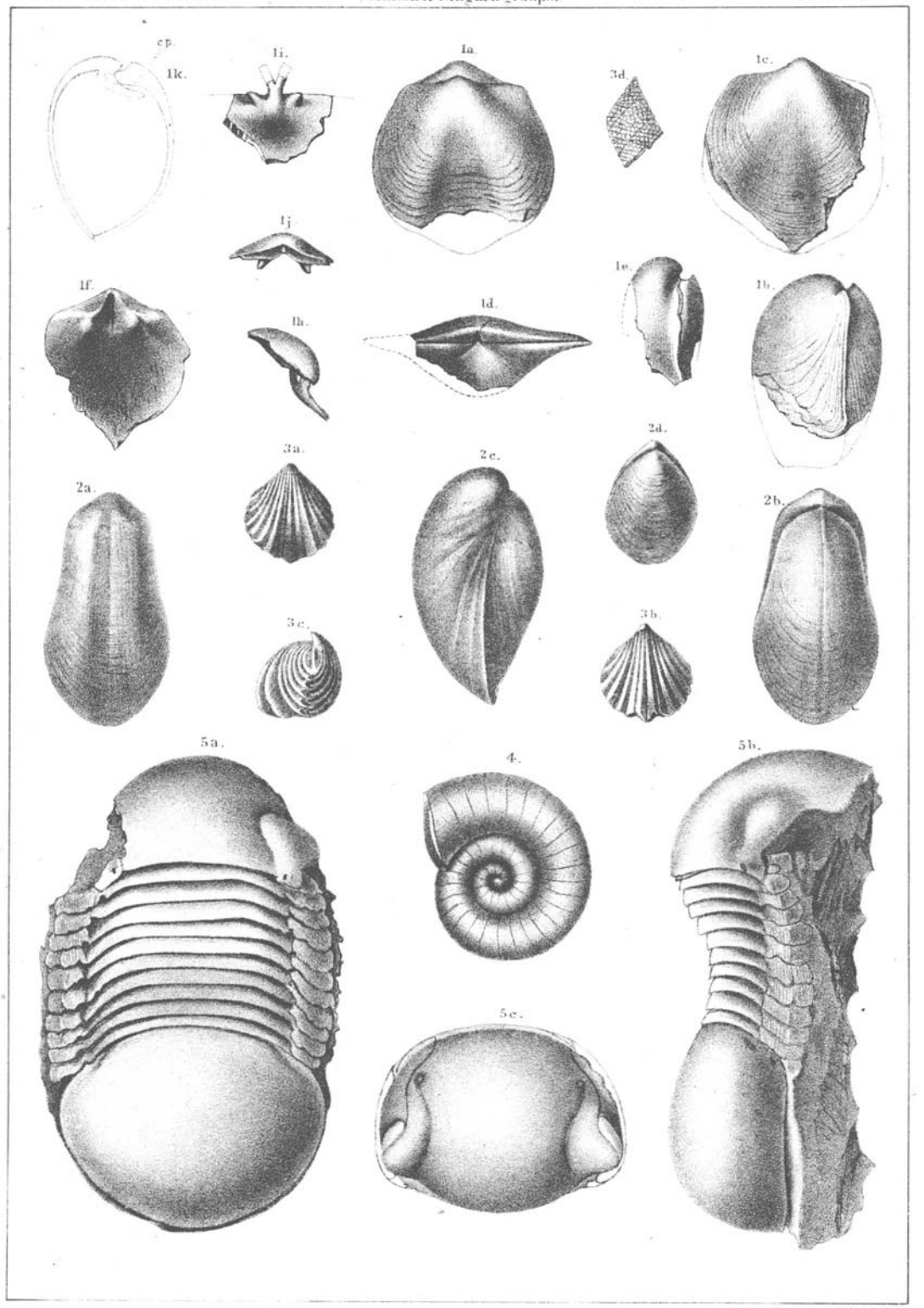
Side view of internal cast, natural size.

Fig. 5. ILLÆNUS INSIGNIS?..... 189

5 *a*. Dorsal view of a nearly entire internal cast; only the lateral portions of the cheeks and parts of the pleuræ being imperfect. The head is bent downward, so as not to show its entire length, as seen from above.
5 *b*. A side view of same.
5 *c*. A separate head of another individual.

Geological Survey of Ohio,

(Clinton & Niagara groups.)



Thos Sinclair & Son lith. Phila.

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PLATE XVI.

PAGE

Fig. 1. TRIMERELLA OHIOENSIS 18

1 *a*. Cast of interior, side views. Nat. size.
1 *b*. Ventral view of internal cast of same.
1 *c*. A posterior view of cast of same.
1 *d*. Dorsal view of same.

Fig. 2. TRIMERELLA GRANDIS 18

2 *a*. A posterior view of internal cast of the original typical specimen, belonging to the Museum of the Canadian Geological Survey, and figured for comparison with fig. 1 *c*.
2 *d*. A dorsal view of same, for comparison with 1 *d*.

Fig. 3. PLATYOSTOMA TRIGONOSTOMA 18

3 *a*. View of upper side of cast.
3 *b*. View of under side of cast.
3 *c*. View of upper side of a smaller specimen.

Geological Survey of Ohio.

UPPER SILURIAN. (Niagara group.) PLATE 16.

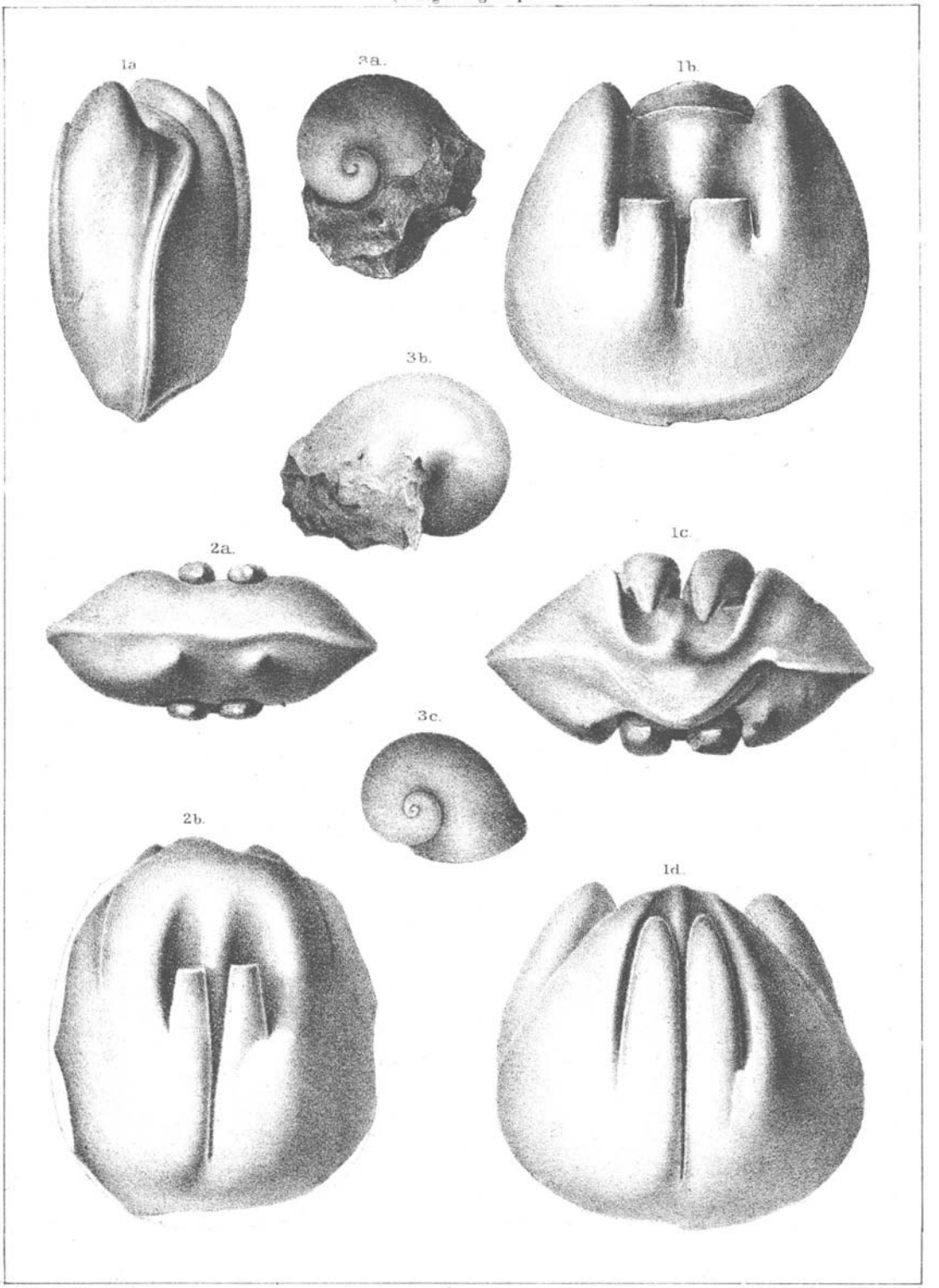

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PLATE XVII.

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Fig. 1. XENOPHORA? ANTIQUA 221

1 *a*. Profile or side view, showing strongly depressed spire, and sharply angular periphery. Nat. size.
1 *b*. Under side of same.
1 *c*. Profile of another specimen.
1 *d*. Upper side of same, showing very oblique costæ obscurely indicated on the cast.
1 *e*. Upper side of the same specimen represented by figures 1 *a*, *b*, and *c*.

Fig. 2. LEPERDITIA ALTA ?..... 187

2 *a*. Left valve, magnified 2 diameters.
2 *b*. Right valve, probably of same species, also magnified 2 diameters.

The concentric lines on both figures are only intended to represent shading, the figures being originally intended to be engraved in lines only.

Geological Survey of Ohio.

DEV. & UPP. SILURIAN. (Cornif. & Water Li. groups.) PLATE 17.

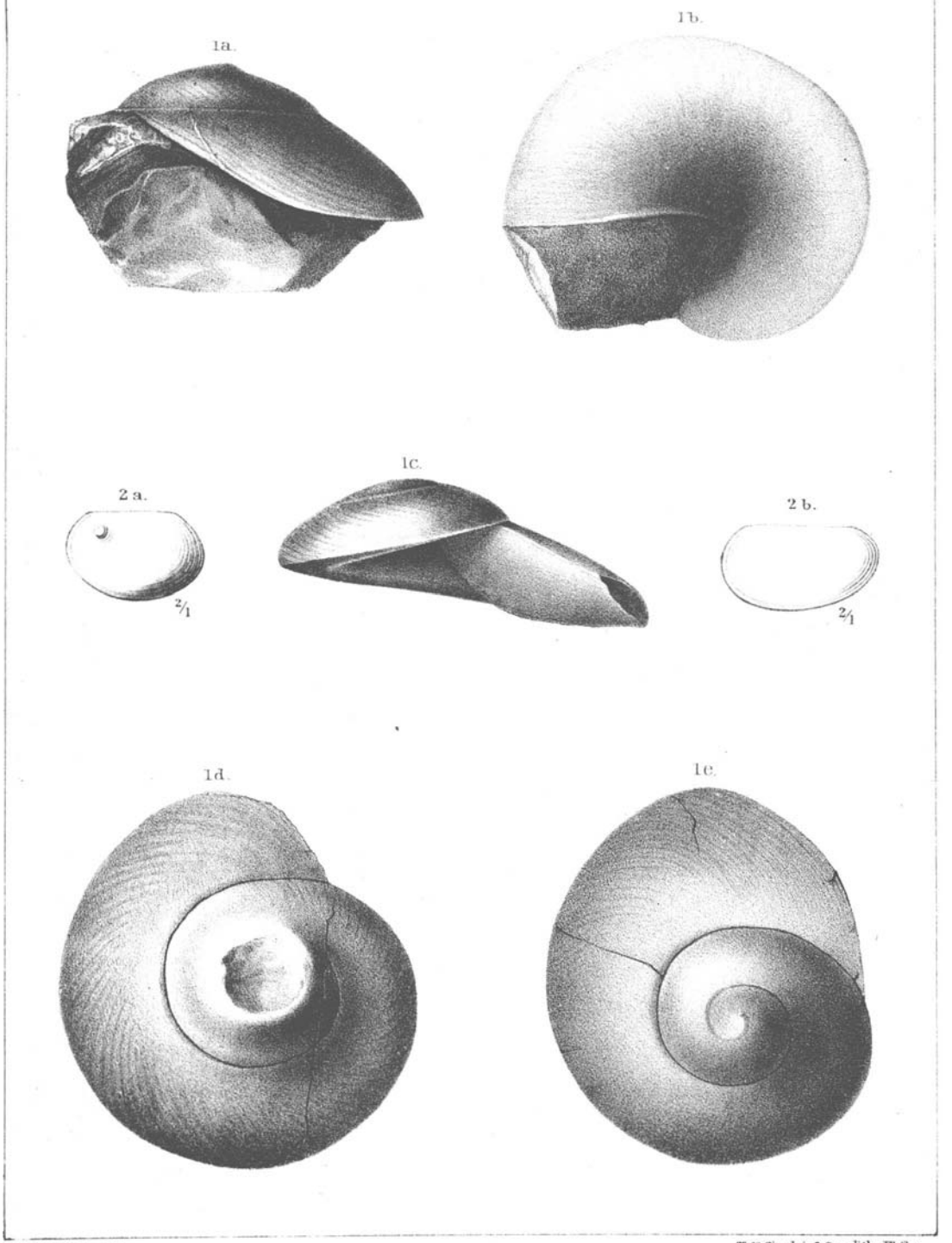

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PLATE XVIII.

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Fig. 1. PTILODICTYA (STICTOPORA) GILBERTI 194

1 *a*. A piece of this fossil as seen lying in the matrix. Nat. size.
1 *b*. Another specimen of same.
1 *c*. A fragment of one of the branches, much enlarged, to show the pores with their slightly raised margins, and the linear ridges between the rows of pores (*s. s.*). It also shows (at *a*) the transversely striated lamina or axis, exposed by the removal of the poriferous part of that side; while at (*i*) the impression of the opposite poriferous side is seen in the matrix.

Fig. 2. PTILODICTYA 195

A part of a broad expansion several inches in size, consisting of the mesial, wrinkled and striated lamina of a species apparently of this genus, and retaining, at places, some remains of the outer poriferous layer, differing little, if any, in the size and arrangement of the pores, and other surface characters, from the last.

Fig. 3. SANGUINOLITES? SANDUSKYENSIS 209

View of left side of a cast. Nat. size.

Fig. 4. SOLEMYA VETUSTA 206

Left view of an internal cast, retaining some fragments of the thin shell.

Fig. 5. CLINOPISTHA ANTIQUA 208

5 *a*. Left side view of a partly exfoliated specimen, showing remains of the ligament on the shorter side at (*l*).
5 *b* Posterior view of same.

Fig. 6. AVICULOPECTEN PARILIS? 197

6 *a*. View of left valve.
6 *b*. Another of same, of larger size.

Fig. 7. LUCINA (PARACYCLAS) OHIOENSIS 199

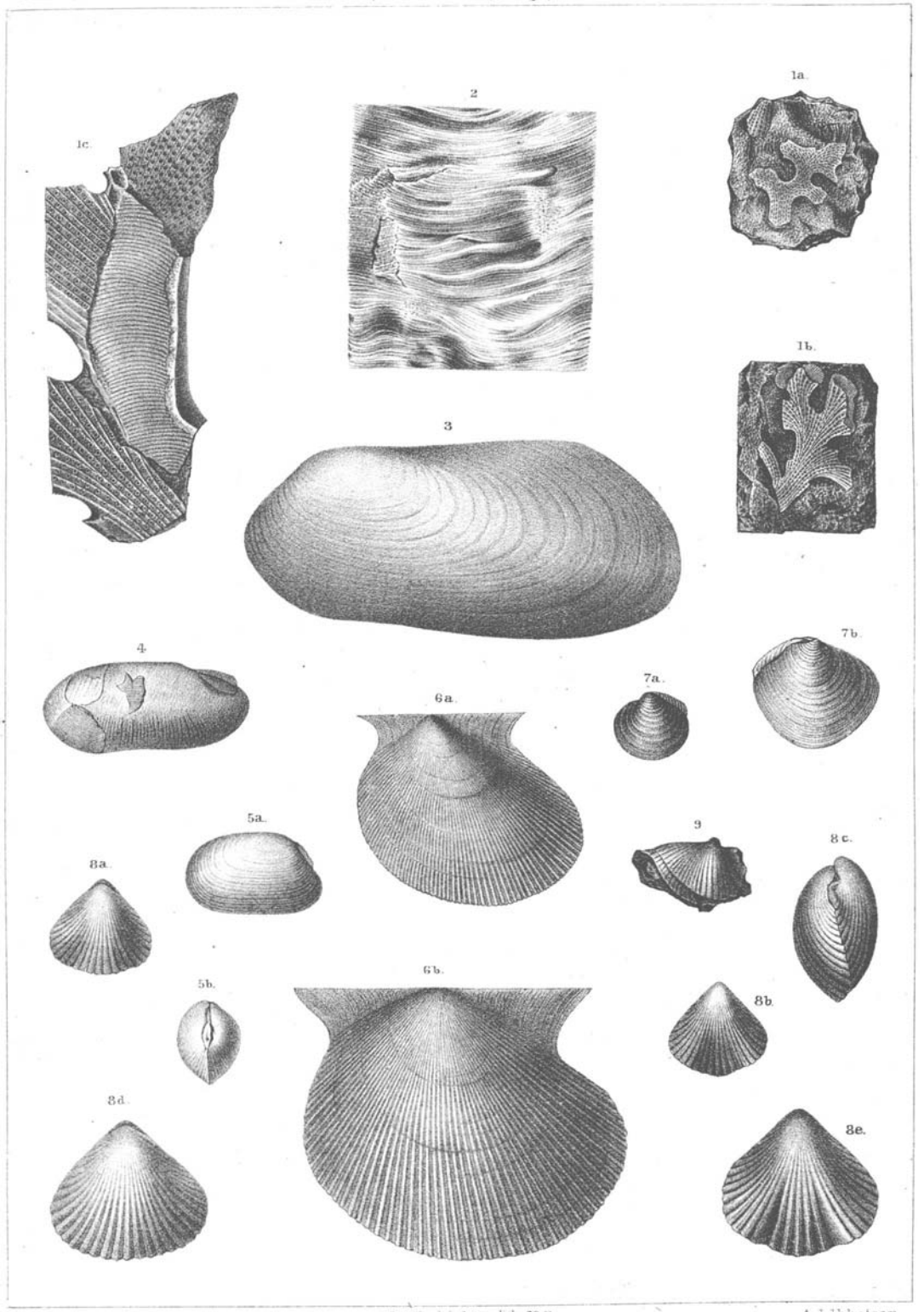
7 *a*. A small specimen. Nat. size.
7 *b*. A larger individual, differing in form, but probably the same species. Its posterior dorsal margin is broken away, and restored in outline.

Fig. 8. RHYNCHONELLA CAROLINA 196

8 *a*. Dorsal view of a small specimen.
8 *b*. Ventral view of same.
8 *c*. Dorsal view of a larger individual.
8 *d*. Ventral view of same. (The mesial fold should be more defined in this figure.)
8 *e*. Profile of same.

Fig. 9. CONOCARDIUM OHIOENSE 203

Side view of a specimen defective at anterior basal margin.



J.C.McConnell, del. Thos Sinclair & Son, lith. Phila. A.J. Ibbotson

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PLATE XIX.

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Fig. 1. ISONEMA HUMILIS 214

1 *a*. View of the upper side of a specimen consisting mainly of a cast of the interior, with portions of the shell attached.
1 *b*. A profile view of the same, showing the broad, flattened inner top (at *l*) partly covered by the rock filling the aperture.
1 *c*. A view of the upper side of another specimen retaining the shell, and showing the surface markings.

Fig. 2. CYCLONEMA CRENULATA 213

2 *a*. Side view. Nat. size.
2 *b*. Same, magnified.
2 *c*. View showing the aperture. Nat. size.
2 *d*. Same, magnified.

Fig. 3. EUOMPHALUS DECEWI 220

3 *a*. View of upper side of a very large, fine specimen Nat. size.
3 *b*. Profile of same, with its under side attached to the matrix.

Fig. 4. NATICOPSIS LEVIS 215

4 *a*. Dorsal side view. Nat. size
4 *b*. View of opposite side, showing aperture.

Fig. 5. TROCHONEMA TRICARINATA 218

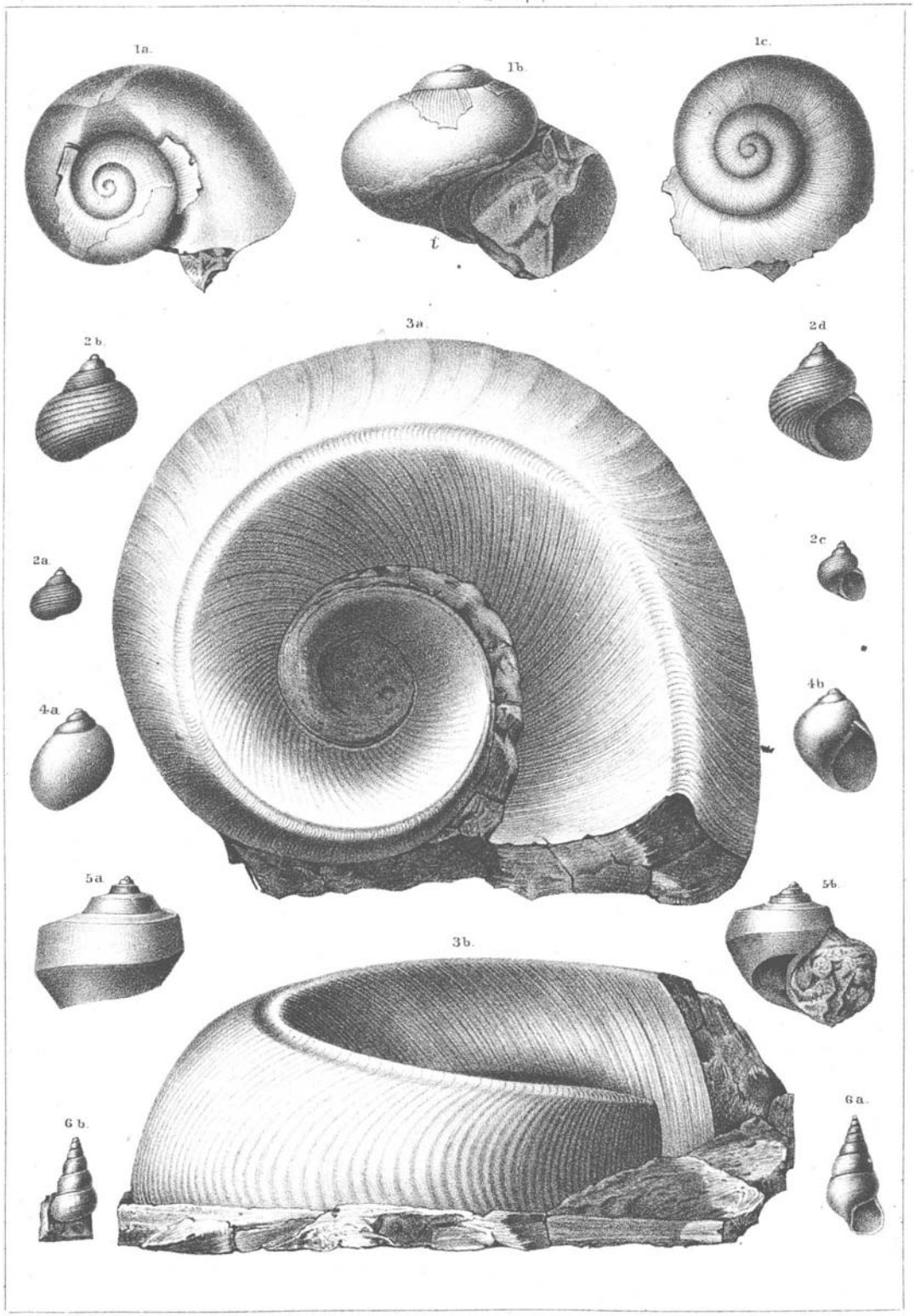
5 *a*. Dorsal side view. Nat. size.
5 *b*. View of opposite side, showing form of aperture, the large umbilicus, etc.

Fig. 6. MURCHISONIA OBSOLETA 218

6 *a*. Aperture—side view. Nat. size.
6 *b*. Dorsal side view.

Geological Survey of Ohio.

DEVONIAN. (Corniferous group.) PLATE 19.



Holmes & Ellis, Lith. Th^s Sinclair & Son, 11th, Phila. A.J. Tobotson.

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PLATE XX.

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Fig. 1. EUOMPHALUS DECEWI 220

A view of the upper side of a medium-sized specimen, as seen lying in the matrix.

Fig. 2. PLATYCERAS ATTENUATUM 212

2 *a*. An internal cast, showing little nodes that occupied depressions on the inner surface, corresponding to surface spines.

2 *b*. A different view of another specimen, also an internal cast.

Fig. 3. ORTHONEMA NEWBERRYI 217

3 *a*. Dorsal side view. Natural size.

3 *b*. Same magnified, to show sur ace markings.

Fig. 4. BELLEROPHON NEWBERRYI 222

4 *a*. Side view of a specimen with the lip broken away.

4 *b*. A dorsal view of same, showing the fine curved striæ, and very narrow dorsal band.

Fig. 5. BELLEROPHON PROPINQUUS 226

A specimen seen lying in the matrix so as to expose the aperture and the thickened lip spread over the umbilicus on each side as well as the stronger and less curved striæ than those seen on fig. 4.

Fig. 6. PLEUROTOMARIA LUCINA ? 226

A specimen consisting of a cast of the interior, with portions of the very thin shell attached.

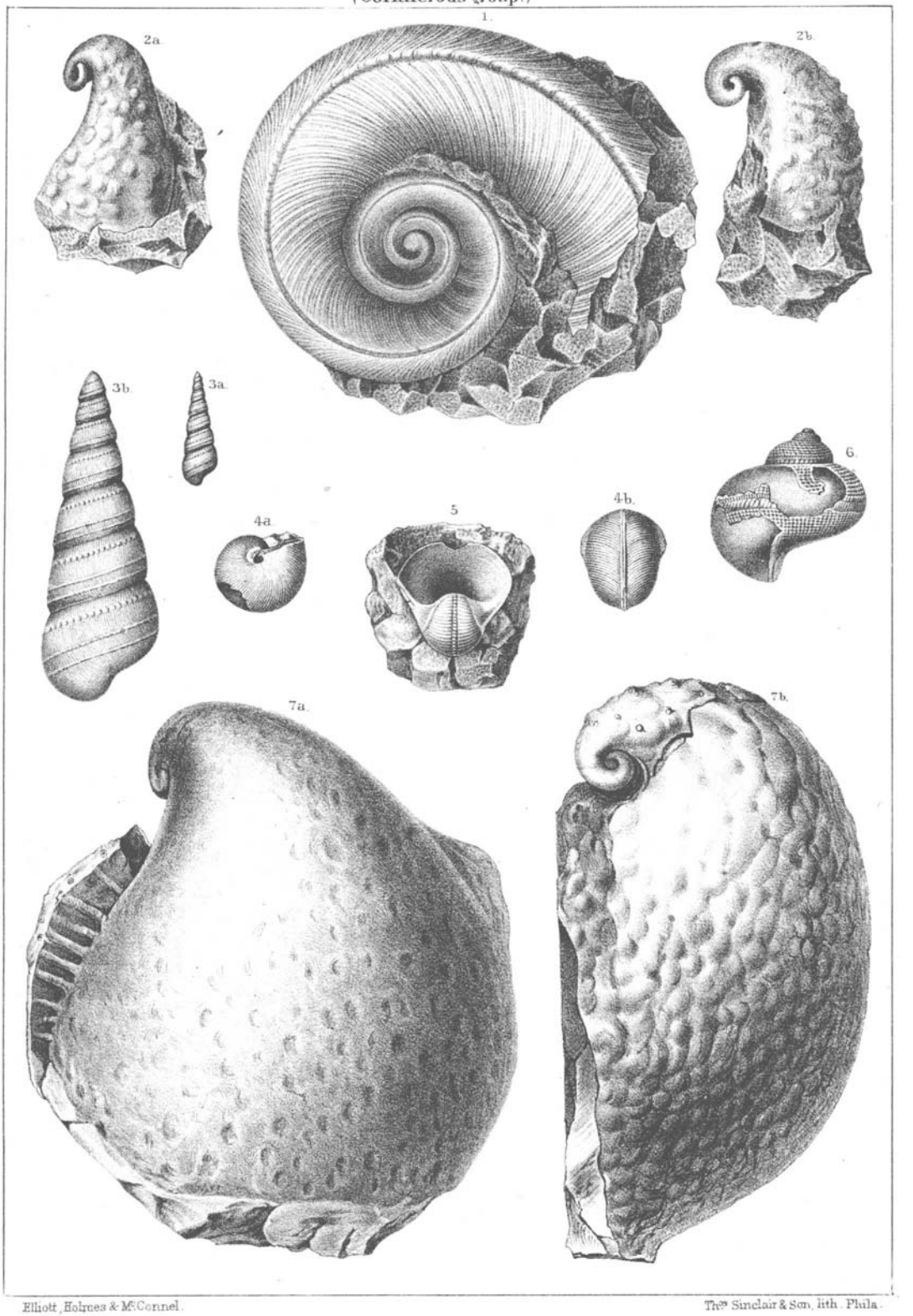
Fig. 7. PLATYCERAS MULTISPINOSUM 210

7 *a*. An internal cast, showing irregularities corresponding to the spines of the exterior, some remains of the bases of which are seen in a part of the matrix remaining attached to the left side of the specimen. (This figure is defective, in having the nodes marking the position of spines too much like *pits*, and very much too scattering.)

7 *b*. A profile view of another specimen; also a cast of the interior, with a little of the shell near the apex remaining. It is not turned so as to show the greatest length of the shell.

Geological Survey of Ohio.

DEVONIAN. (Corniferous group.) PLATE 20.



Elliott, Holmes & McConnel. Thos Sinclair & Son, lith. Phila.

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PLATE XXI.

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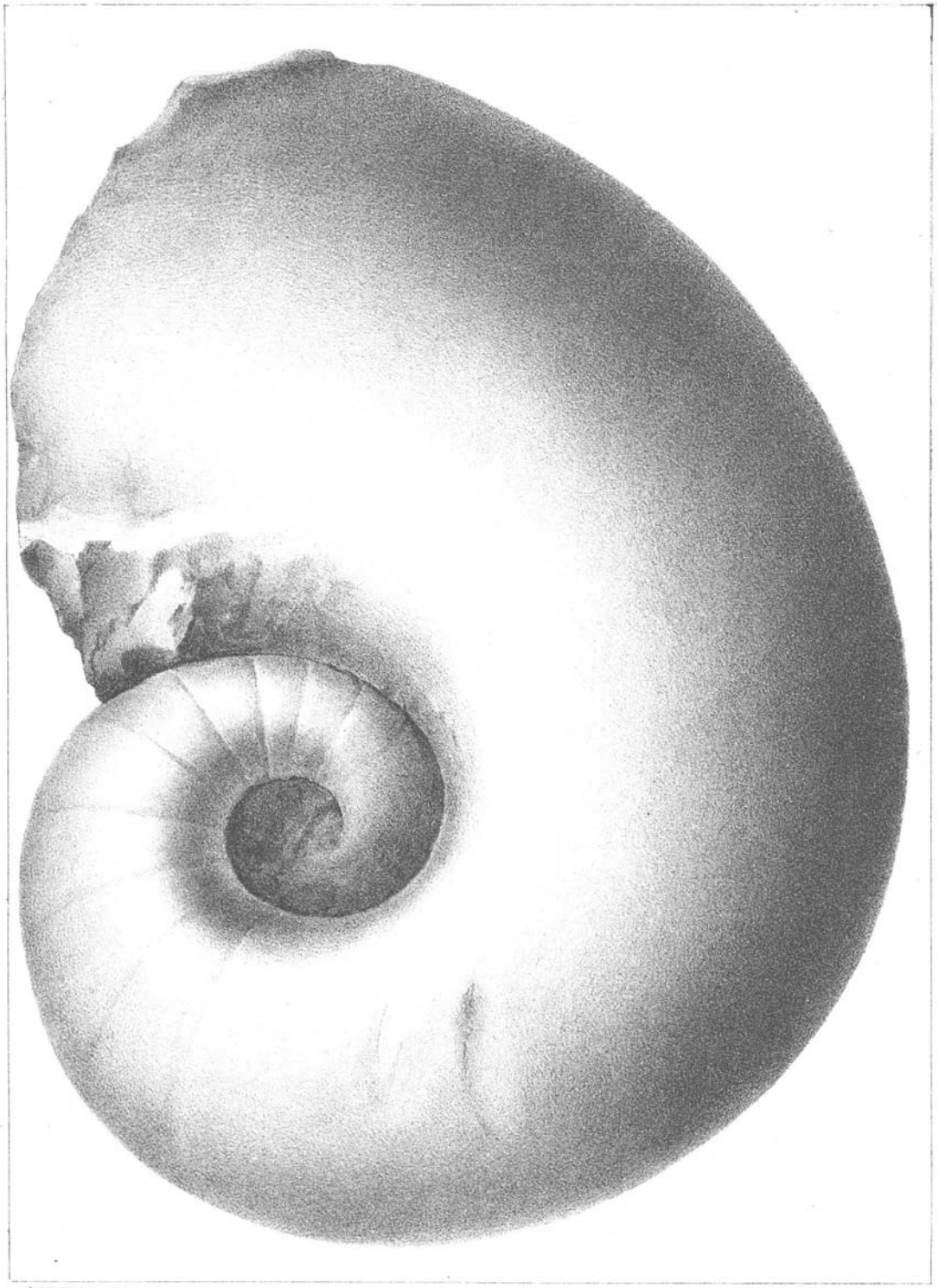
Fig. 1. GYROCERATITES? INELEGANS 232

A cast of the interior, reduced about ¼ diameter in size.



E.W. Elliott del. Thos Sinclair & Son. lith. Phila.

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PLATE XXII.

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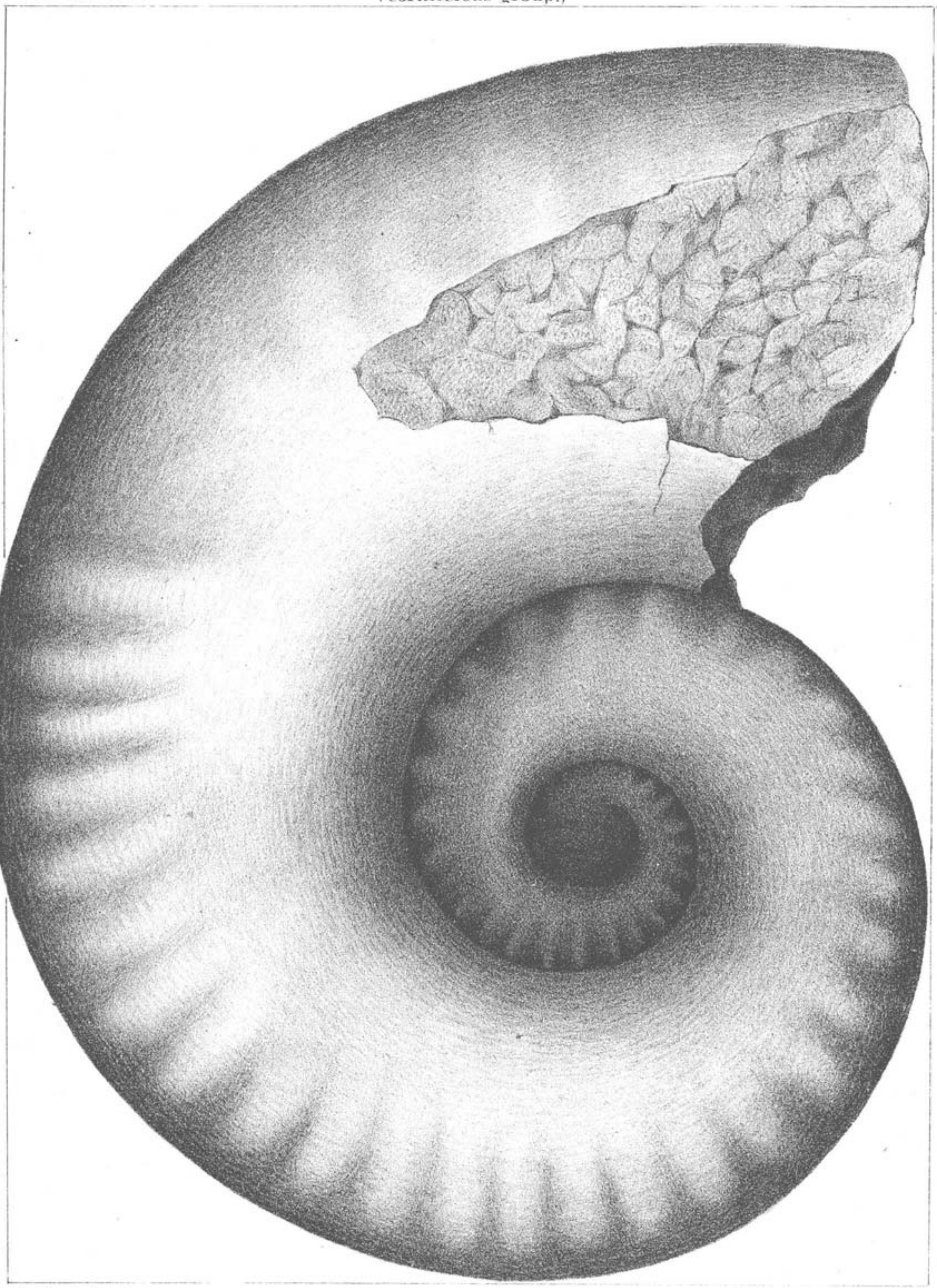
Fig. 1. GYROCERATITES OHIOENSIS..... 230

A side view of a natural cast. Natural size.

Geological Survey of Ohio.

DEVONIAN. (Corniferous group.) PLATE 22.



J. C. Mc Connell, del. Ths Sinclair & S[illegible] lith. Phila.

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PLATE XXIII.

PAGE.

Fig. 1. DALMANITES OHIOENSIS 234

Pygidium drawn from a gutta-percha cast taken in a natural mould.

Fig. 2. CYRTOCERATITES OHIOENSE 229

2 *a*. A side view of an internal cast, with portions of the shell attached, and both extremities broken away.

2 *b*. A ventral view of the same.

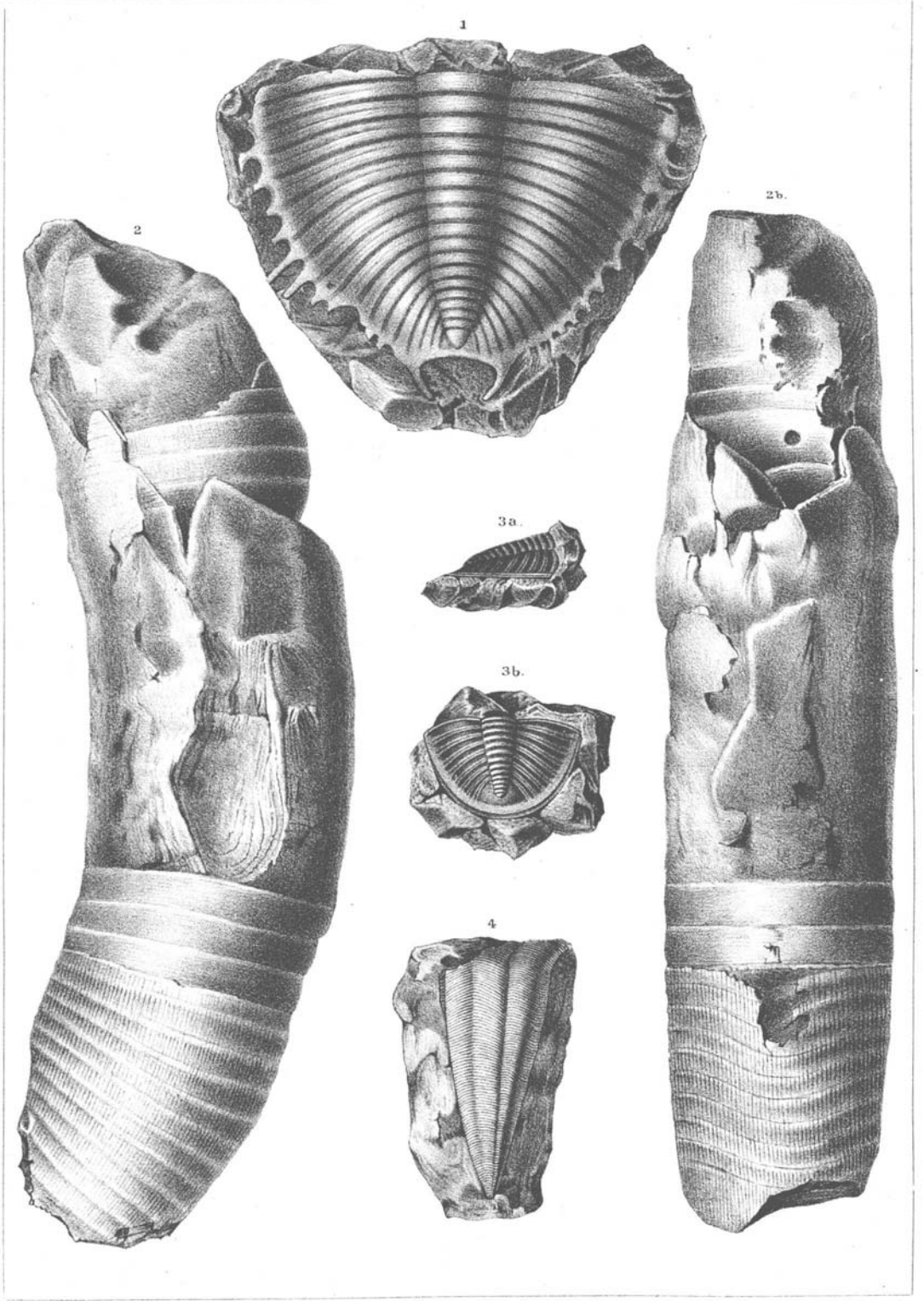
Fig. 3. PROETUS PLANIMARGINATUS 233

3 *a*. A side view of a cast of the pygidium.

3 *b*. A view of same from above.

Fig. 4. CONULARIA ELEGANTULA 228

A view of a part of the shell as seen lying in the matrix.



H.W. Elliott, del. Thos Sinclair & Son lith Phila A.J. Ibbotson.

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