

PALÆONTOLOGY.

BY S. A. MILLER.

PRELIMINARY REMARKS.

THE LOWER SILURIAN SYSTEM is represented, in the southeastern part of the State of Indiana, by rocky strata, about 750 feet in thickness, belonging to what is known to geologists as the Hudson River Group. These rocks have been studied a great deal, especially in the vicinity of Richmond, Weisburg, Versailles, and Madison, and have furnished many new species of fossils that have been described in the palæontological reports of New York, Ohio and Illinois, and in the Cincinnati Quarterly Journal of Science and Journal of the Cincinnati Society of Natural History. I am able now to add a few new species from the same localities, and some from rocks of about the same age, in Tennessee, which constitute what is called the Nashville Group.

The Hudson River Group of Indiana is followed, as it appears to me, by rocks of the age of the Niagara Group. At least, I have been unable to discover any evidence of the existence of the Medina and Clinton Groups, which intervene, between the Hudson River and Niagara, in New York and Canada. The lower part of the Niagara Group, in Indiana, is characterized by the presence of the remains of cystideans; while the upper part abounds with crinoids, brachiopods, bryozoa and other fossils. Most of the cystideans belong to *Holocystites*, a genus quite common in the magnesian limestone of the Niagara Group of Illinois and Wisconsin, but not known to rocks of any other age. This genus is the most remarkable, for variations in size and form, of any known to the subkingdom Echinodermata, beside some species were free, others sessile, and others possessed a column and attached to a muddy bottom with roots. I described, in the Journal of the Cincinnati Society of Natural History and in North American Geology and Palæontology, nineteen species of *Holocystites*, which were collected at Osgood, St. Paul, and near Madison, and am now able to add fifteen new species, from the vicinity of Madison, to this remarkably long list. And it may be worthy to note that about half of all the species of cystideans known from America occur in the Hudson River and

Niagara Groups of Indiana. The upper part of the Group, especially at Waldron, has been famous, for many years, for the abundance and perfection of its fossils. They have been sought to such a degree, that they have almost become an article of commerce, and now ornament every important collection in the civilized world. Only a few new species have been added from these rocks, but among them there are some very peculiar and interesting forms.

I have seen no fossils that indicate the existence of the Guelph Group, in Indiana, but the Waterlime member of the Onondaga Group rests upon the Niagara, and has considerable thickness. It is not very fossiliferous, but a few species new to science have been discovered and are herein described.

Though the Devonian strata of Indiana are very rich in fossils, I have not described many new species from them in this volume.

The Subcarboniferous rocks of Indiana have been famous for their fossils for many years, and new and peculiar forms are being constantly discovered. The lower division is called, in Ohio, the Waverly Group; in Indiana, the Knobstone Group or the Kinderhook Group; in Michigan, the Marshall Group, and in Missouri, the Chouteau limestone. I have added a few new species from this Group, in Indiana, and a few from the Chouteau limestone of Missouri, which throw some light on the Indiana forms.

The Keokuk Group of Indiana, is the most celebrated for fine fossils of all her Subcarboniferous strata, and new species are constantly coming to light wherever the rocks are investigated. I have described a few from rocks of the same age, in Missouri, where, in proportion to the thickness, they seem to be equally as fossiliferous.

I have also described a few from the Burlington, Warsaw and St. Louis Groups, and some from the Coal Measures. All are illustrated, and all except two or three belong to new species, and those are figured to show characters heretofore unknown, or which have been erroneously described.

Those from Missouri were collected by R. A. Blair and F. A. Sampson, two distinguished naturalists and geologists of Sedalia. All of the *Holocystites*, except three, were found by J. F. Hammell, in the Niagara Group of Jefferson County, Indiana, and belong to his collection. Otherwise than as thus indicated, the collections to which the type species belong are mentioned at the end of the several descriptions. The reason for stating the collection to which a type belongs is to afford an opportunity to others to re-examine the type, if the species or characteristics ascribed to it are questioned.

A few words in regard to fossils, their scientific value, and the method of naming them, will probably be appreciated by beginners in the study of Geology.

Fossils represent the skeletons and harder parts of animals and plants. Such parts produce fossils or petrifications, as are sufficiently firm and hard to preserve their form, until water, holding mineral matter in chemical solution, penetrates the most minute cavities, and as the organism decays, or as it is taken up by the solvent power of water, deposits the mineral matter in its stead. Neither plants nor animals turn to stone. Fossils are generally casts, but where the original animal secretion was lime or silica, part of it may have been preserved by the protection afforded from the infiltrated mineral matter, and carbonaceous structures are frequently preserved in fish-teeth and Graptolites. Flesh can not petrify. Where a shell was filled with earthy matter that solidified before the shell was dissolved or otherwise destroyed, we may have a cast of the animal itself; but the casts of the organs of the animals are not shown unless the organs were of a bony texture. Sometimes we find the cast of the external part of a shell, and sometimes a cast of the interior, without the preservation of the slightest part of the original shell, though it may have been harder than the stone itself. It is also quite common to find silicious corals and shells, in which cases the original limestone secreted by the animals has been taken up by water and the silica deposited in its place. Sometimes the process of silicification very much enlarges the fossil without destroying the form.

The geological and relative ages of the rocks are known only by the fossils they contain, except as they may be seen and examined at a single place. Fossils characterize the different Groups of Rocks so fully, that if we know the fossils we know the Group, in any part of America. No two Groups are represented by like assemblages of organic remains, but certain generic and specific forms are characteristic of each. For instance, if we were to find a *Paradoxides*, *Microdiscus*, *Atops* or *Elliptcephala*, we would know it came from rocks below the Silurian, and therefore lower than any rocks exposed in Indiana; if we found a *Glyptocrinus decadactylus*, we would know it came from the Hudson River Group, and a *Holocystites*, would tell us we were in the Upper Silurian; a *Pentremite* or a *Zeacrinus* would inform us that we were much higher in the scale of stratification, and so, the better acquainted we are with the fossils, the greater is our certainty in judging of the relative ages of the rocks. A knowledge of the earth is, therefore, largely dependent upon a knowledge of the fossils. Indeed, the science of Geology is based upon our information respecting the organic remains, and no one can expect to become very proficient in the science who neglects to study palæontology.

Fossils are named in the same way that plants are named in botany and animals in zoology. Each one has a name consisting of two words—the first generic and the second specific. The generic name must always be a noun, the specific name when an adjective must be made to

agree in gender with the generic name. The generic name should always be commenced with a capital letter, while the specific name never should be. For example, the generic name *Orthoceras* is derived from the Greek words, *orthos* (straight) and *keras* (horn); *keras* in Greek, is in the neuter gender, while *orthis* is feminine. *Palæaster* is from *palaios* (anient), *aster* (star); *aster* is masculine. If, now, we wished to indicate by the specific name that three fossils belonging to these genera were flexuous or full of turns, we would write *Palæaster flexuosus*, *Orthis flexuosa* and *Orthoceras flexuosum*. If the fossils had been collected by Mr. Hammell and we wished to name them complimentary to him we would reduce his name to a Latin genitive by adding the letter *i* to it, thus: *Orthoceras hammelli*, *Orthis hammelli* and *Palæaster hammelli*. If the fossils were found at Madison and we wished to indicate that locality by the specific name we would add *ensis* to it; thus, *Orthoceras madisonense*, *Orthis madisonensis* and *Palæaster madisonensis*. When, however, the name of the place ends in *a* or *e* these letters are dropped as in *Orthoceras indianense*, *Orthis indianensis* and *Palæaster indianensis*. When the specific name is a common noun the ending is not changed; for example, *cuneus*, a wedge, would be written *Orthoceras cuneus*, *Orthis cuneus* and *Palæaster cuneus*. It will be seen, the rules of nomenclature are not difficult or hard to learn, and they are the same in all branches of Natural History.

All illustrations of fossils in this work are natural size, except where otherwise expressed.

SUBKINGDOM PROTOZOA.

CLASS PORIFERA.

FAMILY PALÆACIDÆ.

PALÆACIS CAVERNOSA, N. SP.

Plate I, fig 5, summit view, the cell at the upper end not visible; fig 6, view of convex side.

Cuneate below, expanded and broadly rounded above; one side flattened, the other convex in the central part; base sharp and slightly concave. Cells, fourteen, as shown in our specimen, and of unequal size and irregular form; there is one at each end, one of which is not visible in a summit view, and the two larger ones are located near the middle, one on each side; partitions thin. Surface furrows coarse, irregular. Tubuli, rather large, visible to the unaided eye, and quite conspicuous with an ordinary magnifier in the cells and wherever the fossil is fractured.

The species is founded on a single specimen, from which a small piece has been chipped off the lower part of each end. It would seem to be more nearly related to *P. obtusa* than to any other species, though the form is quite different.

Collected in the Knobstone Group or Waverly sandstone of Jackson County, Indiana, and belongs to the State Museum at Indianapolis.

FAMILY UNCERTAIN.

CYCLOSPONGIA, N. GEN.

(*Ety, kuklos, a circle; spongia, sponge.*)

Sponge, circular, button-shaped or discoid, and consisting of numerous thin, calcareous laminæ, having a concentric structure and filled with minute canals or interstices. The structure has some resemblance to that of *Strophochetus richmondense*, but the laminæ are much thinner, and the interlaminar spaces are much less marked and no vertical tubes have been found within them. That was a free sponge, this one is supposed to have been attached to some other object. Spicules, if any, unknown. Type C, discus.

CYCLOSPONGIA DISCUS, N. SP.

Plate I, fig 8, lower side, showing central place of attachment and shallow, undefined, circular furrow. Fig 9, upper face showing concentric lines.

Sponge or spongoid mass small, circular, thin, discoid; upper face slightly convex and marked with numerous small, concentric lines; opposite or supposed under side slightly concave, and bearing a broad, undefined, shallow furrow near the circumference and a round depression in the center, one-fourth the diameter of the fossil and having a depth equal to about one-half its thickness, supposed to be the place of attachment. The fossil arches very gradually into this depression, but the limit of the depression is sharply defined at the bottom, which is nearly flat, except a central dot or minute, conical cavity. The concentric lines on the upper face divide it into a series of concentric rings, while the under face is very smooth; and where the least eroded, shows exceedingly thin laminæ, without any sign or evidence of concentric structure.

The specimens were found by Prof. S. S. Gorby, in the Corniferous limestone at Bunker Hill, Indiana, and vary in size from one-third of an inch to an inch in diameter, and from one-twentieth of an inch to three-twentieths of an inch in thickness. Throughout all the variations in size, they retain the same relative proportions and possess the same characters and the same structure, so far as can be ascertained.

SUBKINGDOM CŒLEENTERATA.

CLASS ANTHOZOA.

SUBCLASS ZOANTHARIA.

ORDER TABULATA?

FAMILY???

The genus *Leptopora* is not clearly referable to the Order Tabulata, as defined by Edwards & Haime, though such forms have been generally referred to it. It may belong to the Alcyonaria where *Heliolites* and *Plasmopora* have been more recently classed. The septa are mere striæ or vertical pseudosepta; no distinct tabulæ exist and the corallites are filled with porous cœnenchyma or vesicular tissue. I know of no nearly related genus and therefore no family to which it can be referred with any degree of certainty. I have hesitated, however, to found a new family, though, if the genus stands alone, it would be referred to the family *Leptoporidae*.

LEPTOPORA GORBYI, N. SP.

Plate I, fig. 1, complete specimen with central hexagonal cell; fig. 2, under side of a smaller specimen, showing concentrically wrinkled epitheca and radiating waves; fig. 3, specimen with heptagonal central cell and commencement of second circle of cells; fig. 4, under side of same.

Corallum consisting of a thin, circular or subelliptical, lenticular expansion, with a concentrically wrinkled epithecal crust, on the lower side. Each side is about equally convex, though the under side is sometimes flat or slightly concave, the margin is extremely thin, and the greatest thickness, in the central part, is usually less than the diameter of a cell.

The central cell is either hexagonal or heptagonal. When hexagonal, it is surrounded by six cells, as shown in figure 1, and ordinarily, these are rounded on the periphery so that the corallum consists of only seven cells; but I have seen some specimens where a second circle of cells had commenced, in which case, the cells in the first series abutting upon them become hexagonal and of about the same size as the central one. When the central cell is heptagonal, it is surrounded by seven cells, but where a second circle of cells had commenced, the cells in the first series, become hexagonal; hence all complete cells are hexagonal, except the central one, which, in some cases, is heptagonal. I have examined more than a hundred and fifty specimens, and, in no case, have I seen a complete circle of the second series of cells; hence the largest and most complete specimens consist of eight cells surrounded by a few, less than ten, incomplete ones. It is the exception rather than the rule, that

there are any cells commenced beyond the first circle, and the increase of the corallites is, in no case, uniform in the second circle, but always greater in one direction than in another. The under side of the corallum is thrown into radiating waves corresponding with the first series of cells. In figure 2, there are six waves corresponding with the six cells, and in figure 4, seven waves corresponding with the seven cells and a slight swelling for each additional cell commenced, in the second circle of cells.

The cells are shallow, separated by a common wall and vertically striated by imperfectly developed septa. In the central cell shown in figure 1, there are forty septa, which is about the number in all complete cells examined. The interior of each cell is flat or slightly concave and filled with coarse, vesicular tissue.

The specimens collected vary in diameter from one-half inch to an inch and a half; diameter of a central cell about .24 of an inch and thickness of corallum varying from .10 to .25 of an inch; depth of a cell about .04 of an inch.

The original definition of the type of the genus, by Prof. Winchell, in the Proc. Acad. Nat. Sci., Phil., p. 3, in 1863, is as follows:

"Polypary subcircular in outline, and slightly convex on the general surface; composed (in the specimens examined) of 25-30 rather large cells, of which the internal ones are hexagonal, and the peripheral rounded exteriorly; margins of cups strongly elevated; radial lamellæ about 20."

"Diameter of mass, .72; diameter of the cells about .14, and their depth about .07. In a specimen whose diameter is 1.27, the diameter of the cells is .22."

It will be observed this species is distinguished from the type of the genus, *Leptopora typus*, by the larger and shallower cells with twice as many imperfectly developed septa. Figure I represents a specimen about .72 of an inch wide, consisting of seven cells, each about .24 of an inch in diameter, and .04 of an inch in depth; while a specimen of *Leptopora typus* of the same size has 25 to 30 cells, about .14 of an inch in diameter, and .07 of an inch in depth. Again, in *Leptopora typus*, the larger the specimen the larger the cells, while in this species the cells do not vary in size with the size of the specimens. Prof. Winchell's specimens were in a limestone matrix and did not show the epitheca. He did not illustrate the species, but Dr. White, in 1883, gave a magnified view of some of the cells, in the 12th Ann. Rep. U. S. Geo. Sur. Terr. pl. 34, figures 12a and 12b.

Collected by R. A. Blair, at several stone-quarries, in the lower part of the Chouteau limestone or Waverly Group, near Sedalia, Missouri, and now in the museum, at Indianapolis, as well as in my own collection, through the generosity of Mr. Blair.

ORDER RUGOSA.

FAMILY CYATHOPHYLLIDÆ.

AMPLEXUS BLAIRI, N. SP.

Plate I, fig. 7, showing annulations and costæ at the dilations.

Corallum below medium size, simple, elongate, subcylindrical, more or less curved, sometimes abruptly bending, irregularly, widely and deeply annulated. It rapidly expands from a pointed base to the first dilation, where it bends abruptly upward. Epithecal crust smooth and very strongly developed within the annulated depressions and much less distinctly at the dilations. Costæ not visible in the depressions, by reason of the thickness of the epitheca. Septa short, subequal, not alternating. Tabulæ concave, central area flat and smooth. Calyx not observed.

The specimen illustrated has the basal point broken off and the top injured so we can not determine whether the expansion, in that part, is the calyx or not. There are twenty-eight septa at the third dilation, where the diameter is .30 of an inch, though above, in the annulated depression, the diameter is only .23 of an inch. The broad and deep, annulated depressions of the coral are regarded as distinguishing features of the species.

Collected by R. A. Blair, in whose honor I have proposed the specific name, in the lower part of the Chouteau limestone, near Sedalia, Missouri, and now in my collection.

AMPLEXUS BICOSTATUS, N. SP.

Plate I, fig. 10, fragment of a silicified specimen showing septa, tabulæ and costæ.

Corallum simple, medium size or large, elongate, subcylindrical, curved, constrictions linear. Epithecal crust very thin. Radial plates or costæ thin and each one grooved in the middle, giving the costæ the appearance of being arranged in pairs. Septa short, equal. Tabulæ inclined and then transverse from the outer walls, central area flat. Calyx not observed. Length unknown.

There are thirty-six septa, where the diameter is .9 of an inch, or thirty-six double costæ, and the tabulæ are distant from each other about .2 of an inch. A specimen five inches in length and broken at both ends tapers only one-fourth its diameter. The structure will distinguish this from all other species.

Found by R. A. Blair, in the Burlington group, near Sedalia, Missouri, and now in my collection.

The progress of palæontological knowledge in this century is well illustrated by this genus, which was described by Sowerby in 1814, in

Mineral Conchology, p. 165, as a multilocular shell, and his type species named *Amplexus coralloides*, because he thought it resembled a coral. His definition of the genus is as follows: "Shell nearly cylindrical, divided into chambers by numerous transverse septa; septa embracing each other with their reflexed margins." In describing the species, he said: "This extraordinary production, an example of the curious structure of organic antediluvian remains, is from the black rock at Limerick. I have been favored with specimens by my ingenious friends, Mr. Wright, of Cork, and Mr. Moore, of Dublin. They seem a type of a peculiar formation or æra in that limestone, which requires some penetrating research. Its resemblance to a coral or madreporæ has probably caused it to be less noticed, as looking like ordinary specimens of branches of that tribe. Upon examining it, however, its uncommon structure is developed, and we are enabled to add another genus to the multilocular shells."

His specimens belong to two or three different species, but he thought they consisted of big shells and little ones. The early geologists of this country, who knew very little about palæontology, bunched specimens in like manner, and referred different species from different Groups to Sowerby's *Amplexus coralloides*, and in my work on North American Geology and Palæontology, on the authority of others, I retained the name for a species from the Warsaw Group, but after careful research and examination, I am convinced there is no species found in this country which can be referred with any confidence to *Amplexus coralloides*, and therefore the name should be stricken from catalogues of American palæozoic fossils.

AMPLEXUS CORNICULUM, N. SP.

Plate I, fig. 21, summit view with calyx broken off; fig. 22, side view.

Corallum small, simple, subturbinate, resembling *Zaphrentis*, more or less curved, surface irregularly constricted by intermittent growth and smaller concentric wrinkles. Epithelial crust not preserved in our specimens. Septa equal, not alternating, coarse, reaching two-thirds of the distance from the wall to the center of the corallum. Tabulæ somewhat irregular in direction and at unequal distances from each other, but directed from the wall obliquely downward for a short distance and then transversely, leaving the central area flat or slightly concave. Calyx circular, shallow, the plain surface at its bottom equal to one-third the diameter of the calyx. Septal fossula not well developed.

There are twenty-four septa in the specimen illustrated, which is .45 of an inch in diameter. Another specimen of the same dimensions preserves the calyx. Other specimens taper to a point. None have been collected larger than the specimens described.

Found by R. A. Blair, at the stone quarries in the upper part of the Chouteau limestone, near Sedalia, Missouri, and now in my collection.

ZAPHRENTIS CHOUTEAUENSIS, N. SP.

Plate I, fig. 11, front view, showing calyx; fig. 12, side view.

Corallum below medium size, slightly curved, rapidly expanding at the sides, and tapering to a point at the base. Usually constricted immediately above the base, and also having shallower constrictions on the convex side; caused by intermittent growth. Epitheca thin. Calyx subovoid, nearly parallel with the long axis of the corallum or standing almost upright; it constitutes nearly the whole corallum, for there is only a small point below it. Septa unequal, a few small ones near the margin of the calyx, but they soon fade away; primary septa short and thick in the expanded part of the calyx and coalesce as they approach the base of the cup. There are thirty-two primary septa in the calyx of the specimen illustrated by figure 11, a much smaller specimen has only twenty-four, and larger specimens probably have as many as forty. Septal fossula large, occupying the central part of the calyx and projecting toward the concave side of the corallum. This species is distinguished by its lateral expansion, upright calyx, and short, thick, coalescing septa.

Found by R. A. Blair, at the stone quarries, in the lower part of the Chouteau limestone, near Sedalia, Missouri, and now in my collection.

ZAPHRENTIS CALYCVLUS, N. SP.

Plate I, fig. 13, front view, showing calyx; fig. 14, side view.

Corallum quite small, slightly curved, turbinate, rapidly expanding from a bluntly pointed base. Surface constricted by intermittent growth and finer transverse wrinkles or concentric striae. Epitheca well developed. Calyx slightly inclined to the long axis of the corallum and very broad and deep, outer wall thin. Septa very short, thick, alternate, increasing with the expansion of the cup by intercalation and bifurcation. There are forty-four septa at the margin of the specimen illustrated by figure 13, and twenty below, where they coalesce with the wall of the calyx in six undefined groups, varying in number from one to six in each, without any proper fossula. Below the point of coalescing with the wall of the corallum, the bottom of the calyx is smooth, and in the specimen illustrated the greatest depth is to the right.

This species is distinguished by the broad and deep calyx, which occupies nearly the whole corallum, and by the short septa coalescing with the wall of the corallum.

Probably it should not be referred to the genus *Zaphrentis*, because the septa are rudimentary or very short and the fossula so characteristic of *Zaphrentis* is absent. It would seem to be nearer *Anisophyllum*, but,

so far, that genus is not definitely known as high as the Subcarboniferous rocks, though Prof. Worthen doubtfully referred a Subcarboniferous species to it. At present the generic reference is provisional.

Found by R. A. Blair in the lower part of the Chouteau limestone, near Sedalia, Missouri, and now in my collection.

ZAPHRENTIS TENELLA, N. SP.

Plate I, fig. 17, showing radiating septa, calyx broken away; fig. 18, side view of same specimen.

Corallum simple, elongate, turbinate, twisted, moderately curved, regularly enlarging and tapering to an acute point at the base. Surface marked by shallow constrictions of growth and smaller concentric wrinkles. Epitheca not preserved. Calyx deep, very slightly inclined to the long axis of the corallum or nearly transverse, outer wall thin. Septa equal, thin, moderately large and uniting around a subcentral fossula, that extends to the wall, on the left side of the corallum. Septal fossula extends from the center to the wall and embraces a rudimentary septum. There are twenty-six septa in the specimen illustrated, which is .35 of an inch in diameter.

This species is distinguished by its elongated form, long, tapering point and number and position of septa and fossula.

Found by R. A. Blair, at the stone quarries, in the upper part of the Chouteau limestone, near Sedalia, Missouri, and now in my collection.

ZAPHRENTIS EXIGUA, N. SP.

Plate I, fig. 19, front view, showing calyx, magnified two diameters; fig. 20, side view of same specimen, magnified two diameters.

Corallum very small, slightly curved, turbinate, and terminating in an acute point. Surface constricted by intermittent growth. Epitheca very thin, distinctly exposing all the costæ. Calyx moderately oblique to the axis of the corallum, broad and deep, outer wall very thin, even transparent. Septa equal, very thin, and uniting around a subcentral fossula, which extends to the transparent wall, on the concave side of the corallum. There are twenty septa in the calyx illustrated, which is about .24 of an inch in diameter.

This species is distinguished by its small size, pointed base, proportionally large calyx, and thin wall and thin septa.

Found by R. A. Blair, at the stone quarries, in the Chouteau limestone near Sedalia, Missouri, and now in my collection.

ZAPHRENTIS TANTILLA, N. SP.

Plate I, fig. 23, view of the calyx, for the purpose of giving an idea of its depth, magnified two diameters; fig. 24, side view of the same specimen, magnified two diameters.

Corallum very small, moderately curved, elongate, turbinate, regularly enlarging, and acutely pointed at the base. Surface bearing a

few shallow constrictions of growth. Epithecæ thin. Calyx very deep, and mouth transverse, not oblique, to the long axis of the corallum. Septa equal, short and uniting at the center of the cavity. The calyx is so deep that I have been unable to see the fossula by looking into it. Where, however, the wall of the calyx is broken away, I have observed a subcentral depression, that indicates the position of a small fossula on the convex side of the corallum. There are twenty-four septa in the specimen illustrated, which is .1 of an inch in diameter; a little larger specimen has thirty septa.

This species is distinguished by its minute size, elongated form, and deep, transverse calyx.

Found by R. A. Blair, at the stone quarries, in the lower part of the Chouteau limestone, near Sedalia, Missouri, and now in my collection.

ZAPHRENTIS DECLINIS, N. SP.

Plate I, fig. 25, view of calyx and concave side; fig. 26, side view of another specimen.

Corallum small, elongate, turbinate, more or less curved, and tapering to a point at the base. Surface with shallow constrictions, caused by intermittent growth, and finer transverse wrinkles or concentric striæ. Epithecæ thin. Calyx moderately oblique to the long axis of the corallum and rather shallow, margin thick. Septa nearly equal, not alternate, thick within the wall, sharp centrally, not twisted; costæ thick, showing externally. Septal fossula not well developed and situate on the convex side of the corallum. There are twenty-four septa in the circumference of a calyx .4 of an inch in diameter.

This species is distinguished, by its elongate, turbinate form, coarse, sharp septa, and wide costæ.

Found in the Keokuk Group, at New Providence, Indiana, and now in the State Museum at Indianapolis.

FAMILY CYSTIPHYLLIDÆ.

CYSTELASMA, N. GEN.

(*Ety. kustis*, a cavity; *elasma*, lamellæ.)

Corallum simple, irregularly turbinate or cylindrical, consisting of an outer wall, transversely wrinkled or constricted, which is connected by oblique plates, irregularly disposed, that give to the interior cystose chambers of unequal size and irregular shape. No septa or regular tabulæ. Structure vesicular. Type C, lanesvillense.

CYSTELASMA LANESVILLENSE. N. SP.

Plate I, fig. 15, summit and side view; fig. 16, side view of another specimen showing rootlets for attachments.

Corallum simple, small, subcylindrical, attaching by rootlets or by a basal pedicel, strongly wrinkled and constricted transversely; sometimes expanding rapidly from a small basal pedicel to the full size of the corallum, as shown in figure 15, or gradually expanding from rootlets, as shown by figure 16. Internal structure consisting of large and small cystose chambers or cavities, without any regular order, the walls being longitudinal, transverse and oblique, sometimes leaving the whole internal diameter of the corallum in a single chamber, and again dividing it into two, three, four or more cavities, some of which are much larger and much more elongated than others. The cavities in our specimens are empty or filled with calcite. There is no calyx, for the summit is open, or divided by the internal walls, showing incomplete cavities, and the same structure that exists below. There are no septa or true tabulæ.

Found in the Warsaw Group at Lanesville, Indiana, and now in the State Museum, at Indianapolis.

SUBKINGDOM ECHINODERMATA.

CLASS CRINOIDEA.

ORDER CYSTOIDEA.

FAMILY HOLOCYSTIDÆ.

HOLOCYSTITES ADIPATUS, N. SP.

Plate II, fig. 1, lateral view; fig. 2, basal view.

Body large, somewhat obovate, free. Seven plates in the basal series, of irregular size, surround an opening, without any indication that the animal was ever attached to any other object. This opening, at the base, is quite peculiar and in striking contrast with the sessile species, that attach by a solid base, as illustrated in *H. madisonensis*. The plates are convex, of unequal size, and irregularly distributed over the surface. Between the first and second series there are four plates on the tumid side of the fossil and one on the opposite side. There are thirteen plates in the second series, five of which abut upon the plates of the first series. The plates are polygonal, some are large and others small, and if they were arranged in series there would be about ten series. Mouth and ambulacral opening not preserved in our specimen. Entire surface tubercular and poriferous.

Collected by J. F. Hammell, in Jefferson County, Indiana, in the lower part of the Niagara Group.

HOLOCYSTITES GORBYI, N. SP.

Plate II, fig. 3, lateral view; fig. 4, summit view.

Body somewhat ellipsoidal, sessile, attaching at one side of the basal part. Covered by five ranges of plates on the anterior side and a few additional plates on the posterior side. Plates slightly convex and poriferous. Mouth large, irregularly pentagonal and surrounded by six plates. Supposed anal opening between the mouth and ambulacral orifice two plates distant from the latter and in a suture between the plates adjoining the latter opening. Ambulacral orifice large, subquadrate, and surrounded by six plates. Four cicatrices for ambulacral spines.

Collected by J. F. Hammell, in the Niagara Group, in Jefferson County, Indiana.

HOLOCYSTITES SCITULUS, N. SP.

Plate II, fig. 5, side view; fig. 6, summit view.

Body small, somewhat globose, sessile, covered by four ranges of plates on the anterior side. Plates poriferous. Mouth large, irregularly pentagonal and surrounded by five plates. Supposed anal opening between the mouth and ambulacral orifice and in the plate adjoining the latter opening. Ambulacral orifice large, elongated side toward the mouth arcuate. Four cicatrices for ambulacral spines.

Collected by J. F. Hammell, in the lower part of the Niagara Group, in Jefferson County, Indiana.

HOLOCYSTITES COMMODUS, N. SP.

Plate III, fig. 1, posterior view; fig. 2, summit view; fig. 5, side view of another specimen. fig. 6, summit view.

Body subglobose or somewhat elliptical, sessile, basal place of attachment small. Covered by six ranges of plates. Plates moderately convex and poriferous. Mouth large, hexagonal and surrounded by six plates. Supposed anal openings two, one in the central part of each plate between the mouth and ambulacral opening. Ambulacral orifice large, subquadrate. Four cicatrices for ambulacral spines. I have illustrated two specimens of this species the better to show its characters and to distinguish it from *H. gorbyi*, which it very much resembles, though it is covered with more plates, has an hexagonal instead of a pentagonal mouth, and has two openings between the mouth and ambulacral orifice instead of one.

Collected by J. F. Hammell, in the lower part of the Niagara Group, in Jefferson County, Indiana.

HOLOCYSTITES MADISONENSIS, N. SP.

Plate III, fig. 3, side view; fig. 4, basal view.

Body rather large, globose, very tumid on one side, sessile, place of attachment large. Plates large, slightly convex and poriferous. There are seven plates, very unequal in size in the first range; sixteen in the second range, and six plates inserted between these ranges on the tumid side. The summit of our specimen is destroyed, but there are apparently six or seven ranges of plates in the species. It need not be mistaken for any other species heretofore described.

Collected by J. F. Hammell in the lower part of the Niagara Group, in Jefferson County, Indiana.

HOLOCYSTITES INDIANENSIS, N. SP.

Plate III, fig. 7, lateral view.

Body, medium size, globose, sessile and covered by five ranges of plates. Plates slightly convex and poriferous. There are six plates in the first range, eight in the second and nine in the third. Mouth subpentagonal, and surrounded by five plates. Ambulacral orifice subquadrate and much smaller than in *H. commodus*. Four cicatrices for ambulacral spines. It is readily distinguished from all other species.

Collected by J. F. Hammell, in the lower part of the Niagara Group, in Jefferson County, Indiana.

HOLOCYSTITES WYKOFFI, N. SP.

Plate IV, fig. 1, posterior view; fig. 2, summit view, compressed at the mouth.

Species sessile, large, globose, rapidly expanding from the top of the second range of plates, excessively tumid on the right side, covered by about twelve irregular ranges of unequal plates, and a few intercalated ones. Plates numerous in each range; the first one having fifteen, and some of them having more than thirty. Ambulacral opening at the summit, large, elliptical, surrounded by six very thick plates, five of them bearing arm cicatrices. Mouth at the margin of the summit and compressed in our specimen, so its shape can not be determined. Surface of the plates bearing small pustules and all of them pierced by numerous pores.

Found in the Niagara Group, of Jefferson County, Indiana, and now in the collection of J. F. Hammell. The specific name is in honor of Mr. Charles W. Wykoff, an active collector of fossils at Madison, Indiana.

HOLOCYSTITES COLLETTI, N. SP.

Plate IV, fig. 3, showing the mouth and ambulacral opening. Part of the plates are broken between the mouth and ambulacral opening.

Body long, slightly curved to the ambulacral side, very gradually increasing in size, toward the anterior end, and covered by nine ranges of rather large plates. The plates in the first and second ranges are longer than wide, while those in the third range are wider than long. The fourth range is composed of the largest plates in the body, and the sixth and seventh ranges are next in size. The summit is prolonged in the direction of the ambulacral orifice, though the orifice is not upon the summit, but upon the left anterior side. The orifice is subelliptical, and surrounded by seven very thick plates. There are no cicatrices or other evidence of arms. The mouth is large, subcircular, situated on the side, at the top of the seventh range of plates and surrounded by five plates. The surface of the plates is pustulated and numerous pores penetrate the body at the pustules.

Found in the Niagara Group, in Jefferson County, Indiana, and now in my collection.

I take great pleasure in dedicating this beautiful species to Prof. John Collett, late State Geologist of Indiana, who has devoted a long and useful life to the advancement of education and the development of the geological resources of the State, and whose genial disposition and kindness of heart have made him beloved by all with whom he has ever come in contact.

HOLOCYSTITES PARVUS, N. SP.

Plate IV, fig. 4, posterior view; fig. 5, summit view.

Species sessile, small, subglobose, and covered by about five ranges of more or less tumid plates of unequal size and a few intercalated ones. Ambulacral orifice at the summit, subelliptical; surrounded by six very thick plates having four arm cicatrices. Mouth at the margin of the summit two plates distant from the ambulacral orifice, subpentagonal and surrounded by five plates. Plates covered with small pustules and pierced with numerous pores.

Collected by J. F. Hammell, in the Niagara Group, of Jefferson County, Indiana.

HOLOCYSTITES SPANGLERI, N. SP.

Plate IV, fig. 6, anterior view.

Species sessile, large, subcylindrical in the central part and pointed below, tumid in the lower part of the left side and covered by about ten irregular ranges of unequal plates and a few intercalated ones. Ambulacral orifice at the summit and surrounded as indicated in our

specimen by six very thick plates. Only one arm cicatrix is preserved in our specimen and, apparently, there were only four cicatrices. Mouth at the margin of the summit, subpentagonal and surrounded by five plates. Plates covered with small pustules and pierced with numerous pores.

Collected by J. F. Hammell, in the Niagara Group of Jefferson County, Indiana. The specific name is in honor of Mr. George Spangler, one of the first collectors of cystideans, in Jefferson County, and now a resident of Los Angeles, California.

HOLOCYSTITES ORNATISSIMUS, N. SP.

Plate V, fig. 1, right side; fig. 2, summit view.

Species sessile, medium size, subglobose, tumid below, on the left, posterior side, and above, on the right anterior side, and covered with seven ranges of plates of unequal size and a few intercalated ones. Ambulacral orifice at the summit, subelliptical, surrounded by six very thick plates, four of which bear prominent arm bases. Mouth near the margin of the summit, subelliptical and surrounded by five plates. Plates ornamented with many large pustules and pierced with numerous pores.

Found in the Niagara Group of Jefferson County, Indiana, and now in my collection.

HOLOCYSTITES BENEDICTI, N. SP.

Plate V, fig. 3, side view.

Species sessile, medium size, subovate, covered with seven ranges of elongated plates and a few intercalated ones. There are ten small plates in the first range and thirteen in the second range. Neither the ambulacral orifice nor the mouth is preserved in our specimen. The plates are ornamented with pustules and pierced with numerous pores.

Found in the Niagara Group, of Jefferson County, Indiana, and now in my collection. The specific name is in honor of Mr. A. C. Benedict, an active collector and an assistant on the Geological Survey of Indiana.

HOLOCYSTITES SUBOVATUS, N. SP.

Plate V, fig. 4, anterior side; fig. 5, summit view.

Species sessile, below medium size, subovate, tumid below, on the left posterior side, and above on the left anterior side, and covered by six ranges of plates and a few intercalated ones. The plates increase in size from below, upward; those on the summit very large. There are apparently, only six plates in the lower range, but they are quite numerous in the third, fourth and fifth ranges. Ambulacral orifice near the summit, subelliptical, surrounded by six very thick plates, four of

which bear prominent arm bases. Mouth eccentric, subelliptical, and surrounded by only four plates. The pustules on the plates are large and the plates are pierced by numerous pores.

Collected by J. F. Hammell, in the Niagara Group of Jefferson County, Indiana.

HOLOCYSTITES PARVULUS, N. SP.

Plate V, fig. 6, left posterior view.

Species small, sessile, subelliptical, pointed below, most tumid on the left side and in front of mouth, and covered with numerous plates of unequal size without definite arrangement above the second series. The whole surface is strongly tuberculated. The attaching plates are not preserved in our specimen; the first and second ranges above these have eight plates each. Ambulacral orifice at the summit, subquadrate, and surrounded by six plates, four of which bear prominent arm bases. The mouth is subpentagonal and distant two plates from the ambulacral orifice. It is surrounded by five plates. The so-called anal opening is in the central part of the plate adjoining the mouth instead of in the suture between the two plates adjoining the ambulacral orifice.

Collected by J. F. Hammell, in the Niagara Group of Jefferson County, Indiana.

HOLOCYSTITES PAPULOSUS, N. SP.

Plate V, fig. 7, left side view, showing how it attached to some small cylindrical object; fig. 8, summit view.

Species sessile, medium size, irregularly subelliptical, and covered by eight ranges of plates, that gradually increase in size upward, and a few intercalated plates on the tumid side. Tumid below on the posterior side, and above on the left anterior side. There are seven plates in the first range that attached to some small cylindrical object. There are fourteen plates in the fifth range which contains more than any other series. Ambulacral orifice at the top of the prolonged summit, subelliptical, surrounded by six thick plates that stand nearly upright; four of which bear strong arm bases. Mouth close to the arm bases, subelliptical and surrounded by five plates. Plates covered with very large pustules and pierced by numerous pores.

Collected by J. F. Hammell, in the Niagara Group of Jefferson County, Indiana.

FAMILY CARYOCRINIDÆ.

CARYOCRINUS INDIANENSIS, N. SP.

Plate V, fig. 9, azygous, side view; fig. 10, view of the summit.

Body subtrubinate, constricted below the arms. Four rather long plates in the first series; two pentagonal and two hexagonal, counting the faces that abut upon the column. Six plates in the second series, longer than wide and larger than those in the first series, two pentagonal, two hexagonal, and two heptagonal; eight plates in the third series; these are shorter and smaller than those in the first series; all of them support arm-plates, and two of them project up between the arm-plates, so that each unites with a small vault plate. There are twenty-one arms disposed in seven clusters; there are five in the cluster on the right of the azygous opening, four in the cluster on the left, and two others have three arms each, and the other three have two each.

The vault is depressed, convex, and sunken between the arm clusters so as to give it a wavy surface. The central plate is large, heptagonal; it is surrounded by seven plates that cover nearly the whole summit. Two of the seven plates curve upward and surround two-thirds of the prominent azygous opening. The seven plates are surrounded by a circle of smaller plates, some of which reach the arm-plates, and others extend to a second series that reach the arm-plates. The azygous opening is prominent and surrounded by either three or four plates; if there are four, one is quite small.

Surface of calyx covered by numerous granules that radiate from the central part of each plate to each angle of the plate; and sometimes they coalesce into radiating lines or ridges; there are also a few pustules between the radiating lines, the number depending upon the size of the space between the lines. The plates of the vault are also covered with granules, but they seem to have no definite arrangement. Every granule is punctured by either one or two pores. In some cases a pore punctures the summit of a granule, and, in other cases the pores penetrate the sides. The pores form a row upon each side of the radiating lines.

This species is distinguished from *Caryocrinus ornatus* by the general form of the calyx, by the general form of the vault, and by the proportionally smaller size of the second range of plates. There are fewer plates on the vault, the arms are much more numerous and differently disposed. The arrangement of the pustules on the plates is also different. These differences seem to me to be sufficient to constitute a new species. The vault of this species is so different from that of *C. ornatus*, the structure of which Wachsmuth thought was generic, and from which he attempted to draw morphological laws of development and to infer

evidences of the relationship of *Stephanocrinus* with *Haplocrinus*, *Cyathocrinus* and other crinoids, that we quote some of his remarks from page 290, Part III, of his Palæocrinoidea. He says:

"As a further proof that the central piece is the representative of the orals, we refer to the Cystid genus *Caryocrinus*, which has three in place of five groups of arms, and which, according to our interpretation, has no proximals. The central piece which occupies the center of figure, and which we think represents the oral pyramid, is surrounded by eight plates, by five (not four) large ones, and three smaller ones, the latter conforming jointly to one of the other five. Three of the plates have a strictly radial position, the three others, including the compound one which takes the azygous side, are interrarial."

He will find some difficulty in discovering eight plates surrounding the central plate in this species where only seven exist, and quite as much trouble in arranging the plates to conform to his views of those occupying radial and interrarial positions.

Collected by J. F. Hammell, in the Niagara Group, in Jefferson County, Indiana.

FAMILY STRIBALOCYSTIDÆ, N. FAM.

This family is proposed to receive the new genus *Stribalocystites*, and for the present, the family characters must be regarded the same as the generic.

STRIBALOCYSTITES, N. GEN.

(Ety. *stribalos*, close pressed, thick; in allusion to the thick, tumid plates; *kustis*, bladder).

Body rudely subovate or subelliptical and covered by about five series of tumid plates. Basals four, unequal. Second series of plates six, unequal. Third series of plates eight, unequal. Fourth and fifth series irregular and covering the summit. No arms. Orifice at the summit, one near the summit on the azygous side, and another on the left near the summit, both being above the third range of plates. Type *S. tumidus*.

STRIBALOCYSTITES TUMIDUS, N. SP.

Plate VI, fig. 33, view opposite the azygous side; fig. 34, basal view, magnified two diameters.

Body small, rudely subelliptical, plates very tumid. Basals four, of unequal size, standing upright, sutures deep, deeply excavated for the column, and pierced by a small round orifice, for the columnar canal. Second series of plates the larger plates of the body, of unequal size, very tumid, two pentagonal, two hexagonal, and two heptagonal. The heptagonal plates are the larger plates in this series. The azygous side is

somewhat depressed convex, and the plate in the second series is wider than high and hexagonal, the plate on either side is heptagonal, it supports on its upper sloping sides two plates of the third series, which are followed by three smaller plates that abut upon the anal or azygous orifice. The plate opposite the hexagonal one, on the azygous side, is hexagonal, and the other two, in the second series are pentagonal. Third series of plates of unequal size and not in line by reason of curving over the large heptagonal plates of the second series.

The plates above the third series are not in ranges and must be otherwise described. The orifice on the azygous side is surrounded by five plates, three small ones below and two larger tumid plates above; the latter abut upon three of the summit plates that surround the ambulacral orifice. The ambulacral orifice is surrounded by seven plates, four of them are very tumid and arranged in a subquadrate outline, with a small plate inserted between them on each of three sides. The two adjoining tumid plates, surrounding this orifice, are the larger ones and belong to the third series. The orifice on the left of the azygous side is surrounded by five plates, two small ones below, inserted above the third range, one that abuts the azygous orifice, and two of the plates that abut the ambulacral opening. Two small plates are also inserted on the right side above the third range of plates. Making in all thirty-two plates.

Collected by A. C. Benedict, in the Niagara Group, at St. Paul, Indiana.

? ? ?

Plate VI, fig. 29, summit view; fig. 30, side view of same, magnified two diameters; fig. 31, summit view of another specimen; fig. 32, side view of same, magnified two diameters.

A minute orifice may be seen at the summit, and also at the base of both these specimens, otherwise the illustrations show all that an examination reveals under an ordinary magnifier. The lower part of each is a short cylinder, the base is flat. The specimen represented by figures 29 and 30 preserves a pyramid, which projects at the base, beyond the cylindrical part above referred to, and consists of transverse imbricating pieces, thrown into longitudinal waves or crossed by concave furrows. There are five of these wave crests, one of which divides the pyramid into two equal parts, and has one wave crest upon one side and three upon the other. The base of the pyramid extends lower upon the side having the three wave crests than upon the other. In addition to these lines and furrows, there are numerous fine lines running down the pyramid on all sides. The specimen represented by figures 31 and 32 I believe to be the same species as that represented by figures 29 and 30, with the pyramidal part broken off at the first concentric imbricating line, above the flange, which projects beyond the cylindrical part of the

body. If so, the imbricating pieces that constitute the pyramid are radiately furrowed upon the uniting faces. If the two specimens belong to distinct species they are nearly related, for the specimen represented by figures 31 and 32 has a convex summit, and is furrowed and radiately lined in the same manner as the other specimen. There is no evidence of any internal cavity.

These specimens are illustrated and defined for the purpose of calling attention to them, but I have not named them, because I do not know to what order, in the Class Crinoidea, to refer them. They are absolutely new to me, and I know of nothing with which to compare them.

Collected by J. F. Hammell, in the Niagara Group, near Madison, Indiana.

ORDER BLASTOIDEA.

FAMILY STEPHANOCRINIDÆ.

STEPHANOCRINUS OSGOODENSIS, S. A. MILLER.

Plate VI, fig. 1, the specimen figured originally; fig. 2, a much smaller specimen; fig. 3, summit view showing ambulacral areas, interambulacral plates, the five plates that cover the oral or central opening, and the anal opening; fig. 4, specimen broken off at the basi-radial suture showing base of radials, apparently, uniting at the center. Magnified two diameters. All the figures on this plate are magnified two diameters.

This species was described in the Journal of the Cincinnati Society of Natural History, vol. 2, p. 116, but the summit and ambulacral structure were then unknown.

The three basal plates form a solid obpyramidal body, (except a minute, round, perforation and shallow cup) hexagonal below, the three angles, at the junction of the plates rather obtuse, the others acute below, but fade away before reaching the top of the plates. Two of the plates are hexagonal, having three upper sides, the other is pentagonal. There is a small hemispherical cavity for the insertion of the column. On account of the thickness of the plates the cup above is very shallow.

The five radial plates form obtuse angles at the sutures, but the plates are convex, longitudinally, which well nigh destroys the pentagonal outline. The plates are longer than wide, expand very little, and are deeply and abruptly excavated above for the reception of the ambulacral structure. The appearance of the plates uniting at the center presented by fig. 4 must be abnormal or due to crystalization, for in another specimen, the basals are seen to possess a small cup.

There are no interradials or third range of plates such as Hall figured for *Stephanocrinus angulatus*, on plate 48, vol. 2 of the Palæontology of New York. I think he was mistaken about the generic

structure of *Stephanocrinus* and that the third range of plates has no existence in either of the species he described. At least, I have collected *Stephanocrinus angulatus*, at Thorold, Canada, and none of the specimens show a suture that indicates the existence of the third range of plates, and none of the Indiana specimens of this or any other species bears any evidence of such a suture. On the contrary, the radial sutures extend to the top of the radial limbs.

The surface, in well preserved specimens, is covered with fine striae which are transverse, longitudinal or oblique on different parts; they are transverse below, and oblique from the upper lateral angles of the radials.

The summit is moderately convex over the ambulacral areas, but does not rise to half the height of the radial limbs. There is one plate in each interambulacral area which rises about as high as the limbs of the radials and has steep sloping sides toward the ambulacra and a steep angular ridge sloping to the mouth or central opening, except one which is truncated at the summit by a round anal opening. These five interambulacral plates correspond, as it seems to me, with the deltoids or oral plates of *Codaster* and other kindred Blastoids. The anal opening is round and situate at an angle of union of a deltoid with two radial limbs. It does not seem to have been covered with plates and I am inclined to think it never was so covered.

The central part of the ambulacral area or mouth is pentagonal, in outline, and covered with a convex pentagonal pyramid, composed of five plates; each ray of the pentagonal pyramid directs its angle toward the central line of an interambulacral plate, and the re-entering angles unite with the median grooves in the ambulacral arms. The ambulacral arms are longitudinally convex with a median groove. No side plates of the ambulacra have been discovered, but there is a distinct furrow upon each side, which, in some specimens, is slightly roughened indicating some probability that they existed. The hydrospires have not been detected, but they may have existed at the ends of the ambulacra or within the thick radial plates.

I place the *Stephanocrinidæ* among the *Blastoidea* on account of the structure described above, which prevails in all the species I have examined, but there are others who think the affinities are with the *Crinoidea* and so class the family.

The specimens represented by figures 1 and 2, I collected several years ago, in the lower part of the Niagara Group, at Osgood, Indiana; and those represented by figures 3 and 4 and others examined were found by Mr. J. F. Hammell in rocks of the same age near Madison, Indiana.

STEPHANOCRINUS ELONGATUS, N. SP.

Plate VI, fig. 5, side view, magnified two diameters.

This species is distinguish from *S. osgoodensis*, by the elongated form of the body, slight contraction of the basal plates and the triangular character of the base. In other particulars, so far as shown by the specimens at hand, they substantially agree. The basal plates are peculiarly elongated, expand very moderately to meet the radials, and are slightly contracted at the lower third. They are distinctly triangular at and below the contraction, while *S. osgoodensis* is hexagonal in the corresponding part. These differences might be regarded, by some, as indicating merely a variety, especially as *S. osgoodensis* is quite variable in size, and, as shown by figure 2, some specimens are more elongated than others; but I have taken them to be of specific importance, because three specimens, one of which is larger than the one illustrated, possess the distinguishing characters, while *S. osgoodensis* can be distinguished among the most minute forms as well as among those of larger size. The characters seem to be fixed in both species.

Collected by Mr. J. F. Hammell, in the lower part of the Niagara Group near Madison, Indiana.

STEPHANOCRINUS OBPYRAMIDALIS, N. SP.

Plate VI, fig. 6, side view magnified two diameters.

Body obpyramidal and regularly expanding from the base to the summit; sharply triangular below and hexagonal above, the outer faces being more or less concave. The basals and radials about equal in length. The sutures in our specimens are exceedingly indistinct and not indicated by the artist in the illustration. Surface marked by transverse striæ, in the lower part, and by lines and granules above. Basal cavity, in which the column attached, hemispherical.

Radial limbs proportionally shorter than in *S. osgoodensis*, and sinus more broadly concave. The plates are very thick. The central part of the ambulacral area or mouth is pentagonal and covered with five plates. Anal opening as in other species of this genus. The other parts of the ambulacra not preserved in our specimens.

This is a very distinct and strongly marked species.

Collected by J. F. Hammell, in the lower part of the Niagara Group, near Madison, Indiana.

STEPHANOCRINUS HAMMELLI, N. SP.

Plate VI, fig. 7, summit view; fig. 8, side view of a large specimen; fig. 9, side view of a smaller specimen with a very small base. Magnified two diameters.

Body triangular at the base, very rapidly expanding to the top of the basal plates; very slightly expanding, in some specimens, above the basals, and in others there seems to be no enlargement whatever. In specimens having the most abrupt expansion, there is no expansion of the radials. The body is pentagonal from the basals upward. It is shorter and more robust than *S. osgoodensis* or any of the associated species. The surface striæ are transverse, longitudinal or oblique on different parts of the body, but they are more conspicuous and better preserved than they are on *S. osgoodensis*, from the same rocks.

All specimens are distinctly pentagonal above the basals, and none of them are constricted, and in these respects they are quite different from typical *Stephanocrinus gemmiformis*, which are rotund in the middle and contracted near the summit. There are no interradians or third series of plates, as defined and illustrated for *S. gemmiformis*, in Palæontology, of New York, vol. 2, p. 215, pl. 48, though this species is very much like the one Hall described and illustrated in the 28th Rep. N. Y. St. Mus. Nat. Hist. p. 146, pl. 14, from Waldron, Indiana, except as to the interradians shown in the diagrammatic view on page 146, and in figure 20, on plate 14, all of which was reproduced on page 279, plate 13, of the 11th Report on the Geology and Natural History of Indiana. I have never seen a fossil from Waldron, having the characters attributed to it in the diagram and illustrations above referred to; but I have seen specimens of *Stephanocrinus* from Waldron, and have them in my collection that agree almost exactly with the species under consideration and are not separable from it by any well defined characters, though as they are from the upper instead of the lower part of the Niagara Group, more complete specimens might show specific differences. I can not believe the form figured and described by Hall, from Waldron, Indiana, is specifically identical with *S. gemmiformis*, which he figured and described from New York, and I believe he is mistaken in both cases concerning the existence of interradian plates. And I may add, if his diagrams and illustrations are correct in regard to the interradian plates, then none of the species described in this article belong to the genus *Stephanocrinus*, but, on the contrary, belong to an undefined genus.

The number and arrangement of the plates in this species is the same as in *S. osgoodensis*, but the limbs of the radials are proportionally shorter and the oral and anal openings proportionally larger. The summit is very slightly convex over the ambulacral areas, but the five plates that cover the oral opening are arranged as in *S. osgoodensis*. In

a specimen having the covering plates of the oral opening quite well preserved, the ambulacral areas appear to be covered with imperfectly preserved plates; and a specimen having the covering plates of the oral opening removed shows concave ambulacral areas. Either a suture or a groove surrounds the ambulacral areas and curves around the points of the interambulacral plates, instead of forming sharp angles, giving the whole the appearance of a five rayed piece with a central pentagonal perforation; but the distal end of each uncovered ambulacral arm looks something like a capital letter B or as if it possessed two hydrospire openings at that place. But there is no depression, at the outer ends of the ambulacral grooves, "semiovoid or horse-shoe-shaped," "reniform" or of any other contour indicating that second radials could ever have been attached. I have examined more than fifty specimens belonging to this genus and have never found the slightest evidence of the existence of a second radial, neither have I found the ambulacral pinnules, which I believe existed; but the former ought not to have escaped observation, if ever present, while the latter being much more delicate might never have been preserved. The appendages, figured on plate lxxxv, vol. 2, of the Palæontology, of New York, do not as it appears to me, resemble the arms of a crinoid, but have the aspect of the pinnules of a blastoid, or at least, approximate them more closely than they do the arms of a crinoid.

Collected by Mr. J. F. Hammell, in whose honor I have proposed the specific name, in the lower part of the Niagara Group near Madison, Indiana.

ORDER PALÆOCRINOIDEA.

FAMILY PISOCRINIDÆ.

PISOCRINUS GEMMIFORMIS, S. A. MILLER.

Plate VI, fig. 10, side view showing the heptagonal plate on the right that supports two radials, and the radial plate on the left; fig. 11, basal view; fig. 12, view from above, showing small central cavity and thickness of plates; figures 24 and 25, supposed to be vaults of this or some other species in this genus. Magnified two diameters.

This species was described in the Journal of the Cincinnati Society of Natural History, vol. 2, p. 113, from Osgood, Indiana, but is now known from Madison, and other places, in the Niagara Group of Indiana.

Calyx globular, contracted above the middle, depressed at the base, which somewhat resembles a bell mouth; plates thick, surface smooth.

The five basal plates form a triangle, almost equilateral. The three plates in the angles are quadrilateral, the other two are of equal size and triangular; the two quadrilateral plates that are united are the larger ones. The basal triangle is followed by a large plate on each of

the three sides, which constitute the principal part of the calyx. One of these plates is followed by two radials as shown in figure 10. The other two are radials in the central part and bear upon their approximate lateral sides a small radial. Two large primary radials and three small secondary radials support the arms or arm-blades. The cicatrices or excavations for the arm-blades are wide and the projecting limbs of the radials short and bent inward.

There are eleven plates in the calyx; five basals, one subradial or azygous plate and five radials, according to Koninck's formula; but they might be defined as five basals, three primary radials, and three secondary radials, for the three large plates occupy the position of subradials, in part, and primary radials in part.

The plates that occupied the place of the arms in ordinary crinoids were evidently blades dovetailed into the top of the radials, as shown to be the case, in *Pisocrinus gorbyi*, though the blades themselves are yet unknown.

Figures 24 and 25 represent the convex side of two plates first discovered by Mr. A. C. Benedict associated with *Pisocrinus* and which he supposed to be the vaults. Wachsmuth had then published the third part of his Palæocrinoidea and described the ventral surface and arms, which he knew nothing, whatever, about, (see p. 173) as follows:

"*Pisocrinus* has similar articular appendages as *Symbathocrinus*, which cover a good part of the ventral surface. The articulation, however, does not occupy the whole width of the radials; there is at each side of the plates an upright extension, which, together with that of adjoining radials, produces interradially, between the arms, a conspicuous projection, similar to that of *Haplocrinus*, but more prominent. The construction of the ventral side is not known, the space beyond the articular faces is open in all our specimens, but probably was covered in a similar manner as in *Symbathocrinus*. The arms are long, simple, rounded along the outer face, and less closely folded than in *Symbathocrinus*. They are composed of extremely long, single joints with parallel upper and lower faces."

Immediately after the discovery of these vaults, as I am informed by Mr. Benedict, he lent the specimens to Mr. Wachsmuth and informed him of the place and surroundings in which they were found and expressed the opinion that they were the vaults of *Pisocrinus*; one of them, Mr. Benedict says, showed indications of being composed of five plates. Afterward, in 1888, Wachsmuth figured the under side of one of these vaults, in the Proceedings of the Academy of Science of Philadelphia, on plate xviii, figure 14, as the "Inner floor of the orals of a *Pisocrinus* from Indiana." And he said, on page 350 of the Proceedings that, "We now recognize also in *Symbathocrinus* and *Pisocrinus* five large orals as covering the greater part, if not all, of the ventral surface, more

or less similar to those of *Haplocrinus*, though with a very different anal arrangement in *Symbathocrinus* and probably also in *Pisocrinus*.

None of the plates now in the possession of Mr. Benedict show any sutures, and only one any indication of a division of the plate, however, I have no reason to doubt the correctness of Mr. Benedict's observation, though Mr. Wachsmuth does not show the division in his illustration which is magnified four diameters. I am quite at a loss to understand why the under side of this vault should be brought in comparison with the upper side of that of a *Haplocrinus*, a genus with which it has no near affinity whatever. I will describe these specimens, as they appear, before considering the questions as to the division into five plates and the purposes subserved. The two plates differ only in size.

These supposed vault plates are convex, central part prominent, height equal to two-thirds the diameter. Apex apparently solid, with the exception of one specimen, which, being somewhat crystalline, shows, on holding it to the light, under a magnifier, some indications of a division. From near the apex, ten striæ originate and radiate toward the margin, but soon appear as upright plates or lamellæ, and have a height, at their distal ends, one-half greater than the distance from each other, or more than half the height of the whole convex plate. Between each of these and near the apex, ten other striæ originate and radiate to the circumference of the plate, with very slight increase in size. Viewed from the under side, the larger striæ may be arranged into five pairs and the smaller ones into two classes. The under side is deeply excavated centrally, in the form of a pentagonal pyramid, from the re-entering angles of which a concave depression extends to the outer margin, and truncates the ends of five of the smaller striæ from the convex side, while the angles of the pyramid terminate in the projecting points of the other five of the smaller striæ. The concave depressions divide the lower side into five equal parts, each one of which includes a pair of the larger striæ, between which is the projecting point of one of the smaller striæ; and the furrows which constitute what we have called the angles of the pyramid, likewise divide the lower side, into five equal parts, each one of which includes two of the larger striæ, separated by a concave depression that truncates the end of one of the smaller striæ.

If one of these plates belonged to a *Pisocrinus* it covered the top of the visceral cavity, or, in other words, constituted the vault; the arm-blades enclosed it; the grooves on the inner side of the arm-blades must have had some connection with the furrows between the radiating striæ, so as to form channels to the margin of the plate. The radiating striæ or lamellæ extend beyond the general contour of the plate so as to leave openings or pores leading to the inner cavity of the calyx at the margin of the plate, otherwise I can see no place for food grooves, nor can I discover any mouth or anal orifice. There was no mouth or other opening

at the summit of the vault, and if it was composed of five plates that united at the apex, their great thickness is inconsistent with the idea that they opened and closed at this point for any purpose. The five grooves on the under side may represent the continuation of the channels to the central part of the visceral cavity, but I can see no ground for comparison with *Stephanocrinus*, *Haplocrinus*, or any other genus with which Wachsmuth has sought to ally it. I quote the remarks of Wachsmuth from Palæocrinoidea, Part III, p. 287, as follows:

"*Stephanocrinus*, undoubtedly, is closely allied to *Allagecrinus*, *Haplocrinus* and *Pisocrinus*, and must be placed with them among the *Larviformia*, but, owing to marked differences in the form and arrangement of the arms, it can not be arranged either with the *Haplocrinidæ* or *Symbathocrinidæ*, and it will be necessary to establish for it a separate family, except in the arm structure the affinities seem to be particularly close with *Pisocrinus*, which has similar interrarial processes, formed likewise by the extended limbs of the radials; but as we know little or nothing of the oral plates and ambulacral structure in this genus, a critical comparison is difficult."

It is sufficient to say there is no affinity in the arm structure of *Stephanocrinus* with *Pisocrinus*, and no similarity in the interrarial processes. Certainly there is no family affinity between the two genera, and I think they are not to be classed in the same order.

PISOCRINUS BENEDICTI, N. SP.

Plate VI, fig. 13, side view, showing the position of the small radial, in the notch, between the upper approximate lateral sides of two large plates; figs. 14 and 15, basal views; fig. 16, summit view, magnified two diameters.

Calyx subcylindrical, and slightly expanding to the upper third; depressed at the base; plates thick; surface smooth.

Basals rather large, curving into the basal cavity and upward so as to be visible in a side view. Plates the same shape as in *P. gemmiformis*, but the triangular plates extend farther beyond the lines of the triangle. The large plates that constitute the principal part of the calyx are more elongated than in *P. gemmiformis*; and the cicatrices or excavations for the arm-blades are narrower, and the radial limbs wider, proportionally. The arm-blades were, no doubt, the same as in *P. gorbyi*, and the dove-tailed tenons narrower and longer than in *P. gemmiformis*. All that I have said in regard to the plates of the vault of *P. gemmiformis* applies with equal or greater force to the vault of this species, for they were found associated with it.

Collected by Mr. A. C. Benedict, now of the Geological Survey, in whose honor I have proposed the specific name, at Marion, Wabash and other places in the Niagara Group in Indiana.

PISOCRINUS GORBYI, N. SP.

Plate VI, figs. 17 and 18 side views; fig. 19 summit view; fig. 20 side view with arms-blades in position, all of which are from Indiana. Figs. 21, 22 and 23, the same species from Tennessee, but having a rather shorter calyx. Magnified two diameters.

Calyx small, variable in size; height and width subequal; base small, round, sunken for the columnar attachment; rapidly expanding in the radial region and strongly lobed toward the tenons of the arm-blades, giving the summit a strong five-lobed outline; plates thick; surface smooth or finely granular.

The five basal plates form a small, nearly equilateral triangle, most of which is sunken in the basal cavity. The basal triangle is followed by a large plate on each of the three sides, which constitute almost the entire calyx. One of these is followed by two radials, and the others are radials in the central part and bear upon their approximate lateral sides a small radial. Thus, two large plates and three smaller ones support the arms. They are each excavated in the central part, which corresponds with the lobes of the calyx by a long dovetailed mortise, and have correspondingly long, wide limbs, that curve inward toward each other. The radial sutures do not divide the apex of the limbs, but terminate a little below on one side; for example, the radial limbs of the small, single, secondary radial are not quite as long as the adjoining limbs of the large primary radials and terminate on the sides below the greatest extension of the latter.

The radials, instead of bearing arms, as in ordinary crinoids, bear long, single pieces, which I designate, by the name of arm-blades. There are five arm-blades, one from the mortise of each radial lobe. They are longitudinally convex, depressed at the sutures, and together form a pentagonal pyramid. Each one has a long, dovetailed tenon inserted in the radial notch, and expands above the tenon to unite with the adjoining arm-blade. The expansions cross the terminations of the radial sutures, so that the suture lines between them are not a continuation of the sutures between the radials. Each arm is longitudinally concave or furrowed on the inside. There may have been more than one arm-blade in each arm, but we only describe one, because no more are preserved in our specimen.

From the shape of the arm-blades, their manner of uniting at the sides, and the insertion of the tenons in the radial mortises, one might infer that they were locked in position and were not capable of being opened. But the radial plates are mortised in the interior and have an internal opening at the base of the mortise so that the arm furrows had a continuous way to the visceral cavity, and therefore, there is no obstacle in the way of supposing the arms could expand or open outwardly as other crinoidal arms did, except the sides of the mortise or radial

limbs must, necessarily, have remained stationary and curved toward the vault. The vault is not definitely known, but the remarks concerning the vault of *P. gemmiformis*, probably apply with equal force to this species, as the vaults which have been found differ only in size and occur in the same rocks with this species and *P. benedicti*. The specimens represented by figures 21, 22 and 23 were collected by Prof. S. S. Gorby, in the Niagara Group, in West Tennessee, and differ so far as can be ascertained, from the species here described, in being proportionally shorter or more depressed. If other parts were known possibly specific characters could be discovered that would distinguish the forms from this species.

The late N. P. Angelin, in *Iconographia Crinoideorum*, described three species of *Pisocrinus*, two of which he illustrated with arms, viz.: *P. flagellifer* and *P. pocillum*. The descriptions are short and I will quote them as follows:

P. flagellifer. "Calyx brevis, cyathoideus; lævissimus, testa crassa. Radialia primaria quinque, inæqualia, posteriora duo et dorsuale angusta, lunulata, inter se similia, intermedia, duo lata et inter se similia; secundaria subrectangularia. Anale magnum, diametro longitudinali transversalem superante, apice acuminatum. Brachia quinque, articuli simplices, teretiusculi, longitudine latitudinem plus triplo superantes. Columna angusta, apice incrassata, articulis crassiusculis."

P. pocillum. "Radialia primaria quinque inæqualia, acuta, posteriora minora, margine superiore plano, anteriora oblongula, clypeiformia; secundaria rectangularia. Interradiale oblongulum, sexangulum. Anale oblongum, acutum, heptagonum. Brachia articulis simplicibus, longissimis, longitudine latitudinem quintuplo superantibus. Columna apice antrorsum incrassata. Affinibus paullo robustior, testa ornatisima instructus."

His illustration of *P. pocillum* shows a transverse face at the top of the calyx, without any indication of radial limbs. The first arm plates are short, not half as long as wide, and unite around the top of the calyx, except at the azygous side, where a triangular plate is inserted to break the circle. The second plates are elongated. The illustration of *P. flagellifer* shows radial limbs and a short arm plate about as high as the limbs, resembling in position the second plate in the radial series of *Platycrinus*, it is succeeded by long plates forming long slender arms. Neither the descriptions or figures throw any light upon the structure of the *Pisocrinus* in Indiana. Possibly they are not congeneric.

The specific name of this species is in honor of Prof. S. S. Gorby. It occurs in the Niagara Group, at Wabash, Marion and at other places in Indiana.

PISOCRINUS CAMPANA, N. SP.

Plate XI, fig. 4, side view; fig. 5, summit view.

Species rather large; calyx bell-shaped, one-half higher than wide, contracted in the middle, rounded below into the basal cavity; plates thick; surface smooth or probably, in perfectly preserved specimens, finely granular.

Basals form a cup conspicuous in a side view, the plates at the angles of the triangle extending high up on the side of the cup, while those between the angles are much lower. The constriction is around the three larger plates of the calyx, and does not include either of the three smaller arm bearing plates. The radial limbs are rather short and thin, and appear to rise higher on the inner side of the test as they approach each other, than on the outer side. The mortises on the inner sides of the radials, or continuation of the arm furrows toward the visceral cavity are large and deep.

This species is distinguished from all others found in Indiana by its larger size, campaniform shape, and small radial limbs. It is not necessary to compare it with any others.

Found in the Niagara Group, at Wabash, Indiana, and now in the collection of A. C. Benedict.

FAMILY ZOPHOCRINIDÆ, N. FAM.

This family name is proposed to receive the new genus *Zophocrinus*, and, for the present, the family characters are the same as the generic.

ZOPHOCRINUS N. GEN.

[*Ety zophos*, dark obscure; *krinon*, lily.]

Body ovate or pear-shaped, and covered by two circles of plates and the vault. Basals or first circle of plates, three forming an obconoidal cup, higher than wide; two of the plates are of equal size, and quadrangular; the other is larger and pentagonal. Second circle of plates, four, three pentagonal and one quadrangular; they are horizontally truncated on top, and bear a circle of numerous pinnules (?) surrounding a vault having a central elevation. Seven plates constitute the test of the calyx. It possessed a column with a small columnar canal. Type, *Z. howardi*.

This genus has the general form of a blastoid, except the summit, which has no resemblance to that order. If there were any of the pores that characterize Cystideans, it might very appropriately be referred to that order. It has neither the form or structure of any known

genus or family of crinoids, and, therefore, it is only provisionally referred to the Palæocrinoidea. It is highly probable that when more is known of its structure and affinities, it will become the type of a distinct order.

ZOPHOCRINUS HOWARDI, N. SP.

Plate VI, figures 26 and 28, side views of two specimens, with basal ends up, (they should be reversed); figure 27, summit view, with an eroded vault. Magnified two diameters.

Body subovate or pear-shaped, greatest diameter at the upper third, pointed below, length more than twice the diameter; surface smooth or possible finely granular; specimens differ much in size.

The basals or first circle of plates form an obpyramidal cup, most rapidly expanding above, and sutures most depressed below so as to give the base, in transverse section, a subhexagonal outline. The cup is one-half higher than wide, the upper faces arcuate. The two smaller plates are equal, quadrangular, the two upper sides the shorter ones. The other plate is pentagonal and has two, upper, short, lateral sides and a longer, central, superior, arcuate side. The base is sunken for the attachment of a small, round column, having a small, central, columnar canal. The second circle of plates or radials, if that is better, are the larger plates of the body, they expand slightly and curve upward, contracting toward the top, where they are horizontally truncated, and when the succeeding plates are attached, they appear as if constricted at this place. They are longitudinally convex, in the central part, and inclined or depressed toward the sutures, so as to distinctly outline the four plates. Three of them are pentagonal and one quadrangular, this is caused by each of three having two under sides, while the other has only one. The length of a plate is about one-half greater than its width. The upper face, while horizontally truncated as seen in a side view, is thickened and beveled toward the interior, and when the superior plates are removed, five pores or arm-openings may be seen to enter the beveled edge of each plate or twenty in all. I do not say these are properly arm-openings, but they are pores passing through the projecting rim of the plates to the visceral cavity of the body, and if this genus is to be classed with the Palæocrinoidea, then they must be regarded as representing the arm openings.

At the time the figures were made, the specimens at hand were eroded, at the summit, and indicated only a single plate or small anchylosed plates with a central elevation for the vault, and hence that is all shown in the illustration; but since that time, Prof. Gorby has purchased Dr. Howard's collection, for the State Museum, at Indianapolis, which contains sixty-five specimens belonging to this species, and the better preserved ones show that twenty compact plates form a circle with pores

passing down perpendicularly through them and connecting with the pores passing through the beveled edges of the plates above described; and within this circle there are smaller plates that cover the vault. Prof. Gorby and Mr. Benedict are of the opinion that the circle of twenty plates are the first arm-plates and although they are different from all other arm-plates with which I am acquainted I yield to their judgment.

Found in the Niagara Group, at St. Paul, Indiana. Dr. F. W. Howard of that place was the first to discover and collect this peculiar species, and I have proposed the specific name in his honor.

FAMILY MELOCRINIDÆ.

MARIACRINUS AUREATUS, N. SP.

Plate VI, fig. 36, side and basal view, magnified two diameters.

Calyx small, bowl-shaped; plates radiately sculptured; each radial series marked by an angular ridge and abruptly curving outward at the top of the calyx. Basals four, unequal, extending beyond the round column, and forming a pentagonal disc. First primary radials, the larger plates of the calyx wider than high, four heptagonal and one hexagonal; second primary radials a little smaller, wider than high, hexagonal; third primary radials as high as wide, hexagonal, axillary. First secondary radials about as high as wide; second secondary radials smaller and axillary, except in the rays adjoining the azygous area, where there are three secondary radials. There are two tertiary radials, the second being axillary, in the ray adjoining the azygous area, preserved in our specimen, and, if the rays are uniform, there are forty arms in this species.

Interradial areas convex, elongate-subovate. Regular interradians seven or eight, the first one resting between the upper sloping sides of two first primary radials, and being nearly as large; it is followed by two smaller plates, and these by two, above which there are two or three minute plates. Intersecondary radial areas having one or two small plates. Azygous area a little wider than the regular areas, and having nine or ten plates; the first one is as high as wide and as large as a first primary radial; it is followed by three plates, and these by two, above which there are three or four smaller ones. One arm commences with three plates in single series, otherwise the structure of the arms is not preserved in our specimen. Vault unknown.

Collected by A. C. Benedict, in the Niagara Group, at St. Paul, Ind.

MARIACRINUS GRANULOSUS, N. SP.

Plate VI, fig. 35, basal view.

This species is founded upon the basals and first radials, and the propriety of founding a species, on such a fragment may well be doubted; but if there is any justification, it is because these parts are so different from all other species described, that it may be readily separated from them.

The basals are small, sunken and form a pentagonal disc, only a little larger than the end of the column; they are thickened and radiately furrowed at the outer circumference of the place of columnar attachment. Primary radials large, four of them heptagonal and one hexagonal; they rapidly expand from the basals upward, the lateral sides are the longer, and the surface is covered with numerous tubercles. The sutures are wide and deeply beveled, and the lower part of each plate terminates in a tubercle-like blunt end, below the point of columnar attachment. Superior face of the plates arcuate about two-thirds the width of each for the second primary radials; upper lateral sides rather steep forming a sharp angle, for the reception of the first interradials.

Distinguished by the large, rapidly expanding, granular, first primary radials, and by the deep, wide, beveled sutures between them.

Collected by A. C. Benedict, in the Niagara Group, at St. Paul, Indiana.

FAMILY CALCEOCRINIDÆ.**CALCEOCRINUS INDIANENSIS, N. SP.**

Plate VI, fig. 37, side view of calyx and part of the column, magnified two diameters. The ventral arching plate should be more sharply pointed at the suture.

Calyx small, basal part; as it appears in a dorsal view, in the form of an inverted, conical frustum, to the shorter plane, of which the column is attached; it is separated from the dorsal side, by a wide, gaping suture, and consists of four plates; it is longitudinally divided, in the center, and has a trapezoidal plate on each side, which extends to the base or place of the columnar attachment. The sides of the calyx are parallel with each other, there being no expansion above the basal suture. The centro-dorsal plate is narrow and tapers a little, from the gaping suture, to the upper dorsal plate. The lower part of the upper dorsal is subtriangular, the lower angle being truncated by the narrow upper end of the centro-dorsal plate. The upper dorsal is not preserved in our specimen. The dorso-lateral plates are irregularly hexagonal and regularly rounded to the ventral side, where each terminates in an angle only slightly truncated, by a ventral plate. Each ventral arching plate is rather large and terminates in a point, at the suture and dorso-lateral

angle of a dorso-lateral plate. Lateral brachials not preserved. Column round and at the distance of half an inch from the calyx, each of the plates has a length about equal to the diameter.

Distinguished by the trapezoidal plates in the base, by the narrow centro-dorsal plate, and by the regularly rounded, parallel sides of the calyx.

Collected by A. C. Benedict, in the Niagara Group, at St. Paul, Indiana.

FAMILY DICHOCRINIDÆ.

DICHOCRINUS HUMBERGI, S., A. MILLER.

Plate VI, fig. 38, side view of calyx, magnified two diameters.

This species was described in Bulletin No. 4, of the Geological Survey, of Missouri, p 26, *from a single specimen, in which the first radials were only about one-half longer than wide. Since that time I have received several specimens which show considerable variation in the size and relative proportions. The specimen illustrated is less than two-thirds the size of the type, and the first radials are twice as long as wide.

Found by R. A. Blair, in the Keokuk Group, at Boonville, Missouri, and now in my collection.

DICHOCRINUS BLAIRI, N. SP.

Plate VIII, fig. 12, specimen with arms and part of column, but having the calyx flattened.

Calyx short, somewhat obconoidal or turbinate; plates thin; surface granular. The two basals form a cup a little more than one-third the length of the calyx; the notch at the union of the basals is distinct.

First radials nearly twice as long as wide, longitudinally convex, and projecting at the arm or brachial facets; very slightly expanding. Articulating facets for the brachials about half the width of the plates, concave and sloping downward. There are two brachials in each series; the first one very short and the second axillary. The first arm-plate is short, the second rather long, constricted in the middle and axillary, giving to the species twenty arms. Arms large, long, and composed of a single series of short, cuneiform plates. Pinnules long and coarse. Column round and composed of very thin plates alternately projecting.

Found by R. A. Blair, in the Keokuk Group, at Boonville, Missouri, and now in my collection. The specific name is in honor of the collector, who is an energetic naturalist, learned geologist, and member of the Geological Board, of Missouri.

*NOTE.—The capital letters in specific names in that Bulletin were inserted without my consent, by the State Geologist, beside, he otherwise interfered with my manuscript, and altered the text without my consent.

FAMILY DOLATOCRINIDÆ.

ALLOCRINUS BENEDICTI, N. SP.

Plate VII, fig. 1, basal view of calyx and part of the arms.

Calyx small, depressed turbinate, interradial areas depressed so as to give a subpentagonal outline to the upper part; sutures distinct; surface granular. The three basals form a pentagonal disc more than twice the diameter of the column; one plate is only half the size of either of the others. First radials large, gradually expanding, wider than high, three heptagonal and two hexagonal. Second radials short, quadrangular, four times as wide as high, and gradually arching from one interradial area to another. Third radials about the same size as the second, but axillary and supporting upon the upper sloping sides the free arms. Arms ten, large, round externally and composed of short plates. Interradial areas depressed. A single interradial rests between the two short superior sloping sides of two adjacent first radials and between the second and third radials, and extends as high as the latter. Vault and other parts unknown.

Found by A. C. Benedict, in the Niagara Group, at St. Paul, Indiana. The specific name is in honor of the collector, who is an excellent palæontologist.

FAMILY EUCALYPTOCRINIDÆ.

EUCALYPTOCRINUS SUBGLOBOSUS, N. SP.

Plate VII, fig. 3, side view of an entire specimen.

Body below medium size; with the arms and interbrachial plates, subglobose, being only slightly produced at the base and less at the summit; surface granular and some of the plates have a central tubercle. Calyx a little more than one-third the entire length of the body. Basal plates nearly covered externally, by the column. First radials wider than high, expanding upward, and almost as large as the second and third together. Second radials quadrangular, one-third wider than high. Third radials hexagonal, rather larger than the second, wider than high, and supporting on the upper lateral sides the secondary radials. First secondary radials pentagonal and smaller than either of the primary radials. Second secondary radials expand upward and each is somewhat in the form of an inverted frustum, but the upper plane is not quite parallel with the lower and supports two tertiary radials upon its slightly sloping sides. The top of the first tertiary radials is on a line with the top of the interradials. The tertiary radials are succeeded by thin, quadrangular plates, which become more and more cuneiform, until they

graduate into an arm composed of a double series of interlocking plates, which gradually tapers to the summit, where the solid interbrachials unite around the orifice. The interbrachial plates consist of one large and two smaller ones in each area; the large one has ten sides and height and width are about equal; the others are of equal size, hexagonal, a little more than twice as high as wide, and extend to the top of the first tertiary radials. The intersecondary radials are single, octagonal, truncate the third radials, and have the form of the two small interradians when united, but smaller than the two together. The solid interbrachials become only slightly narrower in their upward extension, and unite at the summit, with each other and with small plates that surround the orifice.

Found by Prof. S. S. Gorby, in the Niagara Group, at Hartsville, Indiana, and now in his collection.

EUCALYPTOCRINUS ELLIPTICUS, N. SP.

Plate VII, fig. 4, side view of nearly an entire specimen.

Body quite small, and, with the arms and interbrachials, somewhat elliptical in outline, being most strongly produced at the base, and somewhat depressed at the interradian areas; surface of the plates smooth. Calyx not more than one-third the length of the body. Basals nearly covered externally by the column. First radials standing nearly upright, slightly expanding, wider than high, and almost as large as the second and third together. Second radials quadrangular, one-half wider than high. Third radials pentagonal, one-half larger than the second, a little wider than high, and supporting, on the upper sloping sides, the second radials. First secondary radials hexagonal, and about as large as a third radial. Second secondary radials pentagonal, expand upward and support, on the upper sloping sides, the tertiary radials. The top of the first tertiary radials is about on a line with the top of the interradians. The tertiary radials are succeeded by one or two quadrangular plates, and these by cuneiform ones that graduate into an arm composed of a double series of interlocking plates and tapers to the summit, where the solid interbrachial plates surround the orifice. The large interradian plate is depressed in each area, and the two succeeding ones reach only about as high as the top of the first tertiary radials. The intersecondary radials are very small, narrow, and rest between the upper sloping sides of the first secondary plates, without truncating the third radial as is usual in this genus. The solid interbrachials are quite thin until they unite around the orifice.

Distinguished from all other species by the small size, by the general form, comparatively large first secondary plates, sunken interradians,

and by the small intersecondary radials, which rest between the upper sloping sides of the first secondary radials, instead of truncating the third radial as in all other species of this genus.

Found by Prof. S. S. Gorby, in the Niagara Group, at Hartsville, Indiana, and now in his collection.

EUCALYPTOCRINUS GORBYI, N. SP.

Plate VII, fig. 5, side view of calyx; fig. 6, basal view.

This is the largest species found in this country; the calyx, only, is preserved in our specimen, and even that has a fragment broken from one side and part of the first radials torn away.

Calyx broadly subturbinate, constricted in the middle or abruptly expanding from the second radials, and separated into five lobes above; the depressions corresponding with the double interradians, and less distinctly into ten lobes by a slight depression of the intersecondary plates; sutures well defined and always arched or curved instead of being straight as is usual in this genus; surface granular; diameter, 2, 5 inches; height, 1, 5 inches. Basal plates sunken, not exposed externally. First radials very little wider than high, extending below the point of columnar attachment, expanding upward, flattened on their faces, projecting most at the sutures, and, together, forming a subpentagonal cup with a deep columnar pit. Second radials nearly as large as the first and only a little wider than high. Third radials as large as the second, hexagonal, as high as wide, and supporting on steep, upper, lateral sides the secondary radials. First secondary radials pentagonal, and smaller than either of the primary radials. Second secondary radials smaller than the first, pentagonal, about as high as wide, and support, on the steep, upper, sloping sides, the tertiary radials; in one of the rays both the first and second tertiary plates abut upon the upper sloping sides of this plate which gives it an heptagonal outline. The first tertiary plate is triangular, and it is succeeded by at least three thin quadrangular plates that enter into and form part of the calyx. First interradian large, ten sided, long and rather pointed both above and below. The double second interradian is wider and larger than the first and longitudinally concave, giving to the upper part of the calyx its pentalobate character. It extends as high as the sixth plate in the tertiary series. The intersecondary plate is about the size of one of the double interradians, truncates the third radial, extends as high as the sixth plate in the tertiary series, is flattened or concave in the upper part which divides the top of the calyx into ten indistinct lobes.

Found by Prof. S. S. Gorby, in the Niagara Group, near Nashville, Tennessee, and now in his collection.

EUCALYPTOCRINUS ELRODI, N. SP.

Plate VII, fig. 9, side view of the calyx a little elevated at the top, so as to show the columnar cavity at the base; fig 10, basal view of the same specimen.

Calyx medium or above medium size, broadly saucer-shaped or moderately arching from the columnar cavity to the circumference; sutures well defined, even beveled, generally curved; surface covered with round or angular nodes, sometimes they are elongated, but rarely if ever confluent, there seems to be about the same number, occupying about the same position on corresponding radial and interradial plates; diameter, 1, 45 inches, height, .38 inch. Basal plates sunken and rising in the interior nearly as high as the top of the calyx, not exposed externally. First radials wider than long, extending below the point of columnar attachment, gradually expanding, directed outward and rising not more than ten degrees above a horizontal line, and forming a disc with a round, central, columnar pit. Second radials nearly as large as the first, quadrangular, and only a little wider than high. Third radials as large as the second, hexagonal, as high as wide, and supporting on steep upper, lateral sides the secondary radials. First secondary radials, pentagonal, and about the same size as the second or third radials; the unusual proportions are necessary to keep pace with the rapidly expanding calyx. Second secondary radials smaller than the first, pentagonal, one-half wider than high and support on the moderately sloping upper sides the tertiary radials. The first tertiary plates fill the angular spaces, between the sloping sides of the second secondary radials and the interradials and abut against each other, over the apex of the second secondary radials, which makes them quadrilateral, with the longer side above. The first tertiary plates are succeeded by thin, quadrangular plates, one of which, at least, enters into and forms part of the calyx, and two more are necessary to reach as high as the top of the interradials.

The first interradials have ten sides and are about as wide as long. The double second interradial is about as wide and about as long as the first, and marked by an angular depression at the separating suture. The intersecondary plates truncate the third radials, are wider than one of the double interradials and nearly as long. The arms are ornamented by two subparallel ranges of rounded nodes along the central part, and a range of smaller nodes on each margin. The interbranchials bear two or three ranges of rounded, subparallel nodes, with intervening, longitudinal furrows. None of the nodes have been seen confluent or producing either longitudinal or transverse furrows.

This species is distinguished from all others by its comparatively short calyx, and, therefore, by the great width of the secondary and tertiary plates in proportion to their length. It is also distinguished from *E. celatus*, with which it may be compared, by the form of the columnar pit, and also from the fact that the first radials do not incurve at their

basal margins nor recurve upward above the middle. The surface ornamentation is not like that of *E. celatus*, for the nodes are not disposed in the same manner and there are none of the confluent nodes and none of the straight or tortuous ridges that characterize *E. celatus*.

Found in the Niagara Group, at Hartsville, Indiana, and now in the collection of Prof. S. S. Gorby. The specific name is in honor of Dr. Moses N. Elrod, a prominent physician, ardent collector and well known palæontologist of Hartsville, who was the first to discover this species and point out the fact that it is distinct from all others and undescribed.

FAMILY ICHTHYOCRINIDÆ.

LECANOCRINUS TENNESSEENSIS, N. SP.

Plate VII, fig. 7, view of azygous side of calyx; fig. 8, basal view.

Calyx medium size, hemispherical, somewhat inflated on the azygous side; plates thick; surface delicately sculptured. The three basals form a pentagonal disc twice the diameter of the column; the small basal is directly below the first azygous plate. Subradials moderately large, of unequal size, the two larger ones adjoin the first azygous plate and are heptagonal, the one opposite the azygous side is hexagonal and the other two are each pentagonal. The first radials are pentagonal and about twice as wide as high. First azygous plate quadrangular, a little longer than wide, nearly as large as a pentagonal subradial, rests obliquely between the two heptagonal subradials, and supports on the right a first radial, and on the left the second azygous plate. The second plate is one-half larger than the first, hexagonal, rests between the first and one of the sloping sides of a heptagonal subradial, supported on either side by a first radial, and bears two upper sloping sides. The column is round. Arms and vault unknown.

Collected by Prof. S. S. Gorby, in the Niagara Group, sixteen miles west of Nashville, Tennessee, and now in his collection.

When Hall redescribed *Lecanocrinus pusillus*, in the 28th Report of the New York State Museum of Natural History, p. 136, republished, in the 11th Report of the Geological Survey of Indiana, p. 267, he compared it with *Poteriocrinus pisiformis* of Roemer, for what reason I am unable to state, as they seem to have no relation to each other. *Poteriocrinus pisiformis*, as figured and described by Roemer, in Die Silurische Fauna des westlichen Tennessee, p. 54, pl. iv, figures 7a and 7b, has five basal plates and only a single azygous interrarial. It can not be classed in the same family with *Lecanocrinus*. It is either a true *Arachnocrinus*, as pointed out by Meek, in the Geological Survey of Illinois, vol. 11, p. 177, and classed by me, in North America Geology and Palæontology, or it is a *Cyathocrinus*. Wachmuth's late reference of it to *Lecanocrinus* seems to have been without any consideration.

FAMILY POTERIOCRINIDÆ.

SCAPHIOCRINUS PORRECTUS, N. SP.

SCAPHIOCRINUS ROBUSTUS (?) HALL.

Plate VII, fig. 2, side view, showing part of the arms and column.

Calyx short, bowl-shaped, wider than high; plates thick, convex, sutures sunken; surface smooth. Basals forming a flattened, pentagonal disc a little more than twice the diameter of the column. Subradials larger than the basals, expanding but little, standing nearly upright and depressed at the sutures. First radials pentagonal, about twice as large as the subradials, much wider than high, convex, depressed toward the lateral sutures, truncated the full width, and having gaping, serrated sutures separating them from the single brachials. Brachial plates wider than long, contracted in the middle, and having moderately steep upper sloping sides for the articulation of the free arms. Arms ten, no division, round externally, remarkably large and very long, and composed of a single series of tolerably thick, slightly cuneiform plates. Pinnules coarse and composed of long joints. First azygous plate rather large and resting obliquely between the sloping sides of two subradials and the under sloping side of the right first radial. Second azygous plate broadly truncates the subradial on the left of the first azygous plate. Third azygous plate truncates the first, and above, the plates are in the usual alternate double series. Column round, moderately large and composed of thicker and thinner plates, with one projecting here and there beyond the others.

This species is distinguished by the remarkably large, slowly tapering long arms.

Found in the Keokuk Group, at Crawfordsville, Indiana, by the late Dr. C. A. Miller, the distinguished Superintendent of Longview Asylum, and now in my collection. It may be referred to Hall's species, but, if so, his specimen had an abnormal azygous area, and his definition is very incorrect.

POTERIOCRINUS BOONVILLENSIS, N. SP.

Plate VIII, fig. 3, side view; fig. 4, azygous view.

Calyx turbinate or cup-shaped, height and width subequal, and composed of smooth, rounded plates. Basals small, pentagonal, expanding and pierced by a very small columnar canal. Subradials hexagonal, three times as large as the basals, and about as high as wide. Radials pentagonal, wider than high, larger than the subradials, truncated the full width, and having gaping sutures separating them from the single brachials. Each ray has a single axillary brachial, which is as long or

longer than wide, rounded externally, and constricted in the middle; the brachials are of unequal length. Arms ten, composed of long, slightly cuneiform plates. Pinnules coarse.

The azygous area is wide, long, tumid, and exposes eight plates; the first is pentagonal, smaller than a subradial, rests between the upper sloping sides of two subradials, and between the first radial on the right and the second azygous plate on the left, and is truncated on top for the third azygous plate; the second plate is hexagonal, as large or larger than the first, rests upon the truncated end of a subradial and between the first radial and first brachial on the left, and the first and third azygous plate on the right, and is truncated at the upper end for the fourth plate; the third plate is hexagonal, rests upon the first and between the first radial and first brachial on the right, and the second and fourth plates on the left, and is truncated at the upper end for the fifth plate.

The fourth, fifth, sixth, seventh and eighth plates are hexagonal, and alternately arranged. A small part of the proboscis is exposed at the upper end of the specimen illustrated, where it is flattened and composed of smooth, polygonal plates. The column is small, round, and composed of thicker and thinner plates.

Found by R. A. Blair, in the Keokuk Group, at Boonville, Missouri, and now in my collection.

POTERIOCRINUS AGNATUS, N. SP.

Plate VIII, fig. 6, symmetrical side; fig. 7, azygous view of the same specimen, which is injured at the azygous area.

Calyx turbinate, truncated below or cup-shaped, wider than high, and composed of smooth, rounded plates. Basals small, pentagonal, expanding and pierced by a very minute, columnar canal. Subradials, hexagonal, four times as large as the basals, and about as high as wide. Radials pentagonal, about the size of the subradials, nearly twice as wide as high, truncated the entire width of the plates and separated from the single brachials by a gaping suture. Each ray has a single axillary brachial, which is wider than long, rounded externally, and constricted in the middle. Each arm adjoining the azygous area, and the arm opposite thereto, bifurcate on the first plate; there are no other divisions of the arms. Arms sixteen, composed of long, slightly cuneiform plates. Pinnules coarse. The azygous area exposes seven plates, which have the same form and arrangement as those in *P. boonvillensis*, but they are proportionally smaller. Column round.

This species is more robust than *P. boonvillensis*, has shorter brachials, and is distinguished from it and all other species by the number, arrangement and character of the arms.

Found by R. A. Blair, in the Keokuk Group, at Boonville, Missouri, and now in my collection.

ZEACRINUS COMMATICUS, S. A. MILLER.

Plate VIII, fig. 8, a specimen eroded on the azygous side, showing part of the proboscis and what is supposed to be part of the convoluted organ.

This species was described in Bulletin No. 4 of the Geological Survey of Missouri, p. 36, from the Keokuk Group, at Boonville, Missouri. The specimen here illustrated has the azygous plates removed and discloses canals passing up into the proboscis which represent the convoluted organ. Meek described and illustrated the convoluted organ in *Actinocrinus proboscidualis* and Wachsmuth and Springer have illustrated it in *Eretmocrinus verneuillanus*, *Teleocrinus rudis*, *Goniasteroidocrinus tuberosus* and *Batocrinus longirostris*. The organ in our specimen is convoluted and has winding and ascending channels from the base of the azygous area. It appears to be attached to the basal plates, in the central part, and to have the outer covering of the proboscis attached to the top of the first primary radials. There is a cavity between it and the primary radials and subradials. The arm furrows connected with this outer cavity and through it, with the internal canals. The proboscis instead of being a hollow tube contained a solid framework inclosing winding channels.

POTERIOCRINUS CORYPHEUS, N. SP.

Plate IX, fig. 1, view opposite the azygous side showing one ray with two arms and another with four. The specimen is somewhat flattened.

Species robust, arms large and long in comparison with the size of the calyx, and fit closely together. Calyx subturbinate, height a little more than the diameter; sutures distinct, surface granular. Basals gradually expanding and forming a pentagonal cup. Subradials larger than the basals and longer than wide. First radials about the same size as the subradials, wider than long, truncated the entire width above and separated from the single brachials by a gaping suture. Brachials pentagonal, wider than long, rounded and constricted in the middle, and support the free arms upon the upper sloping sides. In the ray on each side of the azygous area and in the one opposite the area, the brachials are followed, on each upper side, by a long, round, axillary plate, giving to each of these rays four arms. The two lateral brachials bear only two arms each. There are no other divisions of the rays. This gives to the species sixteen arms. The first plates are long but they gradually shorten and become more and more cuneiform. The arms are flattened on the sides and fit closely together. Pinnules long and coarse. The azygous area exposes five plates arranged as in other species in this genus. The first azygous plate is smaller than the second and rests between the upper sloping sides of two subradials and the under sloping

side of the first radial on the right, and supports the third azygous plate. The second azygous plate broadly truncates a subradial. Column round, moderately large.

Distinguished from other species by the number and character of the arms.

Found on Indian Creek, in Montgomery County, Indiana, in the Keokuk Group, and now in the collection of Wm. F. E. Gurley.

POTERIOCRINUS AMENUS, N. SP.

Plate IX, fig. 6, view opposite the azygous side, showing one ray with four arms and one with two arms having single brachials, and one with two arms having two brachials.

This species is smaller than *P. coryphæus* and distinguished from it by the structure of the arms, and form of the calyx. Calyx subturbinate, a little wider than high; sutures distinct, slightly depressed; surface granular. Basals small, as high as wide, slightly expanding, and forming a pentagonal cup. Subradials larger than the basals and wider than high. First radials about as high as wide, convex longitudinally, depressed at the lateral sutures, truncated the entire width above, and separated from the brachials by a gaping suture. Single brachials, pentagonal as high as wide, rounded and constricted in the middle, and support the free arms, upon the upper sloping sides; the first brachial in the double series is quadrangular, and wider than high, the second is pentagonal, longer than wide, rounded and slightly concave transversely, and supports free arms on the upper sloping sides. The azygous side is not disclosed in our specimen, but it is probable that the ray on each side of it has four arms and if so the species has sixteen arms. We do not know whether the rays on each side of the azygous area have one or two brachials. The arms are flattened externally or very slightly rounded, especially in the upper part, and flattened on the sides and fit very closely together. The plates are long and very slightly cuneiform below, but gradually shorten and become more cuneiform above. Pinules short and coarse. Column of moderate size, round and composed of subequal plates.

Distinguished by the number and structure of the arms, and especially from the fact that some rays have single brachials and others double brachials.

Found in the Keokuk Group, on Indian Creek, in Montgomery County, Indiana, and now in the collection of Wm. F. E. Gurley.

SCAPHIOCRINUS SAMPSONI, N. SP.

Plate IX, fig. 12, view of a specimen, as it appears on a slab, showing azygous side, arms and column somewhat fractured.

Calyx small in proportion to the size of the arms, low, somewhat bowl-shaped, inflated on the azygous side; surface delicately sculptured, too fine to be shown in the illustration. Basals sunken in the basal cavity so they can not be seen in a side view. Subradials comparatively large and about as high as wide. Radials more than twice as wide as high, truncated the entire width above and separated from the single brachials by a gaping suture. Brachials longer than wide, constricted on the sides, longitudinally angular in the middle, and having moderately steep upper sloping sides for the articulation of the free arms. Arms remarkably large, bear a longitudinal more or less well defined, external, central ridge, and are composed of short, transverse plates, having a width equal to about half the diameter of the arm. Arms numerous, some of those in our imperfect specimen preserve the second bifurcation, which indicates forty or more. First azygous plate rather large, pentagonal, rests obliquely between the upper sloping sides of two subradials and the under sloping side of the right first radial, and abuts the second azygous plate, and upon its upper sloping side, it supports a large hexagonal plate that extends one-third its length above the top of the first radials. The other azygous plates not exposed in our specimen. Column round and composed of quite thin plates, some thicker than others.

Found by F. A. Sampson, in the Chouteau limestone, in Pettis County, Missouri, and now in his collection. The specific name is intended as a compliment to Mr. Sampson, who is a well-known naturalist, palæontologist and active worker in science.

SCAPHIOCRINUS GORBYI, N. SP.

Plate XII, fig. 15, side view, the specimen is depressed.

Calyx short, bowl-shaped, wider than high, plates thick, convex, sutures deeply sunken at the angles; surface smooth. Basals sunken in the columnar cavity and not visible in our specimen. Subradials large, the lower margin curving into the basal depression, and below the middle part curving abruptly upward, nearly as high as wide. First radials pentagonal, gradually expanding between the lateral sides, wider than high, truncated the entire width above, convex longitudinally, slightly constricted in the middle part, sutures sunken, the lower angles depressed into little pits, and separated from the single brachials by a gaping suture. Brachials wider than long, lateral sides short, slightly constricted in the middle, upper sides long and steep. Arms ten, no division, rather small for the size of the calyx, first plates long,

constricted, second, third and fourth plates gradually shortening and constricted, above these the plates are cuneiform, and project at the larger side presenting a rugged aspect. Pinnules long, coarse and composed of long joints, azygous area covered with rather long plates. First azygous plate large, pentagonal, rests obliquely between the upper sloping sides of two subradials and the under sloping side of the first radial on the right, abuts one side against the second azygous plate, and supports the third azygous plate on the upper sloping side. Second azygous plate truncates a subradial, third, fourth and fifth plates arranged as in other species in this genus. Column subpentagonal near the calyx and composed of thicker and thinner plates.

A few plates of the proboscis are visible, at the upper end of our specimen, showing it extended as high or higher than the arms. The plates are large, longer than wide, convex longitudinally, and bear two peculiar teeth-like processes, centrally, on the left side of each. These processes are hollow and differ from all other plates I have ever seen.

Distinguished by the pits, at the angles of the plates in the calyx, and by the proportionally small arms.

Found in the Keokuk Group, at Boonville, Missouri, and now in my collection. The specific name is in honor of Prof. S. S. Gorby, the first State Geologist ever elected, in any country, by the votes of the people.

FAMILY CYATHOCRINIDÆ.

CYATHOCRINUS GURLEYI, N. SP.

Plate IX, fig. 4, showing azygous plate and arms, the arms are torn from the opposite side so as to expose the proboscis, and two holes are shown, at the top of the calyx, in the illustration.

Species rather above medium size; calyx bowl-shaped, one-half wider than high, sunken at the base; subradials protuberant below; sutures depressed between the radials; surface granular.

Basals forming a pentagonal disc, one-half wider than the diameter of the column, not visible in a side view. Subradials large, wider than high, convex, depressed toward the sutures, curving into the basal cavity and abruptly bending upward so as to leave the subcentral part quite tumid. Radials about the size of the subradials, as high as wide, convex toward the brachial sutures, most abruptly depressed toward the lateral sutures; separated from the brachials by a slightly gaping suture; articulating scar longitudinally subovate, about half the width of a plate, very concave or round below, and having the face directed obliquely outward, at an angle of about forty-five degrees. The brachials are rounded externally, there is only one in the ray on the right of the azygous plate while there are three in the right lateral ray and three in the ray on the

left of the azygous plate; the axillary brachials are about the same size; the first one in each compound series is thin, the second one nearly or quite half as high as wide.

The arms are round externally, taper very slowly between the bifurcations, and are composed of rather long plates separated by transverse sutures. The first bifurcation takes place in some of the arms on the third plate, and in others on the fourth plate; the second bifurcation takes place on the fourth, and in others on the sixth, and in others on the eighth plate. This gives to the species forty arms; but there may be another bifurcation in part or all of the rays which is not shown in our specimen.

Azygous plate large, standing nearly upright, extending higher than the radials, transversely truncated above for a large second plate, and at the upper lateral angles for small plates. Proboscis composed of longitudinal series of polygonal plates, four of which series are shown in our specimen. It tapers upward to near the top, then expands a little; the top is covered with polygonal plates. Our specimen preserves part of the top, which may be distinguished in the illustration, but the arms are broken off, which indicates they extended beyond the proboscis, though they may not have covered or protected it. Column medium size, round.

Found in the Keokuk Group, in Washington County, Indiana, and now in the collection of Wm. F. E. Gurley.

CYATHOCRINUS BENEDICTI, N. SP.

Plate IX, fig. 7, view showing azygous plate.

Calyx subturbinate, height and width subequal, truncated below, plates thick, convex; sutures depressed and angles sunken; surface granular. Basals small, forming a low pentagonal cup. Subradials large, not of uniform size, height and width subequal, highly convex, obscure or undefined ridges radiating toward the middle of the sides, angles deeply sunken. Radials larger than the subradials, wider than high, sunken at the angles and the lateral sutures, except at the projecting rim at the top, most convex at the brachial sutures and the rim or projecting flange on the superior lateral sides. Articulating scar about two-thirds the width of a plate, broadly rounded and directed obliquely outward. Azygous plate rather large, truncates a subradial and gradually expands to the top of the first radials. The plates are very thick at the top of the calyx, and the thickness is maintained for the support of the interradials by a projecting flange. The angles for the support of the interradials are quite obtuse. Arms and column unknown.

Distinguished by the thick, highly convex plates and deeply sunken angles, and also by the peculiar projecting flange at the upper lateral sides of the radials, where the interradials are supported.

Found by A. C. Benedict, in the Niagara Group, at Hartsville, Indiana, and now in his collection. The specific name is in his honor.

CYATHOCRINUS SP.

Plate IX, fig. 8, view showing the basals and subradials.

This specimen is illustrated for the purpose of calling attention to it. There is not enough of it to justify giving it a name, though it belongs to an undescribed species. Calyx bowl-shaped, plates highly convex and radiately sculptured in undefined waves toward each side; sutures depressed and angles deeply sunken. Basals form a low pentagonal cup with sharply defined angles and depressed sutures. Subradials very large. Column large and having a very large five-rayed, petaloid, columnar canal.

Found in Niagara Group, at Hartsville, Indiana, and now in the collection of A. C. Benedict.

CYATHOCRINUS LABYRINTHICUS, N. SP.

Plate XII, fig. 11, shows part of the large arm and numerous smaller ones; fig. 12, shows part of the larger arm, and the one on the left wrapping around the calyx; fig. 13, shows the large first radial opposite the azygous area, which bears the larger arm; fig. 14, shows some of the numerous arms.

Calyx small in proportion to the arms, somewhat cup-shaped or sub-turbinate, but having unequal sides; sutures indistinct; surface smooth.

Basals form a shallow cup about two and a half times as wide as the diameter of the column. Subradials about as wide as high and differing slightly in size. First radials unequal in size and not uniform in shape. The first radial opposite the azygous side is the larger one, extends higher than the others and bears the larger arm; it is flattened or depressed and thus adds to the irregularity of the calyx; the arm rises perpendicularly from the calyx, is composed of long, round, constricted plates, bifurcates on the third plate, both divisions again and again dividing on the third or fourth plates above each bifurcation until there are more than forty arms in this ray. The first radial on the right of the one just described is on the left of the azygous area; it is short and wide and has the arm cicatrix facing outward; the arm is directed outward almost at right angles to the calyx and bifurcates on the second plate, one branch of which is wrapped around the calyx, crossing the base of the first large radial above described and bifurcating about every second plate, and each branch dividing in like manner until there are forty or more arms in this division; the other division divides in like manner until there are eighty or more arms in this ray. The radial on the left of the large one first above described, and also the one on the right of the azygous area, are similar to the one described on the left of the azygous area, and the arms are similar and are thrown around the calyx, sometimes completely covering it, and directed upward forming a network or labyrinth of arms around the proboscis and extending beyond it. The other radial and arm is similar to the one first above described,

though a little smaller. I have found it impossible to count the number of arms, in any of the specimens collected, but I would estimate the number somewhere between three hundred and four hundred, probably nearer the latter figure than the former.

The first azygous plate truncates a subradial and is about one-third its size. Part of the proboscis is visible at the top of the specimen illustrated in figure 12. It is composed of moderately large polygonal plates and is compressed or flattened in all our specimens so I can not determine its normal shape, but I infer it was cylindrical in its upper extension. Column round, of moderate size, composed of rather thick plates radiately furrowed near the outer circumference, and possessed of a small internal canal.

Found in the Keokuk Group, at Boonville, Missouri, by R. A. Blair, and now in my collection.

FAMILY PLATYCRINIDÆ.

PLATYCRINUS ALABAMENSIS, N. SP.

Plate IX, fig. 5, side view; calyx flattened.

Calyx cup-shaped, subpentagonal, wider than high, sutures distinct, surface smooth. Basals forming a shallow disc, and having a rather wide, circular ridge surrounding the column, which extends below the point of the columnar attachment; upper faces for the support of the radials concave; keels mark the sutures of the basals and terminate in small tubercles, at the columnar cavity. First radials about as wide as high, slightly expanding above, convex longitudinally, in the central part; articulating facets for the second radials concave, about half the width of the plates; upper faces inclined toward the sutures, so as to form rather sharp angles. Second radials triangular, axillary, and rising in the central part, so as to completely separate the first arm plates. Each arm bifurcates on the second plate, and one of these, in each of the five radial series, again bifurcates on the second plate, which gives to the species twenty-five arms. The arms consist of a single series of long plates, constricted in the central part and expanded at the sutures, until about the fourth or fifth plate above the last bifurcation, when they change into a double series of interlocking plates. The pinnules are very coarse and long-jointed, especially where the arms consist of a single series of plates, and so numerous as to give the head a very bushy aspect. Column quite small, round at the base of the calyx, and composed of alternately thicker and thinner plates. The interradianal that rests between the upper sloping sides of the first radials, is exposed in a side view.

Found in the Subcarboniferous rocks, at Huntsville, Alabama, and now in my collection.

FAMILY RHODOCRINIDÆ.

GONIASTEROIDOCRINUS TUBEROSUS, LYON & CASSEDAY.

Plate IX, fig. 11, side view, showing the vault and pendulous arms, exposing the arm furrows.

This species is illustrated for the purpose of correcting some erroneous observations that have been made about the arms and arm furrows, and for the purpose of showing that if the arms were turned up, they would be like arms in other genera and species of crinoids, and that they differ only in the fact that they are directed downward with the arm furrows outward. The arm furrows are well illustrated in the figure, with the pinnules directed downward. The back of the arms is against the calyx and the furrows and pinnules on the outside. If the arms were lifted up the furrows and pinnules would be over the vault, hence the only difference between the arms of this species and those of other species is that they are directed downward instead of upward. Probably they were capable of lifting themselves up to a greater or less extent, but on account of the expanded vault and so-called pseudo-brachial appendages they could not straighten up or curve over and protect the vault. Some species in this genus have upright arms or those that curve over upon the vault, as *G. spinigerus*, *G. spinosus* and *G. tuberculosis*. I have never seen either species, but Hall figured the two former on a plate dated 1872.

Meek & Worthen, in describing this genus, in Vol. II, Ill. Geo. Sur. p. 219, said :

"True arms, very long, slender, pendulous, and more or less branching, supporting minute, ascending tentacula."

They illustrated the vault, and arms bent downward below it, with the backs of the arms outward, on page 220, which erroneous cut, so far as the arms are concerned, I copied into North American Geology and Palæontology, p. 250. They said :

"The parts in this type homologous with the arms in Rhodocrinus and other crinoids, instead of being stout and erect, as in Rhodocrinus, are very slender, long, pendent organs (see * of cut B, fig. 19), having much the delicacy and appearance of tentacles. In the above cut, the minute true arms of the typical species of *Goniasteroidocrinus*, are seen to branch so as to form nine to each ray. The cut shows only their outside, in which we have seen no indications of ambulacral furrows; but these may have been obliterated in cleaning the specimen, or possibly they may present the anomalous character of being on the *under side*, and thus differ from all other known crinoids."

It will be observed, the arms do not support "minute ascending tentacula;" but on the contrary, bear pinnules directed downward and

outward just as arms do in other crinoids when turned downward. The arms do not have "the delicacy and appearance of tentacles;" but they are reasonably large, composed of a double series of interlocking plates and bear pinnules composed of long joints. Meek & Worthen's cut is erroneous, because it should show a double series of plates below the bifurcations instead of a single series; and the arms are represented with the furrows against the calyx instead of being turned outward.

The mistake of Meek & Worthen respecting the position of the arms was made almost ludicrous, by Wachsmuth & Springer, who accounted for the arms, in the position that Meek & Worthen had erroneously supposed them to be placed in this manner:

"This peculiar structure is easily explained if we consider that the pendent position of the arms in these species is due, not to a forcible bending out of their normal attitude, but to the peculiar construction of the brachial parts, which directs them downward and makes this their natural position; and, while it appears as if the arm structure was entirely reversed in these two types (*G. typus* and *G. tuberosus*), this is really not the case, the furrow is still on the ventral side, but the arms have rotated on their axes so as to bring it on the inner side when hanging down." See their article in Proc. Acad. Nat. Sci. Phil., 1878, p. 262.

I can not understand how any one ever came to the conclusion that a crinoid arm could rotate on its axis. The first plates in an arm are never transverse, beside if they were, the plates were always held in position by ligaments and if the arms were made to rotate the ligaments would necessarily be broken and the arms twisted off. But the facts effectually get away with the erroneous supposition and philosophy.

I take pleasure in correcting any mistake I find in the palæontological part of the Geological survey of Illinois, because I was an assistant on the work on the 7th volume and was frequently consulted by the late State Geologist, Prof. A. H. Worthen, in regard to palæontological subjects and received numerous courtesies from him, during many years of friendly intercourse. I was also the personal friend of Prof. Meek, who adopted and published the first new variety of fossils I described nearly twenty years ago. There is no palæontological work with which I have more cause to be familiar than with that contained in the Geological Survey of Illinois. And yet, in a recent diatribe, by an English school-master, named P. Herbert Carpenter, I am told that "It is not too much to expect" that I should make myself acquainted with the "Illinois Geological Reports."

FAMILY ACTINOCRINIDÆ.

BATOCRINUS AGNATUS, N. SP.

Plate VIII, fig. 1, symmetrical side; fig. 2, azygous side, specimen depressed.

Species medium size. Calyx turbinate or obconoidal, truncated below, higher than wide; arm bases projecting, and openings directed upward; plates convex; surface granular.

Basals three, forming a pentagonal disc about twice as wide as the diameter of the column and abruptly bent upward. First primary radials wider and larger than the second and third together, three heptagonal, two hexagonal, upper face arcuate for the inferior side of the succeeding radial, and the upper lateral sides support the first interradials. Second primary radials quadrangular, about one-half wider than long. Third primary radials wider and larger than the second, pentagonal, the lower lateral sides spreading so as to give the greatest width, at the middle part of the plates, at the angles made with the upper sloping sides. Secondary radials two by ten, the upper the larger, but both variable in size and shape. The ray on the left of the azygous side bears four tertiary radials and four arms, the ray opposite the azygous side bears none and has two arms, the other three arms have three tertiary radials and three arms each, there are, therefore, fifteen arms, in this species. A single plate follows each tertiary radial, and above this the arms are constructed of interlocking plates bearing long jointed pinules.

Regular interradians three, one large, having nine sides, the other two small. Azygous interradians eight, the first one the largest plate in the calyx, and in line with the first primary radials; there are three in each of the two following ranges, and one above, projecting an angle up between the under sloping sides of tertiary radials. Proboscis projecting beyond the ends of the arms. Column round.

This species most resembles *Batocrinus jucundus*, but is distinguished by having only fifteen arms while the latter has sixteen. There are other minor differences that may be noticed by comparison.

Found in the Keokuk Group, on Indian Creek, in Montgomery County, Indiana, and now in A. C. Benedict's collection.

AGARICOCRINUS INDIANENSIS, N. SP.

Plate VIII, fig. 5, symmetrical view.

Species medium size, base concave, the depression including the basals and first and second radials, surface granular. In the ray opposite the azygous side, the third radial is pentagonal, tumid and has the outer face somewhat angular; the superior sloping sides support the secondary radials. There are three, thin, secondary radials in each series; the

first is subquadrangular, about two and a half times as wide as high, and abuts slightly upon the first interradiar, and more upon an interradiar in the second range; the second is pentagonal, three times as wide as high, abuts an interradiar, and supports upon the upper face a third secondary radiar and also part of one of the first arm plates; the third one on the left is somewhat triangular in outline, but as it supports upon the upper sloping sides the two arm plates, it has four sides; the third one on the right is distinguished from the one on the left by abutting against an interradiar, and consequently, has five sides. Arms twelve, three in each ray adjoining the azygous side, and two in each of the other rays; all of them taper rapidly. They are composed of a double series of short, wide plates, abruptly wedgeformed at their junction. There are about fifty plates in each series. Pinnules long and compact.

The first regular interradiar extends nearly as high as the third radiar and supports two, long, narrow plates, and a fourth interradiar is inserted in the range, commencing at the top of the first secondary radiar. This is the structure of the interradiar area on the right of the radiar series above described; the other interradiar areas are not determinable from the specimen at hand. Some of the plates of the vault are visible between the arms of our specimen and indicate a high summit. Column round and rather small.

Found in the Keokuk Group, of Washington County, Indiana, and now in the collection of A. C. Benedict.

AGARICOCRINUS GORBYI, N. SP.

Plate VIII, fig. 9, azygous view, a piece of a column in the azygous area.

Species large, base moderately concave, the concavity not extending beyond the second radials; plates convex or rounded; surface granular. Basals small. Second radials quadrangular, slightly expanding, nearly as high as wide. Third radials pentagonal and hexagonal, wider than high, and supporting on each upper sloping side secondary radials. In the ray opposite the azygous side, and in each of the two lateral rays, there are two secondary radials, in each series, from which the arms arise, making six arms, in these three series. In the ray, on the right of the azygous area, there is a single secondary radiar, which is axillary, and supports one tertiary radiar in the series adjoining the area and two tertiary radials, in the other series which are axillary. There are, therefore, four arms in this ray. In the ray on the left of the azygous area, there is a single secondary radiar, which is axillary, in the series adjoining the area. It supports two tertiary radials on the right and one on the left, from which the arms arise. There are two secondary radials supported on the left side of the third radiar, from which an arm

arises. There are, therefore, three arms in this ray. This gives to this species thirteen arms. The arms are large, very long, and composed of a double series of short plates, abruptly wedged, at their junction. Pinnules long and compact.

There are three regular interradians in each area; the first one is short, not extending as high as the third radials; it is followed by two long narrow plates. The azygous area is wide, and so far as shown in our specimen, is covered with large plates. The column is elliptical near the head, but, probably, round below, and very little larger than an arm.

Found in the Keokuk Group, on Indian Creek, in Montgomery County, Indiana, and now in the collection of A. C. Benedict.

AGARICOCRINUS SPLENDENS, MILLER & GURLEY.

Plate VIII, fig. 10, vault, with azygous area on the right.

This species was described, in Vol. XIII of the Journal of the Cincinnati Society of Natural History, in April, 1890, from the Keokuk Group, at Crawfordsville, Indiana, but it seems it should have been credited to Indian Creek, which is two or three miles from Crawfordsville. The vault was not described. The vault is low. The series of tumid plates that usually extend from the arms to the summit, in species of this genus, are not regular in this species, as will be observed from the illustration. A single row of three plates will be seen on the left of the figure, extending from a two armed ray to the larger plate that crowns the summit; while the three armed ray, on the left of the azygous area and in the center of the figure has two tumid plates over the arm passages, and flattened plates toward the summit. The regular interradians are followed by two ranges of three small plates, and above these there are a few plates irregularly disposed, before reaching the summit plate. The azygous area is quite convex and plates rather large below the opening; about three plates in a range crosses it, though they are not exactly in line; between the opening and the summit plate, the plates are smaller. The opening is directed upward.

Now in my collection.

AGARICOCRINUS DISSIMILIS, N. SP.

Plate VIII, fig. 11, side view of a vault, showing three arm openings in one radial series, the series on the right of the illustration is on the left of the azygous area and has four arm openings.

Body robust, base concave, the depression including the basals, primary radials and first secondary radials; surface strongly granular. The third radials are pentagonal, nearly as high as wide, with steep upper sloping sides. The one on the left of the azygous area supports two secondary radials on each side. The first secondary radial on the right

of the series is a peculiarly wide, curved, hexagonal plate, resting upon the upper sloping side of the third primary radial, abutting two secondary radials on the left and extending to the first tertiary radial; while it supports on top, the second secondary radial and unites with the interradial on the right. The second one is axillary, though it has only four sides, which is caused by the first one curving up to a tertiary radial and thus forming a sharp angle on the left side. There is one tertiary radial on the right and two on the left which support the arms. The first secondary radial in the left series is quadrangular, and about two and a half times as wide as high. The second one is a wide, curved, hexagonal plate abutting on the first secondary and first tertiary radial on the right and the interradial on the left and supporting upon each of the upper sloping sides two tertiary radials. There are, therefore, four arms in this series. The third primary radial in the left lateral series or to the left of the one above described, supports two secondary radials on the right and three on the left. The first one on the right supports the second and also abuts upon a tertiary radial so as to prevent the second from extending to an interradial. The second though axillary has only four sides, which is caused by the first extending to a tertiary radial and thus forming a sharp angle on the right side. There are two tertiary radials in each series. The first secondary in the left series, is a wide hexagonal plate standing somewhat upright and abutting two secondary radials and one tertiary on the right. It is followed by two thinner plates that support an arm. There are, therefore, three arms in this series.

There are only two arms in the series opposite the azygous side. Thus there are nine arms in three series. The other two series are injured, in our specimen, but it is evident the one on the right of the azygous area had three arms, and the other one had two or three arms, which gives to the species fourteen or fifteen arms. The arms are composed of a double series of interlocking plates.

There is only one regular interradial, which is an extremely elongated, polygonal plate extending from the first primary radials to the plates of the vault. The azygous area is wide and covered by numerous plates.

The vault is high, tumid plates extend from the arm series to the summit plate and the interradial areas are flat or depressed. A single row, the first one being quite large, covers the two armed series, and a double row covers each of the other series. The summit plate is very large and surrounded by six large, tumid plates and three smaller ones that separate it from the azygous opening.

It has been usual for authors to call the secondary radials, in this genus, brachials, but the secondary and tertiary radials, in all the species, enter into and form part of the calyx; hence I have used the

same names I would in describing an *Actinocrinus*, *Batocrinus* or other fossil belonging to this family.

Found in the Keokuk Group, in Allen County, Kentucky, and now in the collection of A. C. Benedict.

SACCOCRINUS GORBYI, N. SP.

Plate IX, fig. 2, lateral view, the azygous area being on the right; fig. 3, summit view, the outline of the plates being destroyed on the right. The specimen is a cast.

Calyx bowl-shaped, rounded below, most rapidly expanding immediately below the arms; width nearly twice as great as height. Plates of the cast bear a central tubercle. Basals form a pentagonal disc, about twice as wide as the diameter of the column. First primary radials wider than high, two heptagonal and three hexagonal. Second primary radials a little smaller than the first, two hexagonal, and the two adjoining the azygous area and the left lateral one pentagonal. Third primary radials nearly as large as the second, three pentagonal and two hexagonal and bearing upon the upper sloping sides single secondary radials.

Secondary radials hexagonal and pentagonal and bear upon the superior sloping sides single tertiary radials, except in the rays adjoining the azygous area, where there are two tertiary radials. The tertiary radials unite, cutting off all the interradials, including the azygous plates, from direct connection with the plates of the vault.

There are four plates in each of three of the regular interradial areas and five in the other one. The first one is smaller than a second primary radial, and is followed by two smaller ones, and these by a single plate, except in the area having five plates, and in that there are two, one of which is higher than the other. There are seven plates in the azygous area; the first one is in line with the first primary radials and rather larger than any of them; it is followed by three smaller plates, and these by three still smaller ones.

Vault highly convex or subconical, having a height about equal to that of the calyx and spreading like a canopy over the top of it. It is covered with polygonal plates, the central ones being the larger. The largest plate is subcentral, heptagonal and surrounded by seven sub-equal plates. The cast bears a prominent subcentral tubercle.

Distinguished from other species by the general form, remarkably high and spreading vault, when compared with the size of the calyx, and by the union of the tertiary radials cutting off all connection between the interradials and the plates of the vault. In the latter respect it is like *Batocrinus*.

Found in the Niagara Group, at Adams, in Decatur County, Indiana, and now in the collection of Prof. S. S. Gorby. The specific name is in honor of Prof. Gorby.

ALLOPROSALLOCRINUS GURLEYI, N. SP.

Plate X, fig. 1, lateral view; fig. 2, basal view.

Species small; calyx concave; columnar pit depressed; sutures distinct; interbrachial spaces sunken so as to mark the separation of the five radial series.

Basals three, having an hexagonal outline within the columnar depression. First primary radials one-half wider than long, rounding slightly into the columnar cavity, upper faces arcuate, three heptagonal and two hexagonal. Second radials quadrangular, three or four times as wide as long. Third radials a little wider and larger than the second, pentagonal, axillary, about twice as wide as high. Secondary radials four by nine, and one by one; the first one short, trapezoidal; the second one short but wide and curving around into the sunken interbrachial areas and uniting with the secondary radials on either side; the third one short and curving around the radial extension and uniting with the plates of the vault; the fourth one very short and apparently axillary, for the support of a double series of arm plates. The radial series on the right of the azygous area has, upon the left sloping side of the third radial, a single secondary radial which is axillary and bears upon each of its upper sloping sides four tertiary radials, which are like the secondary radials in other series. There are, therefore, eleven arms.

There is one regular interradian in each area, which has ten sides. It is a large plate. There are four azygous interradians; the first one is in line with the first primary radials and is longer than either of them; it is followed by one plate on each upper sloping side, and another that truncates its upper face.

Vault pyramidal and covered with more or less convex tumid and spinous, polygonal plates. The interbrachial depressions are continued up the vault so as to give it a subpentagonal outline, and the spinous plates are in line with the brachial series. Two or three plates are broken from one side of the summit of our specimen, but no evidence of a proboscis is preserved and its existence may well be doubted.

The type of the genus, (*Alloprosallocrinus conicus*), was described as having only two primary radials in each series, and a specimen in my collection agrees with the description in that respect. If such is a correct diagnosis of the type, we need look no further to distinguish it from the species here described, which has three primary radials. If, however, the second and third radials are ankylosed, in Lyon & Casseday's species, this one may be distinguished from it by its concave calyx, deeply sunken interbrachial spaces, more numerous secondary radials, proportionally smaller and shorter pyramidal vault, without spinous plates in the interbrachial areas, as well as by other differences manifest on comparison.

Found in Brown County, Kentucky, in what is called the Keokuk Group, but I have not seen the locality, and suggest the possibility that it may be the Warsaw Group, and now in the collection of Wm. F. E. Gurley, in whose honor I have proposed the specific name.

RETMOOCRINUS LYONANUS, N. SP.

Plate X, fig. 3, side view showing azygous plates; fig. 4, basal view, part of two of the plates being broken away.

Species rather large; calyx more than twice as wide as high; base expanded; radial series sharply angular and more or less nodose, in the central part of each plate; abruptly expanded from the third radials; arm openings directed horizontally; and plates nodose. Surface probably granular.

Basals three, forming a subcircular, expanded disc, having a diameter one-fourth greater than the diameter of the calyx at the base of the first radials, and being broadly concave below, and having the plates radiately furrowed for the attachment of the round column. First primary radials more than three times as wide as long and bearing a high, sharp, longitudinal ridge in the central part, which is continued across the primary, secondary and tertiary radials to the free arms; upper face arcuate. Second radials quadrangular, three times as wide as long. Third radials pentagonal, more than twice as wide as long. Two secondary radials in each series; the first one more than twice as wide as long and pentagonal by reason of abutting against two interradians at one end; the second one about three times as wide as long, axillary, and supporting upon each upper sloping side the tertiary radials. Tertiary radials three in each series; they are very short and wide; the first plates unite around the calyx except at the azygous area, where the circle is broken by the interposition of a single plate; the second unite in a circle around the calyx; the third are united only in pairs. The five radial series are separated by interbrachial depressions, the most marked being over the azygous area, and each series has four arm openings and four arms. There are, therefore, twenty arms in this species. The arms are not preserved in our specimen.

Regular interradians two, one above the other; the first one is rather large, has nine sides; and bears a strong central tubercle; the second is heptagonal, about half as large as the first, and supports on its two upper sloping sides the under sloping sides of the first tertiary radials. Azygous interradians five; the first one is heptagonal, as large or larger than a first regular interradian and bears a very strong central tubercle; it is followed by three plates, about half as large and each bearing a central tubercle; above the central one of these, a single plate separates the first tertiary radials, and supports upon its two upper lateral sides the

under sloping sides of the second tertiary radials. The vault is much larger than the calyx, high, conoidal, covered with polygonal plates, each one of which is produced in an obtuse spine. The proboscis is broken off from our specimen, as shown in the illustration. Column unknown.

This species is so distinct from all others in the genus, that it is unnecessary to make a comparison for the benefit of any American student, and life is too short to undertake to instruct a weak-minded Assistant Master at Eton College.

Found in the Keokuk Group, at Little Bear River, Kentucky, and now in the collection of Wm. F. E. Gurley. The specific name is in honor of the late distinguished palæontologist, Sidney S. Lyon, whose son, Victor W. Lyon, is the well known geologist and palæontologist of Jeffersonville, Indiana.

BATOCRINUS SPERGENENSIS, N. SP.

Plate X, fig. 5, side view; fig. 6, basal view; the specimen is slightly compressed.

Species above medium size; calyx basin-shaped, three times as wide as high; radials ornamented with a small rounded ridge from the basals to the free arms; arms projecting and openings horizontal; surface irregularly sculptured and coarsely granular.

Basals three, forming a hexagonal disc, which bears a hexagonal, flattened rim that extends below the point of columnar attachment, and within which, there is a concave depression radiately furrowed for the attachment of the column. First primary radials one-half wider than high, upper face arcuate for the reception of the second radials. Second radials quadrangular, as large as the first and about as long as wide, though not quite as wide as the first. Third radials heptagonal, by reason of abutting two interradians at either end, except those adjoining the azygous area which are hexagonal; they are wider than the second radials but not quite as long, and they support on the upper sloping sides the secondary radials. There are two secondary radials in each series, the first is quadrangular, wider than high; the second is axillary and supports upon each of the upper sides two tertiary radials. Tertiary radials short; the first unite around the calyx, except at the top of the azygous area, where a small plate is interposed; the second unite with each other, in each of the five radial series, and with the plates of the vault; they are axillary and bear either a double series of arm plates or bifurcating arms. The arms are not preserved in our specimen. There are twenty arm openings, four for each radial series.

Regular interradians six; the first one is large and followed by two smaller ones and these by two still smaller that are of unequal size, and above these, there is a small elongated plate that supports, upon its upper lateral sides, the second, tertiary radials. Azygous interradians ten;

the first one is in line with the first primary radials, it is followed by three plates and these by three of nearly the same size, and these by two, one of which is on the right side of the area and below the under sloping side of the other, the higher one is in line above the first plate, and it is followed by a narrow elongated plate, that separates the tertiary radials and unites with the plates of the vault. Vault convex and covered with numerous, unequal, convex, coarsely granular, polygonal plates. Proboscis subcentral, rather small, length unknown.

Any citizen of Indiana will be able to distinguish this species from all others in the genus, and we have no Eton Colleges, in this country, where royalty supports effeminate school teachers, who need comparisons made for them, in order to comprehend specific differences.

Found in the Warsaw Group, at Spergen Hill, Indiana, and now in the collection of Wm. F. E. Gurley.

BATOCRINUS DECORIS, N. SP.

Plate X, fig. 7, side view, fig. 8, basal view; some of the plates in the azygous area are anchylosed and therefore not indicated.

Species above medium size; calyx depressed, nearly flat; radials form angular ridges from the basals to the free arms; interrarial areas flattened, though the plates are somewhat convex and bear small tubercles or coarse granules; arm openings horizontal.

Basals three, forming a rather large disc, which bears a round or obscurely hexagonal rim extending below the radial ridges, and within which there is a deep concavity for the columnar attachment. First primary radials about four times as wide as long. Second radials quadrangular, and about three and a half times as wide as long. Third radials pentagonal, nearly three times as wide as long and support the secondary radials. There are two secondary radials in each series; the first usually abuts two interradians and therefore becomes pentagonal, it is about twice as wide as long, the second is more than twice as wide as long, axillary, and supports upon each upper sloping side three tertiary radials. The tertiary radials are short and wide; each of the first ones abut an interrarial; the second unite around the calyx, cutting off connection between the azygous area and the vault; the third unite in pairs and with the plates of the vault; they are axillary and bear either a double series of arm plates or bifurcating arms. The arms are not preserved in our specimen. There are twenty arm openings, four for each radial series.

Regular interradians four; the first one is large, bears a central tubercle, and is followed by two of unequal size and length, and beyond the longer of these, there is a narrow elongated plate that separates the tertiary radials and inserts an angle between the under sloping sides of

the second tertiary radials. Azygous interradials eight, and possibly nine; the illustration shows only five, but the lower central one consists of two anchylosed plates and each of the upper ones should be divided. Vault high, conoidal, covered with unequal, more or less convex, polygonal plates, three of which, above each of the five radial series, is produced into an obtuse spine. The proboscis is subcentral, and where broken off, in our specimen, rather large; length unknown.

Found in the Warsaw Group, at Spergen Hill, Indiana, and now in the collection of Wm. F. E. Gurley.

BATOCRINUS MEDIOCRIS, N. SP.

Plate X, fig. 9, lateral view, showing the ray having seven arms, including the small double arm.

Species rather above medium size; calyx obconoidal, about twice as wide as high; radial ridges small; interradial areas slightly depressed; arms projecting and openings outward; surface delicately sculptured.

Basals three, forming a hexagonal disc, one-half wider than the diameter of the column, which bears a circular rim that projects below the point of columnar attachment. First primary radials a little wider than high, upper face arcuate for the reception of the second radials. Second radials quadrangular, more than twice as wide as high. Third radials pentagonal, larger than the second, more than twice as wide as high, axillary, greatest width below the middle, at the angles formed by the junction of the lower expanding and upper sloping sides. In one lateral ray there are four secondary radials upon one side bearing a double arm and two secondary radials on the other side, followed by two tertiary radials, upon each of its upper sloping sides, from one of which a single arm arises and from the other two arms, making five arms in this radial series. The single arm is between the double arms. In the other lateral ray there are two secondary radials upon each side followed by three tertiary radials, in each of the four series, the one on the right supports a double arm, the next one a single arm, the next a double arm and the next a small or rudimentary arm, making seven arms in this radial series. If the small double arm is regarded as abnormal, then the arms will be substantially the same as they are in the other lateral ray. There are three rays on each side of the azygous area which bifurcate, making six arms in each series; in the distal rays there are four secondary radials, in the proximate rays three, the last being axillary and bearing on one side two tertiary radials and on the other three, the arms bifurcate on the first plate. The arms bifurcate on the fourth secondary radials, in the series opposite the azygous area, giving it four arms. There are, therefore, twenty-eight arms in this species, or if the

small double arm, in one of the lateral series, is deemed abnormal then twenty-six arms. Arms large, long, round and composed of a double series of interlocking plates. Pinnules long and dense.

Regular interradians five, the first one large, followed by two smaller ones of unequal size and these by two smaller ones also of unequal size. Azygous interradians nine, the first one in line with the first primary radials, octagonal, and the largest plate in the calyx; it is followed by four plates and these by three smaller ones, above which, there seems to be only one. Vault convex. Column round.

This species is distinguished by the structure of the lateral rays, by the number of arms, and by the four plates in the second range in the azygous area. In other particulars it is much like *B. boonwillensis*.

Found by R. A. Blair, in the Keokuk Group, at Boonville, Missouri, and now in my collection.

BATOCRINUS GORBYI, N. SP.

Plate X, fig. 10, side view, with part of the arms removed showing calyx, vault and part of the proboscis.

Species medium size; calyx globose; height and width about as eight to eleven; arm bases projecting and openings directed upward; surface of plates convex, transversely angular; sutures beveled.

Basals three, forming a hexagonal disc, two-thirds wider than the diameter of the column, truncated or flattened below, standing upright, exposing a height about equal to the distance from the column to the margin. First primary radials very little wider than high, upper face slightly arcuate, sutures deeply beveled, and bearing a sharp, transverse, central ridge. Second radials quadrangular, about one-fourth wider than long and having a central transverse angular ridge. Third radials wider and larger than the second, three hexagonal and two pentagonal, greatest diameter below the middle, at the angles with the upper sloping sides. Secondary radials two by ten, generally wider than long, the upper the larger, but both of them of variable size and shape in the different series; nine of them bear tertiary radials, but an arm rises from the second secondary radial, in the series opposite the azygous side. Tertiary radials one by eighteen. The arms do not bifurcate. There are thus nineteen arms composed of a double series of interlocking plates, from the first plate that follows the tertiary radials and the secondary radial. The arms are long and rounded externally. Pinnules numerous and composed of ten or twelve long joints.

Regular interradians three, the first one large and having nine sides, the other two smaller and one only about half as large as the other. Azygous interradians nine, the first one is heptagonal, rests upon the basal plates, in line with the first primary radials, and is the largest

plate in the calyx; it is followed by three plates, and these by three smaller ones, and the latter by two still smaller. Vault high, conoidal, and covered with convex polygonal plates. Proboscis almost central, small, cylindrical, extending beyond the arms and covered with rather large, slightly convex plates. Column round, medium size and composed of alternately thicker and thinner plates.

Distinguished by its globose calyx, conoidal vault, beveled sutures, transversely angular ridge in the central part of the plates, and number of single arms. This is a marked species approaching *Eretmocrinus* in form.

Found by R. A. Blair, in the Keokuk Group, at Boonville, Missouri, and now in my collection. The specific name is intended as a compliment to Prof. S./S. Gorby.

BATOCRINUS CRAWFORDSVILLENSIS, N. SP.

Plate X, fig. 11, side view, showing top of vault, and proboscis broken off; fig. 12 azygous view.

Species rather below medium size; calyx obpyramidal, truncated below, one-half wider than high; each radial series bears an angular ridge from the basal plates to the free arms, the axillary plates being tumid; interradian areas depressed and plates convex; arm openings directed upward; surface more or less sculptured.

Basals three, forming a disc about twice the diameter of the column and bearing a subcircular rim projecting below the point of columnar attachment; truncated below and having a deep cavity for the insertion of the end of the column. First primary radials sculptured, one-half wider than high. Second radials quadrangular, one-half wider than high. Third radials pentagonal, one-half wider than high, axillary, and support on the upper sloping sides the secondary radials. There are two secondary radials in each of the lateral rays, the second ones being axillary, and bearing upon each upper sloping side four tertiary radials, the last one of which is axillary and bears two arms. This gives to each lateral ray eight arms. In the ray opposite the azygous area there are five secondary radials, the fifth ones being axillary and each bearing two arms, which gives to this ray four arms. There are two secondary radials adjoining the azygous area on each side, the second ones being axillary and bearing upon one upper sloping side three and upon the other four tertiary radials, the last ones of which are axillary and bear two arms; there are five secondary radials on the distal side of each third primary radial adjoining the azygous area, the fifth ones being axillary and each bearing two arms. This makes six arms in each ray adjoining the azygous area and gives to the species twenty-four arms.

The arms are delicate, reach but little beyond the summit of the vault, and are composed of a double series of small plates. Pinnules small.

Regular interradials three, the first one large and tumid, the other small and convex, one extends higher than the other. Azygous interradials six, the first one heptagonal, in line with the first radials, the largest plate in the calyx, tumid and sculptured; it is followed by three plates of moderate size and above these there appear to be two small ones. Vault highly convex, almost equaling the calyx in size and covered with large, tumid, polygonal plates. Proboscis subcentral, evidently short.

Found in the Keokuk Group, at Crawfordsville, Indiana, and now in the collection of Prof. S. S. Gorby.

BATOCRINUS BOONVILLIENSIS, N. SP.

Plate X, fig. 13, showing the right lateral series.

Species large; calyx turbinate, rapidly expanding, twice as wide as high; each radial series bears an angular ridge from the basal plates to the arms; interradial areas flattened; arm openings directed upward; surface granular.

Basals three, forming a subcircular rim, a little wider than the diameter of the column and projecting below the point of columnar attachment. First primary radials wider than high, upper faces slightly arcuate for the reception of the second radials. Second radials quadrangular, twice as wide as high. Third radials small, more than twice as wide as high, the one on the left of the azygous area hexagonal, the others pentagonal and support on the upper sloping sides the secondary radials. There are two secondary radials in each of the lateral rays and three in the rays adjoining the azygous area and in the ray opposite thereto. In the lateral rays, there are four tertiary radials in one outer series and three in the other, and two in each of the inner ones; from the latter only a single arm arises, but the arms bifurcate in the former, making six arms in each lateral series. There are three rays on each side of the azygous area which bifurcate, making six arms in each series; in the distal rays there are four secondary radials, in the proximate rays three, the last being axillary and bearing on one side two tertiary radials and on the other three; the arms bifurcate on the first plate. The arms bifurcate on the first plate above the third secondary radials in the series opposite the azygous area, giving it four arms. This makes twenty-eight arms in this species. Arms large, long and composed of a double series of interlocking plates. Pinnules long and dense.

Regular interradials five, the first one large, two in the second range and two smaller ones above, one of which projects high between the adjacent radials. Azygous interradials nine, the first one heptagonal, in

line with the first radials and the largest plate in the calyx; it is followed by three plates, and these by four smaller ones, and the latter by a single one still smaller. Vault convex, covered with convex polygonal plates and bearing a long, small proboscis. Column round.

This species is distinguished by the angular ridges on the radial series, flattened interrarial areas, by the two single arms in each of the lateral rays, and by the number of arms.

Found by R. A. Blair, in the Keokuk Group, at Boonville, Missouri, and now in my collection.

BATOCRINUS GURLEYI, N. SP

Plate XI, fig. 9, azygous view of calyx and vault; fig. 10 symmetrical view of specimen with arms.

Species medium or below medium size; calyx somewhat obpyramidal, rapidly expanding, about twice as wide as high; radial series forming angular ridges from the basal plates to the free arms; interrarial areas flattened; arms projecting below and openings directed horizontally; surface finely sculptured and granular.

Basals three, forming a hexagonal disc, one-half wider than the diameter of the column, truncated below and exposing a height about equal to the distance from the column to the margin. First primary radials nearly as high as wide, upper face strongly arcuate for the reception of the second radials. Second radials quadrangular, about twice as wide as high. Third radials pentagonal, larger than the second, more than twice as wide as high, axillary, greatest width below the middle at the angles formed by the junction of the lower expanding and upper sloping sides. In each lateral ray there are two secondary radials succeeded by three tertiary radials that bear single arms or four arms in each lateral series. In the ray opposite the azygous area, there are four secondary radials that bear single arms or two arms, in that ray. On each side of the azygous area, there are four secondary radials in the distal series that bear single arms, and two in the proximate series, followed by tertiary radials that bear single arms or three arms in each ray adjoining the azygous area. There are, therefore, sixteen arms in this species. The arms are coarse, long, uniform in size, and composed of a double series of interlocking plates. Pinnules long and dense.

Regular interradians three, the first one very large, the other two small and of nearly equal size. Azygous interradians seven, the first one heptagonal, in line with the first primary radials and the largest plate in the calyx; it is followed by three plates, the lateral ones being as large or larger than the central one; these are succeeded by two plates that are followed by a single small one that separates the under sloping sides of the third tertiary radials. Vault depressed, convex toward the margin,

but becoming more convex toward the proboscis and covered with convex polygonal plates. Proboscis small, subcentral. Column round.

Collected by R. A. Blair and F. A. Sampson, in the Keokuk Group, at Boonville, Missouri, and now in their collections and in mine. The specific name is in honor of Wm. F. E. Gurley, of Danville, Illinois.

BATOCRINUS VENUSTUS, N. SP.

Plate XI, fig. 11, side view, showing arms; fig. 12, showing calyx and vault.

Species robust, above the average size. Calyx depressed or saucer-shaped; radial ridges not defined; height of calyx less than one-fourth the diameter; arm openings directed horizontally and arms projecting before curving upward; interrarial areas not defined; surface smooth or possibly granular.

Basals three, forming an hexagonal disc, a little more than one-half wider than the diameter of the column and bearing a rim that extends below the point of the columnar attachment, within which the hemispherical cup is radiately furrowed. First primary radials more than twice as wide as high, upper face slightly arcuate for the reception of the second radials. Second radials small, quadrangular, less than twice as wide as high. Third radials small, pentagonal, twice as wide as high, axillary, greatest width below the middle at the angles formed by the junction of the lower expanding and upper sloping sides. There are two secondary radials and three tertiary radials in each of the lateral rays, or four arm openings to each ray. In the ray opposite the azygous area there are four secondary radials and two arm openings. On each side of the azygous area there are four secondary radials in the distal series, two in the proximate series, followed by two tertiary radials in one branch and three in the other, or three arm openings to each ray. This makes sixteen arm openings to the vault. The arms bifurcate on the second plate; there are, therefore, thirty-two arms in this species. The arms are rather small, very uniform in size, and composed of a double series of short, interlocking plates. Pinnules long and compact.

Regular interradians three, the first one moderately large, the other two small. Azygous area wide; interradians seven, the first one large, followed by three plates in the next range, and three in the next. Vault high, conoidal, having three times the capacity of the calyx, and covered with large, slightly convex polygonal plates. Proboscis subcentral, rather large, very long, cylindrical, extending beyond the arms, and covered with large polygonal, granular plates. Column round, small, and composed of alternately thicker and thinner plates.

Found by R. A. Blair, in the Keokuk Group, at Boonville, Mo., and now in my collection.

BATOCRINUS PULCHELLUS, N. SP.

Plate XI., fig. 13, side view of calyx and vault; fig. 14, side view showing arms.

Species medium size. Calyx subglobose, one-half wider than high, plates convex, angular; sutures deeply beveled; arm-bases projecting at the lower side, openings directed upward; surface granular.

Basals three, forming an hexagonal disc, about twice as wide as the diameter of the column, truncated below, standing upright and exposing a height less than the distance from the column to the margin. First primary radials one-half wider than high, upper face slightly arcuate for the reception of the second radials. Second radials quadrangular, one-half wider than high. Third radials pentagonal, larger than the second, axillary, greatest width below the middle at the angles formed by the junction of the lower expanding and upper sloping sides. Secondary radials two by ten, wider than long, but both of them slightly variable in size and shape in the different series; eight of them bear single tertiary radials. Tertiary radials one by sixteen, or all the rays have tertiary radials except the one opposite the azygous area, where the arms rise from the secondary radials. There are eighteen arm-openings to the vault and eighteen arms in this species. None of the arms bifurcate. The arms are coarse, long, sharply rounded externally, and composed of a double series of interlocking plates. Pinnules long and dense.

Regular interradials three, the first one large, the other two smaller, but differing in size. Azygous interradials eight, the first one heptagonal, in line with the first primary radials and the largest plate in the calyx; it is followed by three smaller plates, and these by three still smaller ones, and the latter by a single plate. Vault moderately high, and covered with convex polygonal plates. Proboscis small, subcentral, cylindrical, extending beyond the arms, and covered with convex, polygonal plates. Column round, rather large, and composed of alternately thicker and thinner plates.

This species has some resemblance to *B. gorbyi*, but it is a much smaller species, has proportionally a smaller vault and much larger arms, beside, this species has only eighteen arms, instead of nineteen, and there is a corresponding difference in the construction of the calyx.

Found by R. A. Blair, in the Keokuk Group, at Booneville, Missouri, and now in my collection.

BLAIROCRINUS, N. GEN.

(*Ety. proper name; krinon, lily; the generic name is dedicated to R. A. Blair, of Sedalia, Missouri.*)

This genus belongs to the *Actinocrinidae*. The calyx is low, saucer-shaped, but not depressed at the base. The surface is deeply sculptured and bears radial ridges, though the interradial areas are not sunken. The vault is elevated immediately above the arm-openings and more or less convex above, with a short subcentral proboscis, having an opening on top, surrounded by numerous small plates. The plates of the vault are smooth, convex or spinous.

There are three basal plates, usually anchylosed, that form a flat, hexagonal disc, extending beyond the column and perforated, at the center, by a minute, five-rayed opening for the columnar canal. Primary radials three by five. Secondary radials one by ten, axillary. Tertiary radials one by twenty. Regular interradials, one large plate resting upon the upper sides of first radials, followed sometimes by two ranges of two small plates, and then by two elongated plates that connect with the plates of the vault; in other cases only one range of small plates intervene. First azygous plate in line with the first radials, followed by ranges of two plates until they connect with the plates of the vault.

It need hardly be compared with *Batocrinus*, *Dorycrinus*, or *Eretmocrinus*, from which it is distinguished, by the general structure of the calyx and vault, and by the union of the interradials with the plates of the vault. It is distinguished from *Actinocrinus* by the general form of the calyx and vault, by the basal plates, interradial areas and short proboscis, though it seems to be more nearly related to that genus than to any other in the family. Type, *Blairocrinus trijugis*.

BLAIROCRINUS TRIJUGIS, N. SP.

Plate XI, fig. 1, summit view; fig. 2, side view; fig. 3, basal view.

Calyx saucer-shaped, height from one-fourth to one-third the diameter; plates deeply sculptured; radial ridges sharp; interbrachial areas sunken; arm-openings directed nearly horizontally.

Basals three, forming a thin, almost flat, hexagonal disc, nearly covered below by a round column, which is indicated by strong radiating furrows upon the basal plates. There is a minute, five-rayed perforation in the center for the columnar canal. The basals are thin where they rest upon the column, but bear a thickened rim surrounding it, with nodes or short ridges extending toward the center of the adjoining plates. First primary radials large, nearly as high as wide, two heptagonal and three hexagonal, deeply sculptured, having stellate rays from

the center toward the center of the adjoining plates. Second primary radials quadrangular, twice as wide as high, but width less than that of a first primary, radial ridge larger than the transverse one and central node distinct. Third primary radials very little larger, if any, than the second, pentagonal, axillary. Tertiary radials small, single, axillary. There are twenty elongated arm-openings to the vault, but the tertiary radials bear a ridge that forms a notch in the lower part of each orifice, which shows that the species possessed forty arms.

Regular interradians, one large, hexagonal plate, resting between the upper sloping sides of two first primary radials, followed by two smaller ones, that separate the secondary radials, and these by two which fill the interbrachial space and connect with the plates of the vault. In some cases the large plate is heptagonal by reason of abutting against a third primary radial. The first azygous plate is hexagonal, in line with the first primary radials, but somewhat smaller; it is followed by two plates of nearly its own size, and these by two that separate the secondary radials, and these by two that fill the interbrachial space and connect with the plates of the vault. The azygous area has only two more plates than each of the regular areas, and the plates are but little larger.

The vault is elevated, and the arm-openings of each radial series is separated by a large plate, standing upright, between each pair of third radials and the openings, and a smaller plate, in like manner, separates the plates and orifices of each pair. These plates and the elongated orifices are succeeded by three large spinous plates that suggested the specific name. The three spinous plates over each radial series are uniform so far as observed. Above the spinous plates the vault is convex, covered with rather large, plain, polygonal plates that graduate into a short, subcentral proboscis, that terminates in a large number of very small plates. The central part of the summit of the short proboscis is open.

Found by R. A. Blair, in the Chouteau limestone near Sedalia, in Pettis County, Missouri, and now in my collection.

FAMILY EUPACHYCRINIDÆ.

EUPACHYCRINUS TUMULOSUS, N. SP.

Plate IX, fig. 9, azygous view of calyx; fig. 10, basal view with azygous side below.

Calyx low, broadly basin-shaped, diameter twice as great as the height, except upon the azygous side, which is bulged and elevated; plates remarkably tumid and sutures sunken; surface granular.

Basals form externally a small, flat, pentagonal disc, deeply sunken in the basal cavity, and internally a moderately elevated cone. Subradials much the larger plates of the calyx, very tumid, curving into the basal

cavity and extending upward two-thirds the height of the calyx, unequal; the one on the right of the azygous area about one-half larger than the one on the left.

Radials twice as wide as high, pentagonal, the one upon the right of the azygous area rests upon an upper sloping side of the large subradial and the first azygous plate, and between a radial and the third azygous plate, while the one upon the left rests between the upper sloping sides of two subradials and between a radial and the second azygous plate. They are truncated the entire width above and separated from the brachials by a gaping suture; a crenated ridge the width of a plate marks the depth of a gaping suture, and within it there is a furrow upon the upper face of the plate; the lateral sides of each plate, behind the furrow, project upward, leaving a central notch-like depression between them.

There are three tumid plates in the azygous area. The first one is more than half as large as an average subradial, pentagonal, rests obliquely between the upper sloping sides of two subradials and below the first radial on the right, and supports the other two, its upper angle is on a line with the upper face of the opposite radials. The second azygous plate is about one-fourth as large as the first, and rests between it and the radial on the left, and extends in a sharp angle to the subradial so as to separate the first azygous plate from the radial on the left. The third azygous plate is about as large as the second, rests upon the first and between the second, on the left, and the first radial on the right. The cicatrix on the basals shows the column is rather small. Other parts of this species unknown.

Distinguished by the remarkably tumid plates and by their relative proportions, and also by the azygous area and plates, from other species.

Found in the Kaskaskia Group, in Breckinridge County, Kentucky, and now in the collection of William F. E. Gurley.

EUPACHYCRINUS HARRI, N. SP.

Plate XI, fig. 8, view opposite the azygous area.

Calyx low, sunken at the base, basin-shaped; diameter twice as great as height; plates convex; sutures beveled; surface finely granular.

Basals form, externally, a small pentagonal disc, one-half wider than the diameter, of the column sunken in the basal cavity so as not to be visible in a side view; and, internally, they form a small cone. Subradials the larger plates of the body, slightly convex, curving into the basal cavity and extending upward more than half the height of the calyx; unequal, the two adjoining the azygous area being larger than the others. Radials pentagonal, two and one-half times as wide as high,

truncated the entire width above and separated from the brachials by a gaping suture. At the depth of the suture there is a serrated ridge for the articulation of the brachials, and behind this the upper face of the plates is prolonged toward the interior, leaving the orifice, at the top of the radials, less than half the greatest diameter of the calyx. Brachials single, axillary, convex, and obtusely angular in the upper central part; more than twice as wide as high; sunken at the lateral sutures.

In the ray opposite the azygous side there are only two arms, as shown in the illustration. In the lateral rays the arms bifurcate on the first plate which gives to each ray four arms, as shown in the illustration. This evidently shows the species has eighteen arms. The arms, so far as preserved in our specimen, in the ray opposite the azygous area, are longitudinally angular in the central part and composed of a single series of plates, while all the other arms are flat, externally, and composed of a double series of interlocking plates. The arms are flattened on the sides so as to fit closely and compactly together. Pinnules rather small and not compact but free. Column rather small, composed of alternately thicker and thinner, externally convex or beaded plates, radiately furrowed on their uniting faces.

Found by S. J. Hare, in the Coal Measures, at Kansas City, Mo., to whose collection it belongs. The specific name is in honor of the collector.

ORDER MYELODACTYLOIDEA.

FAMILY MYELODACTYLIDÆ.

MYELODACTYLUS GORBYI, N. SP.

Plate XI, fig. 6, side view; fig. 7, showing the circular pore in the outer whorl and the lines indicating the connection between the whorls and places of passage of the radiating pores. The two lower dark spots represent fractures.

The specimen from which this species is named preserves nearly two and a half coils, and the outer one bears the evidence of having been surrounded by another, so that a perfect specimen would have, probably, four or more coils. The coils consist of a double series of plates, the inner series being much smaller than the outer, and they taper gradually toward the center, so that both sides of the specimen are concave. The outer whorl or series of plates is flattened on the lateral sides. The thickness of the plates is about one-half the width of the dorsal side. The dorsal side is slightly convex and marked with a furrow near each side, where the inner series or coil attached, and minute pores may be seen in each furrow between each of the plates representing the radiating system of circulation. The plates of the inner series are about one-third as large as the plates of the outer series. The circular canal in the large series is wide and narrow or corresponding with the outer

shape of the coil. The circular canal in the smaller series can not be definitely determined from our specimen. The two lower pores in fig. 7, as illustrated, are probably both erroneous, and represent the fracture rather than the pores.

The overlapping finger-like processes, which I described in *M. bridgportensis*, have been broken off from our specimen, but the place of attachment may be clearly seen with the aid of an ordinary magnifier.

The characters of this genus, so far as known, were first ascertained by me from casts found in the magnesian limestone at Chicago. The radiate and concentric system of pores and passages then described are found to exist in the species under consideration, but they are not so conspicuous as they are in the Chicago species. The shape of the coils will readily distinguish this species from all others heretofore described.

Found in the Niagara Group, near Nashville, Tenn., and now in the collection of Professor S. S. Gorby, in whose honor I have proposed the specific name.

CLASS ECHINIDA.

ORDER PERISCHOECHINIDA.

FAMILY ARCHÆOCIDARIDÆ.

EOCIDARIS BLAIRI, N. SP.

Plate XII, fig. 1, flattened specimen, mouth central; fig. 2, specimen depressed in the opposite direction, or laterally, showing spines.

Body depressed spheroidal, having, as near as can be estimated from our specimens, a height equal to about half the lateral diameter. Ambulacral areas linear, indicated by concave depressions or slight swellings of the interambulacral areas, but the areas are so narrow and the plates so minute they can not be determined in our specimens. Interambulacral areas covered with hexagonal plates. In the middle part of each area there are two rows of large plates and one row of smaller ones on each side. Each plate has a large, perforated, central tubercle for the articulation of the primary spines, and minute tubercles around the margin for the articulation of secondary spines. The area between the central tubercle and the marginal tubercles is concave. Primary spines long, gradually tapering, slightly compressed or nearly round, articulating end moderately enlarged or bearing a small ring; surface, under a good magnifier, shown to be minutely granular; secondary spines very small, length about half the diameter of a plate.

This species is so distinct from all others that no comparison with any of them is necessary.

Found by R. A. Blair, in the Keokuk Group, at Boonville, Missouri, and now in my collection.

CLASS STELLERIDA.

ORDER ASTEROIDEA.

FAMILY ONYCHASTERIDÆ.

ONYCHASTER ASPER, N. SP.

Plate XII, fig. 3, large specimen, covered with the outer integument of small plates and broken down spines; fig. 4, a smaller specimen, with part of the outer integument preserved and having the arms abruptly bent toward the ventral side; fig. 5, a still smaller specimen, showing the infolding arms, with part of the integument removed.

Dorsal side covered with an integument of small plates and numerous short spines. Central disc rather large, circular, convex, inflated from the point of contact with the arms. The outer integument covers the whole surface of the central disc leaving no orifice exposed. Where the outer integument is worn off the disc is composed of rather large, polygonal, spine bearing plates. The spines do not arise from the center of the plates, but laterally from little pits or sockets at the sutures. These sockets give the plates a somewhat sculptured appearance. The spines have a bulb at the base and taper to an obtuse point above.

The arms are long, rounded on the dorsal side, and very flexible. *Fig. 4* shows the arms abruptly folded from the middle over the ventral part, while *figs. 3 and 5* have the arms folded like the claws of a bird grasping some small object. There is a row of spines on each side of the arm furrows.

This species is so different from the type that the generic reference is very doubtful.

Found by R. A. Blair and F. A. Sampson, in the Keokuk Group, at Boonville, Mo. The specimen represented by *fig. 3* is in Mr. Sampson's collection, and those represented by *figs. 4 and 5* are in my collection.

ONYCHASTER CONFRAGOSUS, N. SP.

Plates XII, figs. 6 and 7, dorsal views of two specimens.

This species is so different from the one last described, and also from the type of this genus, that it may not be congeneric with either of them. I have no doubt that it belongs to the same family. I have seen only the dorsal side of the disc and the dorsal and lateral sides of the rays. There is no such integument of small plates covering the dorsal side as belongs to *O. asper*, but the surface is covered with short spines.

The central part of the disc is somewhat injured in our specimens, and its character can not be definitely determined. It is surrounded by

large, centrally convex, six-rayed plates. These rays seem to be the elevated ridges that separate the sockets for the insertion of the spines. Outside of this circle of ten six-rayed plates, there is a circle of quadrilateral plates more or less sculptured by the sockets for the spines, and here the radials may be said to commence. The dorsal side of each ray consists of three series of plates, and there is one series upon each side, or five series in an arm. The first plates are connected laterally by smaller ones, in the angular depressions, between the commencement of the rays, which form part of the disc. All of the radial plates are more or less sculptured by the depressions for the insertion of the spines. The spines are longer than the diameter of a plate, bulbous at the lower end, and taper to an obtuse point. The arms are long, round on the dorsal side, flexible and capable of being rolled up on the ventral side or being twisted laterally. No such ovarian pores piercing the plates of the disc, as described and illustrated in *O. flexilis*, have been discovered.

Found by R. A. Blair, in the Keokuk Group, at Boonville, Mo., and now in my collection.

ONYCHASTER DEMISSUS, N. SP.

Plate XII, figs. 8, 9 and 10, three views of different specimens,

This species hangs its arms down and folds them like the claws of a bird grasping some small object, and in these respects is more like *O. flexilis* than either of the preceding species. The central disc is slightly concave, subpentagonal in outline, and the rays drop down at right angles to the circumference of the disc.

In the center of the disc there is a low, subcircular elevation, in which I have been unable to find any sutures, or to determine whether or not there is an opening of any kind, it appears to consist of a single plate. It is surrounded by a series of ten plates that form the subpentagonal rim of the central disc. These plates are large, very convex, radiately sculptured, and bent down in the direction of the radial series as well as curving in to unite with the central plate. The sculpturing is due to the sockets for the insertion of the rays. The radial series commence from this circle of plates. The rays are angular on the dorsal side or obtusely rounded. The dorsal side of each ray consists of three series of plates, and there is one series on each side, or five series in an arm. The first two plates in each ray are connected laterally by smaller ones, which form part of the disc, in the angular depressions, between the commencement of the rays. All of the radial plates are more or less sculptured or pitted by the depressions for the insertion of the spines.

The arms are longer, more angular and have rather smaller spines than either of the preceding species. I have been unable to detect any

ovarian pores, but spine sockets very much resembling pores are indicated in fig. 8, but they occur in the sutures and are readily distinguished from pores that pierce the plates.

Found by R. A. Blair, in the Keokuk Group, at Boonville, Missouri, and now in my collection.

ORDER AGELACRINOIDEA.

FAMILY AGELACRINIDÆ.

ECHINODISCUS SAMPSONI, N. SP.

Plate XII, fig. 16, outer part of the specimen destroyed; mouth in the interambulacral area on the left.

Body circular, thin, interambulacral areas depressed, flat; ambulacra higher than wide and regularly arched at the top; diameter of a complete specimen, probably three inches.

Plates in the interambulacral areas large, not imbricating, and those adjoining the ambulacra curved upward nearly half the height of the ambulacra. A few plates adjoining or near the orals are preserved in the wider interambulacral area of our specimen, which show the mouth is distant more than half an inch from the central point of the union of the ambulacra. Ambulacra long, radiating in nearly straight lines from the central part of the disc, and curving back from near the margin, and covered by numerous small plates that are thrown into a waving line on top. These plates are too small to be shown in the illustration.

Found by F. A. Sampson, in the Keokuk Group, at Boonville, Missouri, and now in his collection. The specific name is in his honor.

SUBKINGDOM MOLLUSCA.

CLASS BRACHIOPODA.

ORDER ARTHROPOMATA.

FAMILY TEREBRATULIDÆ.

CRYPTONELLA OVALIS, N. SP.

Plate XIII, fig. 1, dorsal view of a large specimen; fig. 2, side view of same.

Shell subovate, gibbous, rounded in front, greatest width slightly above the middle. Surface concentrically banded, the bands apparently imbricating. Shell structure punctate.

Ventral valve more gibbous than the dorsal; arcuate from the beak to the front; greatest convexity above the middle. Beak prominent, incurved, inflected along the umbonal slopes, truncated by a small foramen. No hinge area.

Dorsal valve shorter than the ventral, less gibbous, greatest convexity above the middle. Beak incurved beneath the beak of the ventral valve. No hinge area.

This species resembles *Cryptonella planirostra*, but is much more gibbous, and the ventral valve is more convex than the dorsal, while in that species the dorsal valve is most convex. Our specimens vary in length from three to seven-tenths of an inch.

Found in the Hamilton Group, at Bunker Hill, Indiana, and now in the collection of Prof. S. S. Gorby.

TEREBRATULA GORBYI, N. SP.

Plate XIII, fig. 3, dorsal view; fig. 4, side view of same.

Shell variable in size, but growing very large; elongate-elliptical in a dorsal view; cuneate in front in a side view; valves unequally gibbous; rounded in front; sides subparallel. Shell structure beautifully punctate, under an ordinary magnifier, and the punctures may be seen with the unaided eye.

Ventral valve more gibbous than the dorsal; arcuate from the beak to the front; greatest convexity in the middle part. Beak very prominent, strongly incurved, inflected along the umbonal slopes; truncated by a very large foramen. No hinge area.

Dorsal valve much shorter than the ventral, less gibbous, somewhat depressed, convex in the middle part. Beak incurved beneath the beak of the ventral valve. No hinge area.

This species may be distinguished by its large size, elongate-elliptical form, and large foramen.

Found by Prof. S. S. Gorby in the Keokuk Group, at Edwardsville, Indiana, and now in his collection and in the State Museum, at Indianapolis. The specific name is in honor of the collector.

FAMILY PENTAMERIDÆ.

PENTAMERUS COLLETTI, N. SP.

Plate XIII, fig. 5, dorsal view of a fragment showing beaks and the narrowness of the species; fig. 6, side view of a specimen crushed in front.

Shell large, subovate, gibbous, narrow, rounded in front, greatest width above the middle. Surface longitudinally striated; striæ moderately large; concentrically marked with strong imbricating lamellæ, marking stages of growth. No mesial fold or sinus.

Ventral valve much more gibbous than the dorsal; arcuate from the beak to the front; most rapid curvature from the beak over the umbo; greatest convexity above the middle; umbo very high, rapidly inflected

or rounded along the umbonal slopes. Beak prominent, pointed, incurved over the beak of the other valve and resting the point upon the umbo, without exposing any of the concave arch beneath. No hinge area.

Dorsal valve much shorter than the ventral and less gibbous; regularly curved from beak to front; greatest convexity near the middle. Beak strongly incurved into the ventral valve.

Distinguished by the narrowness of form, high umbo of the ventral valve, and the character of the plications and concentric lines of growth.

Found in the Waterlime Group, at Kokomo, Indiana, and now in the collection of Prof. S. S. Gorby. The specific name is in honor of Prof. John Collett, late State Geologist of Indiana.

FAMILY ORTHIDÆ.

ORTHIS BENEDICTI, N. SP.

Plate XIII, fig. 7, ventral view; fig. 8, dorsal view; fig. 9, lateral view.

Shell medium or below medium size; wider than long; hinge line exceeding the breadth of the valves at any part farther forward; lateral margins oblique but rounding to the front, which is regularly arched. No mesial fold or sinus.

Dorsal valve much more convex than the other, greatest convexity in the middle part; umbo prominent; beak pointed, contracted on the sides, and incurved over the area; area of moderate height, oblique, sharp along the margin, and continuing to the lateral extremities. Surface marked by coarse radiating striæ, with wide and deep furrows, which gradually increase in size toward the front and lateral margins. The striæ increase by intercalation, but rarely beyond the umbo; no increase by bifurcation on our specimen, and no imbricating marks of growth or concentric striæ.

Ventral valve most convex near the apex of the beak, from which it slopes regularly and evenly to the front and lateral margins. Beak elevated, straight, pointed. Cardinal area rather high at the beak and sloping to the lateral extremities, very oblique, or standing at an angle of only about forty-five degrees to the plane of the valve, and quite sharp along the margin. Surface marked by coarse radiating striæ, with wide and deep furrows, which gradually increase in size toward the front and lateral margins, and increase by intercalation as they do on the dorsal valve.

The species is founded on a single incomplete specimen, but it is so different from any heretofore described, from rocks of the same age, that I have not hesitated in naming it.

Found in the Niagara Group, at Hartsville, Indiana, and now in the collection of Mr. A. C. Benedict. The specific name is in honor of the collector.

FAMILY NUCLEOSPIRIDÆ.

NUCLEOSPIRA INDIANENSIS, N. SP.

Plate XIII, fig. 13, dorsal view; fig. 14, ventral view; fig. 15, profile or lateral view.

Shell small, transversely subelliptical, compressed; valves nearly equally convex; hinge line short. No area. Surface marked by radiating striæ that do not increase by implantation or bifurcation, but gradually enlarge toward the basal and lateral margins, and these are crossed by fine concentric striæ. Shell distinctly punctate under an ordinary magnifier.

Ventral valve most convex, the greatest convexity a little above the middle and in the umbonal region, a little concave toward the front, which shows an undefined sinus; beak small, pointed, extending a little beyond the beak of the dorsal valve and slightly incurved over its apex.

Dorsal valve slightly less convex than the ventral, greater convexity about the middle; undefined mesial fold in front; beak slightly incurved into the other valve. Some of the shell is exfoliated from the umbonal region of our specimen, and exposes a small sinus from the beak over the umbo. Interior unknown. This species is quite different from any hitherto described, and therefore no comparison is necessary.

Found in the Hamilton Group, at Bunker Hill, Indiana, and now in the collection of Professor S. S. Gorby.

FAMILY PRODUCTIDÆ.

PRODUCTUS BLAIRI, N. SP.

Plate XIII, fig. 16, a cast showing the external markings of the dorsal valve, the shell being exfoliated; fig. 17, cast of the interior of the ventral valve, the shell being exfoliated.

Shell medium size, wider than long, hinge line equaling the width of the shell and inflected or turned up at the cardinal extremities. Visceral portion of the shell nearly flat; margin abruptly deflected at the sides and in front. A broad undefined mesial sinus arises on the flat visceral region of the valve and continues over the deflected margin to the front. Surface marked by uneven, radiating costæ, over the visceral portion, which become, in their extension toward the front and lateral margins, more uneven and much coarser; the increase is by implantation. The surface of both valves is also marked with rather obscure, somewhat irregular, concentric wrinkles, and, as shown in the cast, covered with more or less numerous elongated nodes that I suppose represent the bases of appressed spines. And a small fragment of what I suppose to be the shell of the same species bears short, appressed, tubular spines. These were born upon both valves. The illustration of the cast of the interior of the ventral valve does not show them as distinctly as the cast of the exterior of the dorsal valve, but the fragment

above referred to is from the exterior of a ventral valve, and it shows them quite as large and abundant as they are upon the opposite valve.

This shell will be readily distinguished from others by its large, flattened, visceral region, short deflected lateral and front margins, coarse striæ and appressed spines. None have been described from rocks of the same age having any close resemblance to it.

Found by R. A. Blair, in considerable abundance, in the Chouteau limestone, at Sedalia, Missouri, and now in my collection. The specific name is in honor of the collector.

ORDER LYROPOMATA.

FAMILY DISCINIDÆ.

DISCINA SAMPSONI, N. SP.

Plate XIII, fig. 10, cast of a large dorsal valve; fig. 11 smaller dorsal valve with shell only slightly exfoliated; fig. 12, cast of the ventral valve, showing concentric lines and longitudinal slit. It should be reversed on the plate so as to have the slit above.

Shell about medium size; oval; antero-posterior diameter greater than the transverse. Upper or dorsal valve quite convex; apex situate at the posterior third of the shell, acute and directed backwark. Surface of the dorsal valve marked with obscure radiating and concentric lines, too indistinct to be shown in the illustration without giving an erroneous impression of their size. The cast represented by fig. 10 has a delicate sinus extending from near the beak nearly half way to the front of the shell and four pits just beyond the end of the sinus. The pits are shown in the illustration and the sinus may also be detected.

Under or ventral valve flat and marked with about sixteen strong concentric lines. Oval impression extending from the center about half way to the posterior margin.

Found by R. A. Blair and F. A. Sampson, in the Chouteau limestone, at Sedalia, Missouri, and now in Mr. Sampson's collection and in mine. The specific name is in honor of the collector.

CLASS PTEROPODA.

ORDER THECOSOMATA (?).

FAMILY CONULARIIDÆ.

CONULARIA SAMPSONI, N. SP.

Plate XIV, fig. 11, natural size; fig. 12, part of same magnified two diameters.

Shell rather small, slender, elongate-pyramidal, with equal or sub-equal lateral surfaces. Lateral surfaces nearly flat, having a delicate

mesial ridge where the shell is well preserved, but showing a lineal, mesial furrow where the shell is exfoliated. Each of the four angles sharply and deeply furrowed. Surface marked with fine, crenate, transverse costæ that are separated by wider, rounded furrows. The costæ are straight and directed a little forward near the apex and terminate alternately at the mesial ridge; but farther forward they curve and finally make a more or less marked sigmoid flexure before terminating at the mesial ridge. Furrows between the costæ smooth. The crenulations on the costæ are extremely fine, and only visible with the aid of a good magnifier where the shell is well preserved.

Found by F. A. Sampson, in the Chouteau limestone, at Sedalia, Missouri, and now in his collection. The specific name is in honor of the collector.

CLASS GASTROPODA.

ORDER BRANCHIFERA.

FAMILY CALYPTRÆIDÆ.

PLATYCERAS PETTISENSE, N. SP.

Plate XIV, fig. 1, lateral view of an internal cast.

Shell rather large, pyramidal, most rapidly expanding toward the aperture, laterally compressed, apex pointed and slightly curved. The anterior half of the shell bears five unequal, wide longitudinal furrows, that increase in size toward the aperture and are separated by narrower, rounded longitudinal ridges. The furrows are rounded and deep, leaving the diameter of the aperture, from furrow to furrow, less than half the diameter from ridge to ridge. The diameter of the aperture, from the anterior to the posterior side, is one-half greater than the lateral diameter. Peristome deeply sinuous. The species is founded on internal casts, but some of them preserve the markings of concentric undulating striae, which became subimbricating toward the aperture.

This species is more like *P. quincyense* than any heretofore described; but in that species the shell is straight, obliquely conical, narrowing regularly from the aperture, the ridges regularly disposed and each flattened or slightly concave along its middle, aperture subcircular with a tendency to a pentahedral outline; characters quite different from those possessed by this species.

Found by R. A. Blair, in the chert, in the Burlington Group, at Sedalia, Mo., and now in my collection.

PLATYCERAS MISSOURIENSE, N. SP.

Plate XIV, fig. 2, lateral view of an internal cast.

Shell medium or above medium size, erect, conical, most rapidly expanding toward the aperture after the commencement of the longitudinal furrows; apex pointed. Ten longitudinal furrows arise about or nearly midway in the length of the shell and increase in size to the aperture; they are separated by ten broadly rounded longitudinal ridges. The furrows are narrowly rounded, in contrast with the broadly rounded ridges. Five of the furrows are larger than the other five, and they divide the ridges into five subequal pairs. The species is founded upon an internal cast, but the shell was doubtless ornamented with concentric undulating striae.

This species is so different from all others, from rocks of the same age, that comparisons are unnecessary.

Found by R. A. Blair, in the chert, in the Burlington Group, at Sedalia, Mo., and now in my collection.

PLATYCERAS BOONVILLENSE, N. SP.

Plate XIV, fig. 15, posterior view showing aperture and apex; fig. 16, lateral view.

Shell small, conical, almost regularly arched on the dorsal and ventral sides and acutely pointed at the apex. Lateral diameter greater than the dorso-ventral diameter. Aperture subcircular, very oblique. Surface of the shell bears obscure lines of growth arching from an obscure and undefined sinus on the back of the shell toward the aperture. This species is distinguished from all others by its small size, general form and nearly perpendicular, subcircular aperture.

Found by R. A. Blair in the Keokuk group, at Boonville, Missouri, and now in my collection.

PLATYCERAS NASUTUM, N. SP.

Plate XIV, fig. 17, lateral view; fig. 18, anterior view.

Shell below medium size: highly arched in the middle part with a strong backward obliquity and a slender apex which makes about one volution over and near to the posterior side of the aperture. The shell rapidly expands below the apical volution, especially on the anterior side. Antero-posterior diameter more than twice as great as the lateral diameter. Lateral slopes expanding very little. Posterior side only slightly concave. Anterior side more than twice as long as the posterior. An undefined depression arises on each side of the anterior slope and gradually expands to the aperture, leaving the central part of the anterior slope narrowly rounded or subangular. Aperture subovate, greatest breadth at the posterior third, and antero-posterior diameter

twice as great as the extreme lateral diameter. Anterior lip more or less sinuous. Surface marked by distinct lines of growth that curve backward in crossing the anterior slope, making a sigmoid flexure on each side of it. A lateral view of a specimen may be said to have a fanciful resemblance to a Roman nose, which suggested the specific name.

Found by R. A. Blair and F. A. Sampson in the Chouteau limestone, at Sedalia, Missouri, and now in Mr. Sampson's collection and in mine.

FAMILY PLEUROTOMARIIDÆ.

PLEUROTOMARIA HARRI, N. SP.

Plate XIV, fig. 3, front view, showing aperture and height of shell; fig. 4, summit view, showing surface furrows.

Shell above medium size, depressed, length less than half the breadth. General form much like an *Holopea*. Volutions five, rounded on the top and side, but subangular at the periphery and flattened below; the first two very small and the last one constituting three-fourths of the shell. Suture deep, canaliculate. Aperture large, subovate. Umbilicus closed. Surface ornamented with nine or ten wide revolving furrows on the upper side of the whorls or above the fissure in the outer lip, and about twice as many smaller furrows on the under side or below the fissure in the outer lip. The furrows are rounded and the ridges that separate them narrow and angular. Very fine thread-like lines, closely arranged, mark the volutions transversely.

Though a large number of species of *Pleurotomaria* have been described, I do not call to mind any one with which this species might be confounded, and hence no comparison is necessary.

Found by Sid. J. Hare in the Upper Coal Measures, at Kansas City, Missouri, and now in my collection. The specific name is in honor of the collector.

PLEUROTOMARIA SEDALIENSIS, N. SP.

Plate XIV, fig. 13, lateral view.

Shell medium or below medium size, trochiform, height and breadth subequal; spire conical. Volutions five, rounded, the last one subangular on the periphery. Suture deep, canaliculate. Umbilicus closed. Surface ornamented with three wide, shallow, revolving furrows above the subangular periphery, separated by narrow, angular ridges, and crossed transversely, by small, distant, thread-like lines. Aperture not preserved. This species is generally found in the shape of casts in the hard limestone, but one specimen, in Mr. Sampson's collection, preserves part of the surface ornamentation.

Found by R. A. Blair and F. A. Sampson in the Chouteau limestone, at Sedalia, Missouri, and now in Mr. Sampson's collection and in mine.

FAMILY SUBULITIDÆ.

MACROCHILINA BLAIRI, N. SP.

Plate XIV, fig. 5, front view.

Shell above medium size, subglobose or somewhat elongate; height one-third more than the greatest breadth, rhombic-subovate. Spire conical, acutely pointed, and forming more than one-third the length of the shell. Volutions six, convex, smooth, increasing rather rapidly in size, the last one large, constituting more than half the length of the shell, but not very ventricose. Suture distinct, somewhat canaliculate. Aperture subovoid or somewhat rhombic, angular above and subangular below. Outer lip sharp and regularly curved. Inner lip thickened, but without any twisting or transverse wrinkles. The callosity of the inner lip smooth. Surface, so far as it can be ascertained, smooth.

Found by R. A. Blair, in the Chouteau limestone, at Sedalia, Missouri, and now in my collection. The specific name is in honor of the collector.

SUBULITES BENEDICTI, N. SP.

Plate XIV, fig. 6, posterior view.

Shell below medium size, rather short, fusiform, slightly bent to one side or curved above the body volution, and consisting of five or six rather rapidly tapering, moderately convex whorls. The body volution forms nearly two-thirds the length of the shell. Sutures only slightly oblique. Aperture narrow, elongate and terminal. Surface of the shell in our specimen smooth, though it may be slightly eroded, or at least sufficient to destroy delicate lines.

Distinguished from *S. brevis*, which it most resembles, by the convex whorls and less oblique sutures, beside it tapers much more rapidly above the body volution, which would be even more apparent in a cast.

Found by A. C. Benedict, in the Niagara Group, in Franklin County, Indiana, and now in his collection. The specific name is in honor of the collector.

FAMILY BELLEROPHONTIDÆ.

BELLEROPHON GORBYI, N. SP.

Plate XIV, fig. 7, front view; fig. 8, side view; fig. 9, dorsal view.

Shell medium size, involute, longer than wide. Volutions expanding very moderately, rounded over the dorsum, and subangular on the sides. Umbilicus deep, sides converging with a slightly convex outline from the subangular sides. Mesial band or keel narrow, subangular.

Aperture wider than high, subelliptical or reniform. Lip moderately thickened at the inner whorl, but not spreading, thinner on each side of the sinus in the outer margin. Surface beautifully sculptured and ornamented by numerous strong waving lines that curve forward from the mesial band on the dorsum and backward over the subangular sides, without interruption, and down the converging sides to the umbilicus.

This is a beautiful species, and distinguished from all others, in rocks of the same age, by the reniform aperture, subangular sides and surface ornamentation.

Found by Prof. S. S. Gorby, in the Hudson River Group, in Dearborn County, Indiana, and now in his collection. The specific name is in honor of the collector.

FAMILY TURRITELLIDÆ.

ACLISINA BELLILINEATA, N. SP.

Plate XIV, fig. 10, front view.

Shell long, slender, elongate-conical, very slowly enlarging from an acute apex. Volutions about fourteen, last one not larger in proportion to the gradual increase in size of the shell than the others. Suture distinctly defined or canaliculate, and the volutions convex. Surface ornamented by small, prominent, thread-like revolving lines or costæ, separated by impressed spaces, from two to five times their breadth, the closer ones being on the under side of the volutions and the more distant ones on the outward sloping faces below the suture. A good magnifier discloses numerous minute, sigmoid lines of growth crossing the spaces between the revolving lines, or curving gently backward from the suture toward the middle of the whorl. Aperture nearly circular, but straightened on the inner lip below.

Found by F. A. Sampson, in the Chouteau limestone, at Sedalia, Missouri, and now in his collection.

FAMILY PATELLIDÆ.

TRYBLIDIUM INDIANENSE, N. SP.

Plate XIV, fig. 14, apical or dorsal view.

Shell patelliform, oval, narrowed anteriorly, widened posteriorly; greatest width behind the median, transverse axis of the shell. Apex within the anterior third of the shell, moderately elevated. Greatest convexity of the shell immediately behind the apex. Shell sloping very gradually toward the posterior part of the shell and more abruptly in front of the apex, until it approaches the margin, where it graduates

into a wide, very gently convex marginal slope, which in front becomes nearly flat. Surface of the shell, though not well preserved in our specimen, evidently concentrically lined, but if other ornamentation existed, it is wholly obliterated.

The internal scars are unknown, but from external appearance of the shell, there is no reasonable doubt about the generic reference.

Found by A. C. Benedict, in the Hudson River Group, in Fayette County, Indiana, and now in his collection.

FAMILY PLATYSTOMIDÆ.

PLATYSTOMA BROADHEADI, N. SP.

Plate XIV, fig. 19, front view; fig. 20, summit and lateral view of a large specimen.

Shell small, varying much in size, transverse, more than twice as wide as high, consisting of two and one-half volutions, the last one very rapidly expanding. Apex depressed nearly on a plane with the top of the last volution, very small and closely inrolled. Aperture entire and transversely elliptical. Lip thin; surface marked with wavy lines of growth.

From an examination of the aperture of several specimens, I am convinced this species never attached to other objects, at the mouth, like *Platyceras*, and, therefore, it can not be referred to that genus. As able an author and scientist as Lindstrom, of Sweden, classes *Platystoma* as a synonym of *Platyceras*, but as their habits of life were entirely different, I prefer to retain both generic names; and if *Platyceras* is to be classed with the living limpets, in the family *Calyptræidæ*, I prefer a separate family for *Platystoma*. Of course the shells, above the mouth, very much resemble each other, except there are usually more whorls in *Platystoma* than there are in *Platyceras*.

Found by R. A. Blair and F. A. Sampson, in the Chouteau limestone, at Sedalia, Mo., and now in Mr. Sampson's collection and in mine. The specific name is in honor of Prof. G. C. Broadhead, late State Geologist of Missouri.

FAMILY EUOMPHALIDÆ.

STRAPAROLLUS BLAIRI, N. SP.

Plate XV, fig. 3, part of the last whorl, showing some of the surface markings.

Shell very large, discoid, apex nearly on the level with the plane of the body whorl. Volutions two or a little more than two, subcircular, regularly rounded, except a slight flattening on the upper side, very gradually tapering from the apex, barely contiguous, the adjacent sides

not being perceptibly flattened. Lower side broadly umbilicate or concave and perforated, the concavity equaling the diminishing size of the volutions. Aperture slightly expanded, subcircular, a little transverse, outer margin slightly advanced beyond the inner margin; curved a little upward from the plane of the last volution.

Surface marked by crowded concentric striæ, directed forward from the inner side of the volution.

Found by R. A. Blair in the Chouteau limestone, at Sedalia, Missouri, and now in my collection. The specific name is in honor of the collector.

CLASS CEPHALOPODA.

FAMILY ORTHOCERATIDÆ.

ORTHOCERAS HARRI, N. SP.

Plate XVI, fig. 2, specimen compressed in the central part, making it appear somewhat fusiform.

Shell small, elongate, tapering very gradually from the body chamber to the apex. Body chamber rather long and cylindrical. Septa only slightly arched and distant from each other toward the apex from one-third to one-fourth the diameter, but near the body chamber one-sixth to one-seventh the diameter; in other words, the chambers increase more in diameter than in length with the growth of the shell. Siphuncle rather large and slightly constricted in passing through the septa. Surface smooth.

Found by Sid. J. Hare, in the Upper Coal Measures, near Kansas City, Missouri, and now in my collection. The specific name is in honor of the collector.

FAMILY CYRTOCERATIDÆ.

CYRTOCERAS NASHVILLENSE, N. SP.

Plate XVI, fig. 1, side view.

Shell rather large, very gradually curving from the body chamber; greater diameter from the dorsal to the ventral side. Septa highly arched and distant about one-fourth the transverse diameter of the shell. Body chamber and siphuncle unknown.

Found near Nashville, Tennessee, in the Niagara Group, and now in the collection of Prof. S. S. Gorby.

CYRTOCERAS SAFFORDI, N. SP.

Plate XVII, fig. 2, side view; fig. 3, showing siphuncle.

Shell large, rapidly tapering, strongly curved. Septa moderately arched, chambers thin. Surface showing longitudinal lines on the inner half. About ten chambers on the dorsal side and about twenty on the ventral side equal the diameter. Transverse section circular.

Siphuncle small, expanding in the chambers, and placed close to the outer margin. Though our specimen is only a fragment, the species may be readily distinguished by the rapidly tapering and strongly curved shell and small siphuncle at the extreme outer margin.

Found by Professor S. S. Gorby, in the Nashville, or Hudson River Group, at Nashville, Tennessee, and now in his collection.

CYRTOCERAS INDIANENSE, N. SP.

Plate XVIII, fig. 1, specimen from St. Paul; fig. 2, specimen from Hartsville.

Shell large, curved near the apex. Transverse section subelliptical, the greater diameter being from the dorsal to the ventral side. Septa highly arched, and distant about one-third the transverse diameter at the place of measurement. Siphuncle subcentral, more than one-third the diameter of the shell, subcylindrical or very slightly expanding in the chambers and sharply contracted at its passage through the septa, appearing as if it was transversely cut by the septa. Where the outer shell is preserved neither the chambers or septa can be seen. Surface covered by very fine transverse lines that arch toward the apex on the outer side of the shell. There are about thirty-five or forty transverse lines in an inch. Body chamber unknown.

Collected in the Niagara Group, at St. Paul and at Hartsville, Indiana, and now in the State Museum, at Indianapolis. The larger specimen, from St. Paul, I prefer to consider the type of the species, as, possibly, the smaller one may be distinct from it. The only difference shown in our specimens is the proportionally larger siphuncle in the St. Paul specimen. The siphuncle in the Hartsville specimen is only about one-fourth the transverse diameter of the shell, and possibly better preserved specimens might show other differences that would distinguish it.

FAMILY GOMPHOCERATIDÆ.

GOMPHOCERAS CLARKI, N. SP.

Plate XIX, fig. 1, showing siphuncle and curving septa.

Shell exceedingly large and rapidly tapering from the body chamber. Transverse section subelliptical. Septa deeply concave and curve toward the apex twice, or make a sigmoid flexure, giving the chambers

a waving outline. The distance between the two arching curves is about one-third the circumference of the shell, on one side and opposite thereto the curving toward the body chamber is correspondingly increased. The distance between septa is about two-fifths of an inch. Siphuncle excentric, mopiliform and about an inch in diameter. The species is founded on a single specimen, preserving three chambers and part of eleven more. Body chamber and aperture unknown.

Found by Dr. J. C. Clark, in whose honor the specific name is proposed, in the St. Louis Group, at Corydon, Indiana, and presented by him to the State Museum, at Indianapolis.

FAMILY PHRAGMOCERATIDÆ.

PHRAGMOCERAS MISSOURIENSE, N. SP.

Plate XV, fig. 2, lateral view.

Shell rather below medium size, broadly rounded on the outer side, arched, laterally compressed, the contraction of the chamber approaching the slit being strongly marked. Body chamber short. Septa concave, chambers more than three times as long on the outer side as they are on the inner side.

The lip projects from the inner side so that the dorso-ventral diameter is twice as great as the lateral diameter. The specimen illustrated is on a slab and does not show the projecting lip nor full curvature of the shell. Other characters unknown.

Found by R. A. Blair, in the Chouteau limestone, in Pettis County, Missouri, and now in my collection.

FAMILY NAUTILIDÆ.

SOLENOCHILUS ROCKFORDENSE, N. SP.

Plate XVI, fig. 3, side view. Plate XVII, fig. 1, dorsal view, showing siphuncle. Both illustrations rather smaller than the specimen.

Shell very large, globose, expanding. Volutions two, moderately embracing, increasing rapidly in size, and a little wider from the dorsal to the ventral side than transversely. Umbilicus deep, apparently perforated and having almost perpendicular walls to the second volution. Septa very concave and distant, about one-fifth the transverse diameter of the volutions at the place of measurement. Siphuncle medium size and seemingly in contact with the outer shell. The body chamber is not preserved in our specimen but the cast shows that it had a length of about one-fourth of a volution and it was, probably, greatly expanded.

Collected in the Waverly or Knobstone Group, at Rockford, Indiana, and now in the State Museum, at Indianapolis.

FAMILY GONIATITIDÆ.

GONIATITES INDIANENSIS, N. SP.

Plate XIX, fig. 2, side view; fig. 3, dorsal view of broken specimen.

Shell small; each outer volution embraces the inner ones. Umbilicus does not expose any of the inner volutions. Four furrows or constrictions radiate from the umbilicus and cross the dorsal side dividing the shell into four subequal parts. Dorsal side round. Body chamber, sutures and surface markings unknown.

The species is founded upon two sandstone casts from the Knobstone or Waverly Group, of Clark County, Indiana, now in the State Museum at Indianapolis. The smaller specimen is only half the diameter of the one illustrated.

/ GONIATITES BROWNENSIS, N. SP.

Plate XVIII, fig. 3, side view; fig. 4, dorsal view, showing part of a septum.

Shell medium size, globose, broadly rounded on the dorsal side. Outer volutions not entirely covering the inner ones. Umbilicus moderately large, showing less than one-fourth the vertical diameter of each inner volution. Dorso-lateral lobe acutely pointed. Dorsal lobe angular, but the entire shape not determined. The sinuosities of the septa are quite complex, there being three conical points, at the ventral side, corresponding with the dorsal and dorso-lateral angles of the lobes. Outer chamber and siphuncle unknown.

Our specimen is silicified. It was collected in the Waverly or Knobstone Group, in Brown County, Indiana, and now belongs to the State Museum, at Indianapolis.

GONIATITES GORBYI, N. SP.

Plate XV, fig. 1, lateral view, showing part of the body chamber.

Shell very large, lenticular, volutions all embraced within the outer one, so the number can not be determined. Sides depressed, convex. Periphery angular. Umbilicus closed. Body chamber having the length of about one-fourth of a volution. The sinuosities of the septa are very numerous, there being ten or twelve lobes and as many saddles on each side. They are generally linguiform, though one series is trifid and another bifid, and, as the body chamber is approached, two are bifid and one trifid. The linguiform lobes and saddles have some resemblance, in shape, to those of *Goniates lyoni*.

Collected by R. A. Blair, in the lower part of the Choteau limestone or Waverly Group, at Pin Hook Bridge, in Pettis County, Missouri, and now in the collection of the author. The specific name is in honor of Prof. S. S. Gorby, State Geologist.

CLASS LAMELLIBRANCHIATA.

ORDER ASIPHONIDA.

FAMILY SCHIZODIDÆ.

SCHIZODUS HARRI, N. SP.

Plate XX, fig. 1, interior of left valve; fig. 2, left valve; fig. 3, cardinal view.

Shell rather large but quite variable in size; transversely subelliptical or subtrapezoidal in outline; widest in front; convex in the middle and cuneate below and toward the anterior and posterior ends; anterior end regularly rounded; basal margin curving slightly and terminating rather abruptly at the posterior extremity; dorsal line regularly curving from the beaks to the posterior extremity. Umbonal region regularly rounded toward the beaks. Beaks moderately prominent, rising above the cardinal line, obtusely pointed, and located a little forward of the middle of the shell. Posterior umbonal slopes broadly rounded from the beaks obliquely to the posterior basal extremity.

Pallial line indistinct and some distance from the margin. An undefined ridge extends from beneath the beaks more than half way to the posterior basal extremity. Two teeth in the left valve, the anterior one just forward of the beak and directing its cutting edge forward and obliquely downward; the posterior one rising below the beak and directed backward with its cutting edge downward. An elongated socket occurs above and behind the posterior tooth. Surface nearly smooth, showing lines of growth only near the hinge line at the anterior and posterior extremities.

This genus has been referred to the families *Trigoniidae* and *Lucinidae* that belong to different orders. I can not see that it has any near relationship with either *Trigonia* or *Lucina*. It has also been referred to the family *Cytherodontidae*, but it is as far from *Cytherodon* as it is from the other genera. The Carboniferous shells have not been very satisfactorily classed in families and a general overhauling is necessary. I have used the name *Schizodidae* only provisionally and for the purpose of calling attention to the subject, and not with the intention, at present, of establishing the family.

Found by Sid. J. Hare, in the Coal Measures, at Kansas City, Mo., and now in my collection. The specific name is in honor of the collector.

FAMILY MODIOMORPHIDÆ.

CYPRICARDELLA GORBYI, N. SP.

Plate XX, fig. 6, right valve; fig. 7, cardinal view.

Shell small, transversely subtrapezoidal in outline, height nearly equaling the length, most convex in the umbonal region, cuneate below and toward the anterior end. Anterior end nearly straight and directed but little forward half the width of the shell and then abruptly rounded into the basal margin; basal margin slightly rounded in the middle and toward the posterior end. Cardinal line horizontal from the beaks back three-fourths the length of the shell; posterior extremity obliquely truncated. Beaks at the extreme anterior end, very prominent, sharp, rising high above the hinge line and coming in contact. Umbonal slope distinctly angular and extending to the post-inferior extremity. Surface marked by numerous concentric, imbricating lines of growth. Interior unknown.

Found by R. A. Blair, in the Keokuk Group, at Boonville, Missouri, and now in my collection. The specific name is in honor of Prof. S. S. Gorby.

FAMILY PECTENIDÆ.

AVICULOPECTEN SCULPTILIS, N. SP.

Plate XX, fig. 5, left valve.

Shell medium size. Body subovate, axis slightly inclined to the hinge line. Height one-half more than the length. Hinge line shorter than the greatest width of the shell. Anterior margin broadly rounded below the ear; basal and posterior margins rounded. Beak anterior to the middle of the hinge, rounded, acute, and projecting beyond the cardinal line. Umbonal region moderately convex. Anterior ear small, subtriangular, lateral margin concave. Posterior ear three times as large as the anterior one, subtriangular, lateral margin concave; separated from the body of the shell by a well defined, deep, arcuate sulcus.

Surface ornamented by very close, fine rays and close, concentric, imbricating striæ that form a beautiful network made rough by the concentric striæ crossing the rays. The radiating lines do not appear on the anterior ear, which is marked only by the fine, concentric lines. The rays and striæ are more prominent on the posterior ear than elsewhere on the shell and give it a strongly pitted aspect.

Found by Sid. J. Hare, in the upper Coal Measures, at Kansas City, Missouri, and now in my collection.

PTERNOPECTEN SEDALIENSIS, N. SP.

Plate XX, fig. 8, right valve with the posterior wing broken off; fig. 9, an entire specimen.

Shell small. Valves subequal. Hinge line straight, equal to the greatest length of the shell and longer than the height of the shell. Anterior end slightly arcuate; basal margin uniformly rounded; posterior margin oblique. Beak obtuse, rounded, directed slightly forward. Anterior ear triangular, flattened and distinctly defined. Posterior ear triangular, twice as large as the anterior one and separated from the body by an undefined depression. Surface ornamented by distant rounded rays, with an occasional short one implanted near the margin, and obscure distant concentric striæ.

Found by R. A. Blair, in the Chouteau limestone, at Sedalia, Missouri, and now in my collection.

ORDER SIPHONIDA.**FAMILY GRAMMYSIIDÆ.****GRAMMYSIA BLAIRI, N. SP.**

Plate XX, fig. 4, view of the two valves.

Shell medium size, transversely subelliptical, length one-third greater than the height, umbonal region gibbous. Anterior end rounded from the lunule to the base; base forming a semielliptical curve; posterior end regularly rounded. Cardinal line almost horizontal, and extending about half the length of the shell. Beaks prominent and coming nearly in contact forward of the anterior third of the shell. Posterior umbonal slopes broadly rounded, not defined. Surface ornamented with wide concentric undulations or furrows that increase in size from the beak to the base and are separated by narrow ridges. Interior unknown.

Found by R. A. Blair, in the Chouteau limestone, at Sedalia, Missouri, and now in my collection. The specific name is in honor of the collector.

FAMILY CONOCARDIIDÆ.

CONOCARDIUM INDIANENSE, N. SP.

Plate XX, fig. 10, view of the ventral or under side from point of alation to the posterior end.

Shell medium size. Ventral view somewhat angularly subovate. Margins of the valves nearly straight, and incurved toward each other, uniting with denticulated edges anteriorly and gradually separating posteriorly and terminating in a wide, subovate hiatus. Surface marked by transverse, distant striæ, between which there are finer lines, all of which are crossed longitudinally by lines of irregular size. The longitudinal lines do not cross the transverse striæ on the incurved part of the margins. The species is founded on a single specimen, which is on a slab exposing only the ventral side.

Found in the Keokuk Group, at Crawfordsville, Indiana, and now in the State Museum, at Indianapolis.

CONOCARDIUM PARVULUM, N. SP.

Plate XX, fig. 11, side view, small piece broken from the posterior end. Magnified two diameters.

Shell very small, subtrigonal. Height and length subequal. Hinge line straight, horizontal. Beaks acute, projecting beyond the cardinal line. Anterior umbonal rib sharply angular, and nearly at right angles to the cardinal line. Anterior end moderately arched and having an acutely pointed cardinal extremity. Valves uniting with denticulated edges anteriorly and gradually separating posteriorly, and terminating with a wide, subovate hiatus. Surface marked with moderately distinct transverse striæ and apparently no other ornamentation. Striæ finer on the anterior face of the valves than behind the umbonal ridge.

Found by Prof. S. S. Gorby, in the Hamilton Group, at Bunker Hill, Indiana, and now in his collection.

CONOCARDIUM EXIGUUM, N. SP.

Plate XX, figs. 12 and 13, side views of two different specimens. Magnified two diameters.

Shell small, subtrigonal, length behind the alation one-fourth greater than the height. Hinge line straight, horizontal. Beaks obtuse. Anterior umbonal rib directed obliquely forward; sides convex behind the umbonal rib, followed by an undefined depression that terminates in an undefined sinus or slight curvature on the ventral side of the shell. Hiatus much elongated on the ventral side. Valves uniting with crenate edges.

Surface ornamented with rather coarse radiating costæ and concentric imbricating lines of growth. Costæ finer on the anterior end than behind the umbonal ridge.

Found by Professor S. S. Gorby, in the Hamilton Group, at Bunker Hill, Indiana, and now in his collection.

CONOCARDIUM ELRODI, N. SP.

Plate XX, fig. 14, view of the ventral or under side, with the alation in front. Magnified two diameters.

Shell very small, subtrigonal; length behind the alation about equal to the height. Hinge line declining behind the beaks. Beaks obtuse. Cardinal extremity pointed in front. Anterior umbonal rib directed obliquely forward, and shell gently sloping behind. Hiatus much elongated on the ventral side, and, in our specimen, apparently closed at the end. No denticulations on the uniting edges of the valves. Alation in front of the umbonal slope nearly equaling in length the shell behind the beaks.

Surface ornamented with longitudinal striæ, crossed by fine transverse lines, that give it a highly ornamental, cancellated appearance.

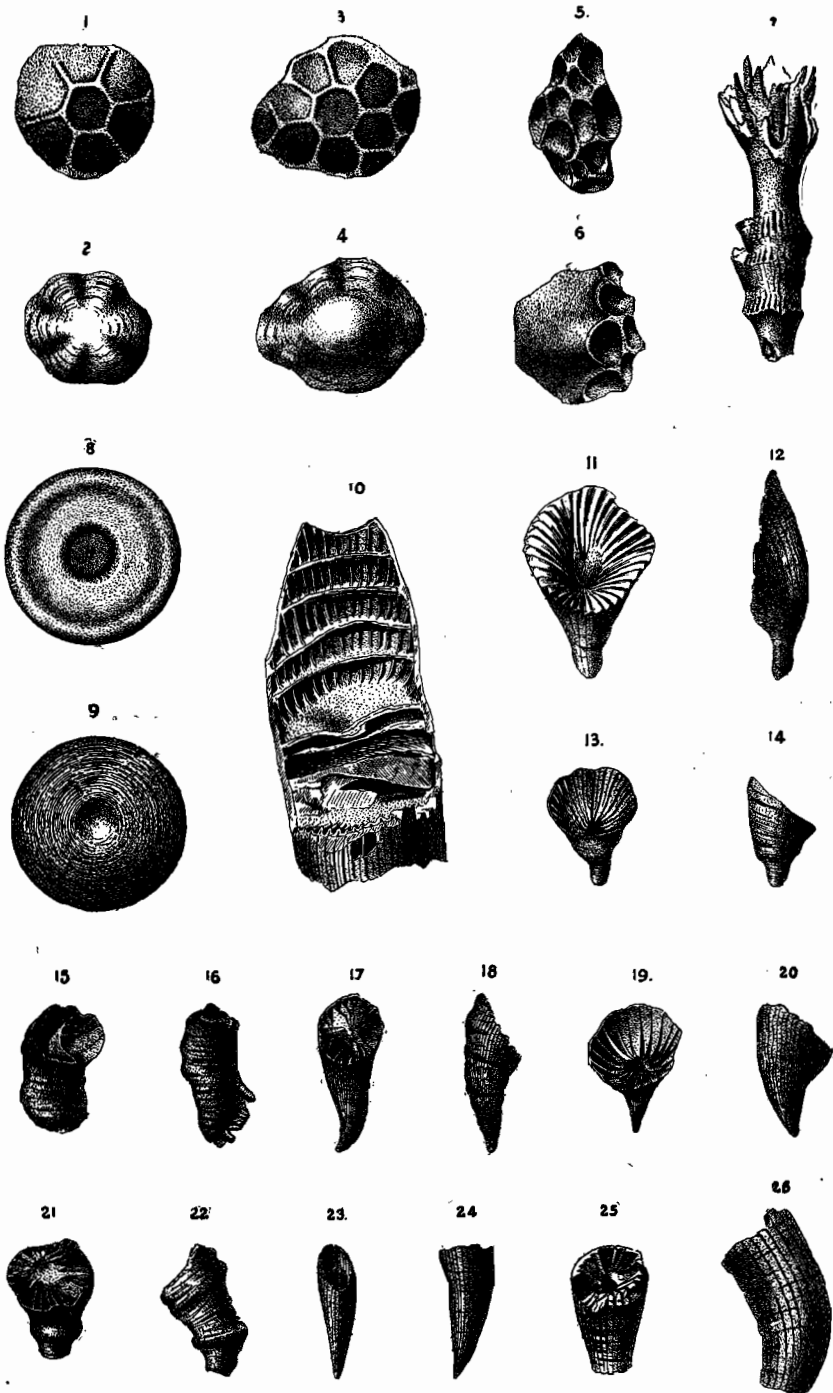
Found by Dr. M. N. Elrod, in the Niagara Group, at Hartsville, Indiana, and now in his collection. The specific name is in honor of the collector.

EXPLANATION OF PLATES.

INDEX TO PLATES.

PLATE I.

	Page.
<i>Leptopora gorbyi</i> , n. sp. Fig. 1, complete specimen with central hexagonal cell; fig. 2, under side of a smaller specimen, showing concentrically wrinkled epitheca and radiating waves; fig. 3, specimen with heptagonal central cell and commencement of second circle of cells; fig. 4, under side of same	616
<i>Palæacis cavernosa</i> , n. sp. Fig. 5, summit view, the cell at the upper end not visible; fig. 6, view of convex side	614
<i>Amplexus blairi</i> , n. sp. Fig. 7, showing annulations and costæ at the dilations	618
<i>Cyclospongia discus</i> , n. sp. Fig. 8, lower side, showing central place of attachment and shallow, undefined, circular furrow; fig. 9, upper face, showing concentric lines	615
<i>Amplexus bicostatus</i> , n. sp. Fig. 10, fragment of a silicified specimen, showing septa, tabulæ and costæ	618
<i>Zaphrentis chouteauensis</i> , n. sp. Fig. 11, front view, showing calyx; fig. 12, side view.	620
<i>Zaphrentis calyculus</i> , n. sp. Fig. 13, front view, showing calyx; fig. 14, side view	620
<i>Cystelasma lanesvillense</i> , n. sp. Fig. 15, summit and side view; fig. 16, side view of an other specimen showing rootlets for attachments	623
<i>Zaphrentis tenella</i> , n. sp. Fig. 17, showing radiating septa, calyx broken away; fig. 18, side view of same specimen	621
<i>Zaphrentis exigua</i> , n. sp. Fig. 19, front view, showing calyx, magnified two diameters; fig. 20, side view of same specimen, magnified two diameters	621
<i>Amplexis corniculuni</i> , n. sp. Fig. 21, summit view with calyx broken off; fig. 22, side view.	619
<i>Zaphrentis tantilla</i> , n. sp. Fig. 23, view of the calyx, for the purpose of giving an idea of its depth, magnified two diameters; fig. 24, side view of the same specimen, magnified two diameters	621
<i>Zaphrentis declinis</i> , n. sp. Fig. 25, view of calyx and concave side; fig. 26, side view of another specimen	622

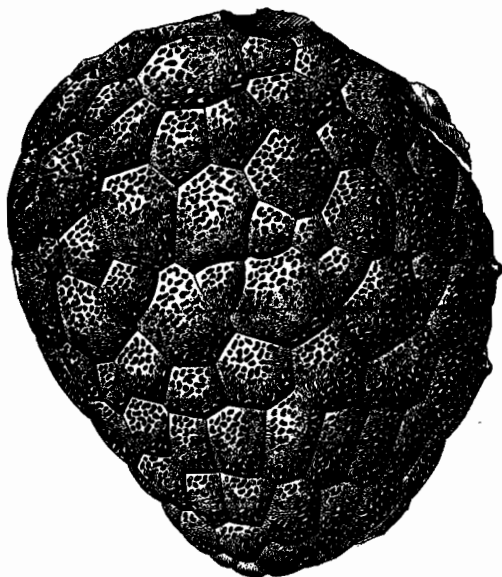


INDEX TO PLATES.

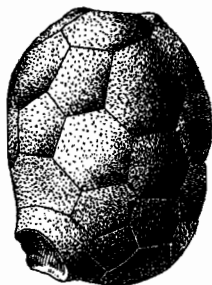
PLATE II.

	Page.
Holocystites adipatus, n. sp. Fig. 1, lateral view; fig. 2, basal view . . .	623
Holocystites gorbyi, n. sp. Fig. 3, lateral view; fig. 4, summit view . . .	624
Holocystites scitulus, n. sp. Fig. 5, side view; fig. 6, summit view. . . .	624

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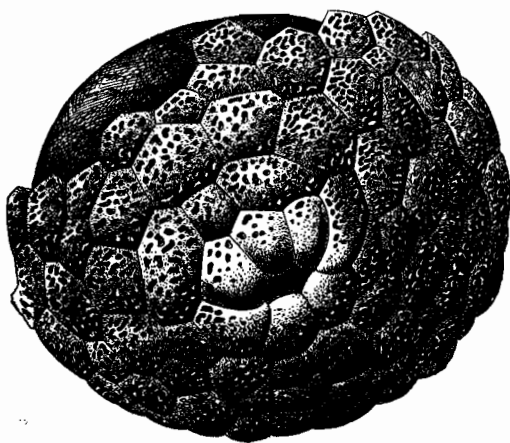
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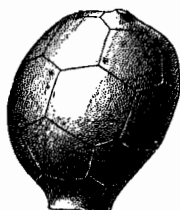
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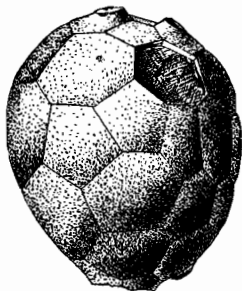


INDEX TO PLATES.

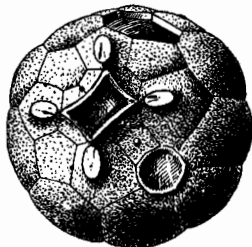
PLATE III.

	Page.
Holocystites commodus, n. sp. Fig. 1, posterior view; fig. 2, summit view; fig. 5, side view of another specimen; fig. 6, summit view . . .	624
Holocystites madisonensis, n. sp. Fig. 3, side view; fig. 4, basal view . .	625
Holocystites indianensis, n. sp. Fig. 7, lateral view	625

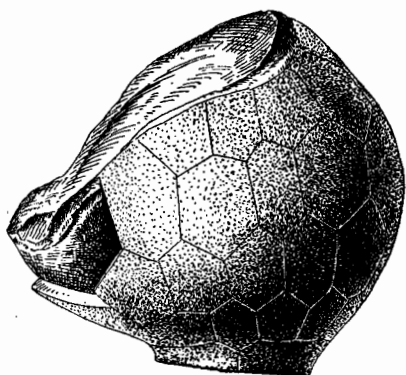
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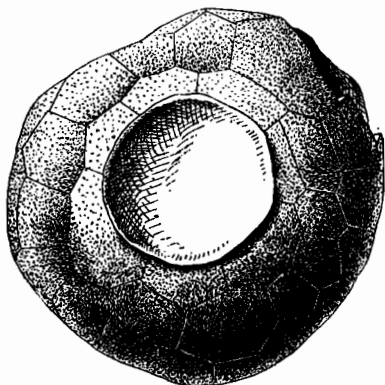
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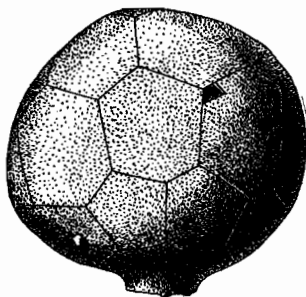
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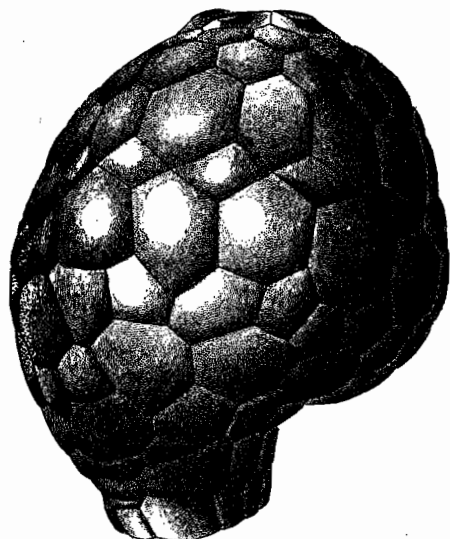


INDEX TO PLATES.

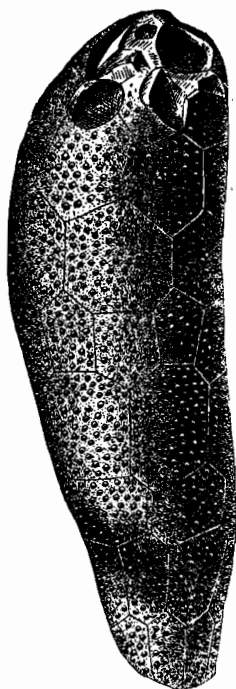
PLATE IV.

	Page.
Holocystites wykoffi, n. sp. Fig. 1, posterior view; fig. 2, summit view, compressed at the mouth	625
Holocystites colletti, n. sp. Fig. 3, showing the mouth and ambulacral opening. Part of the plates are broken between the mouth and ambulacral opening	626
Holocystites parvus, n. sp. Fig. 4, posterior view fig. 5, summit view . .	626
Holocystites spangleri, n. sp. Fig. 6, anterior view	626

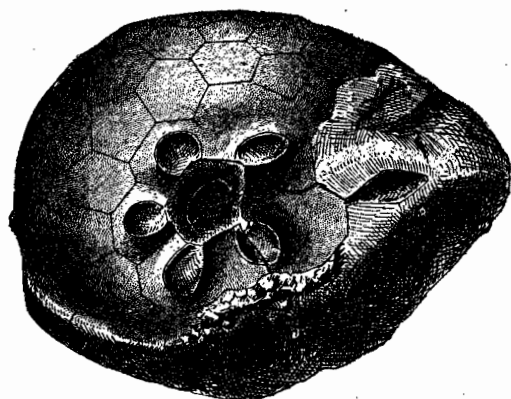
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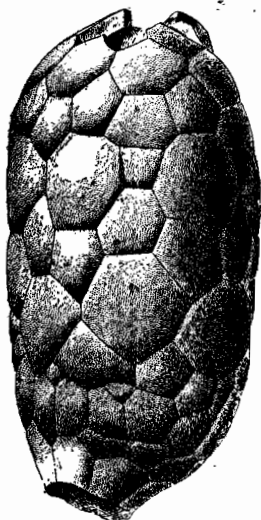
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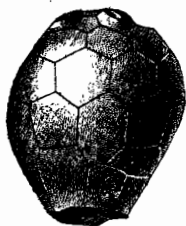
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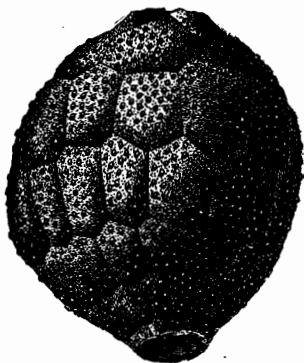


INDEX TO PLATES.

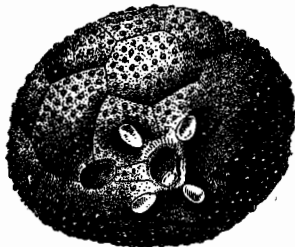
PLATE V.

	Page.
<i>Holocystites ornatissimus</i> , n. sp. Fig. 1, right side; fig. 2, summit view	627
<i>Holocystites benedicti</i> , n. sp. Fig. 3, side view	627
<i>Holocystites subovatus</i> , n. sp. Fig. 4, anterior side; fig. 5, summit view .	627
<i>Holocystites parvulus</i> , n. sp. Fig. 6, left posterior view	628
<i>Holocystites papulosus</i> , n. sp. Fig. 7, left side view, showing how it attached to some small cylindrical object; fig. 8, summit view .	628
<i>Caryocrinus indianensis</i> , n. sp. Fig. 9, azygous, side view; fig. 10, view of the summit	629

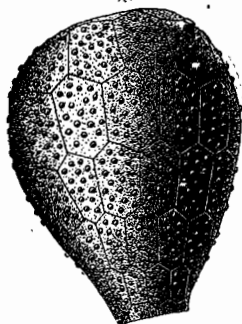
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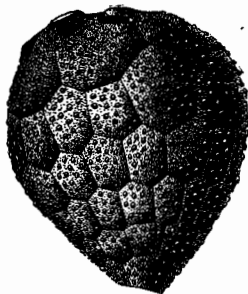
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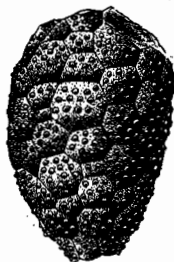
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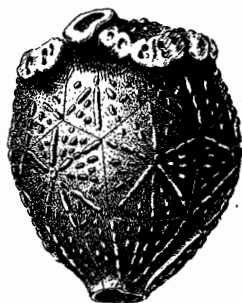
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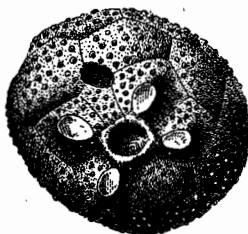
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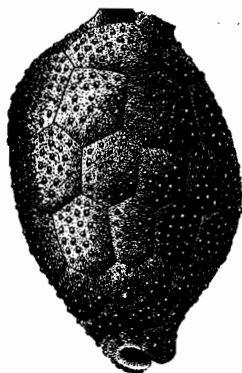
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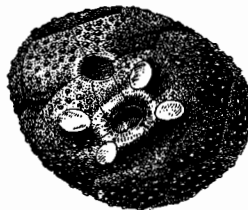
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10.



PLATE VI.

	Page.
Stephanocrinus osgoodensis, S. A. Miller. Fig. 1, the specimen figured originally; fig. 2, a much smaller specimen; fig. 3, summit view showing ambulacral areas, interambulacral plates, the five plates that cover the oral or central opening, and the anal opening; fig. 4, specimen broken off at the basiradial suture showing base of radials, apparently, uniting at the center. Magnified two diameters. All the figures on this plate are magnified two diameters	632
Stephanocrinus elongatus, n. sp. Fig. 5, side view, magnified two diameters	634
Stephanocrinus obpyramidalis, n. sp. Fig. 6, side view magnified two diameters	634
Stephanocrinus hammelli, n. sp. Fig. 7, summit view; fig. 8, side view of a large specimen; fig. 9, side view of a smaller specimen with a very small base. Magnified two diameters	635
Pisocrinus gemmiformis, S. A. Miller. Fig. 10, side view showing the heptagonal plate on the right that supports two radials, and the radial plate on the left; fig. 11, basal view; fig. 12, view from above, showing small central cavity and thickness of plates; figs. 24 and 25, supposed to be vaults of this or some other species in this genus. Magnified two diameters	636
Pisocrinus benedicti, n. sp. Fig. 13, side view, showing the position of the small radial, in the notch, between the upper approximate lateral sides of two large plates; figs. 14 and 15, basal views; fig. 16, summit view, magnified two diameters	639
Pisocrinus gorbyi, n. sp. Figs. 17 and 18, side views; fig. 19 summit view; fig. 20, side view with arm-blades in position, all of which are from Indiana; figs. 21, 22 and 23, the same species from Tennessee, but having a rather shorter calyx. Magnified two diameters	640
Zophocrinus howardi, n. sp. Figs. 26 and 28, side views of two specimens, with basal ends up (they should be reversed); fig. 27, summit view, with an eroded vault. Magnified two diameters	643
? ? ? Fig. 29, summit view; fig. 30, side view of same, magnified two diameters; fig. 31, summit view of another specimen; fig. 32, side view of same, magnified two diameters	631
Stribalocystites tumidus, n. sp. Fig. 33, view opposite the asygous side; fig. 34, basal view, magnified two diameters	630
Mariacrinus granulatus, n. sp. Fig. 35, basal view	645
Mariacrinus aureatus, n. sp. Fig. 36, side and basal view, magnified two diameters	644
Calceocrinus indianensis, n. sp. Fig. 37, side view of calyx and part of the column, magnified two diameters. The ventral arching plate should be more sharply pointed at the suture	645
Dichocrinus humbergi, S. A. Miller. Fig. 38, side view of calyx, magnified two diameters	646

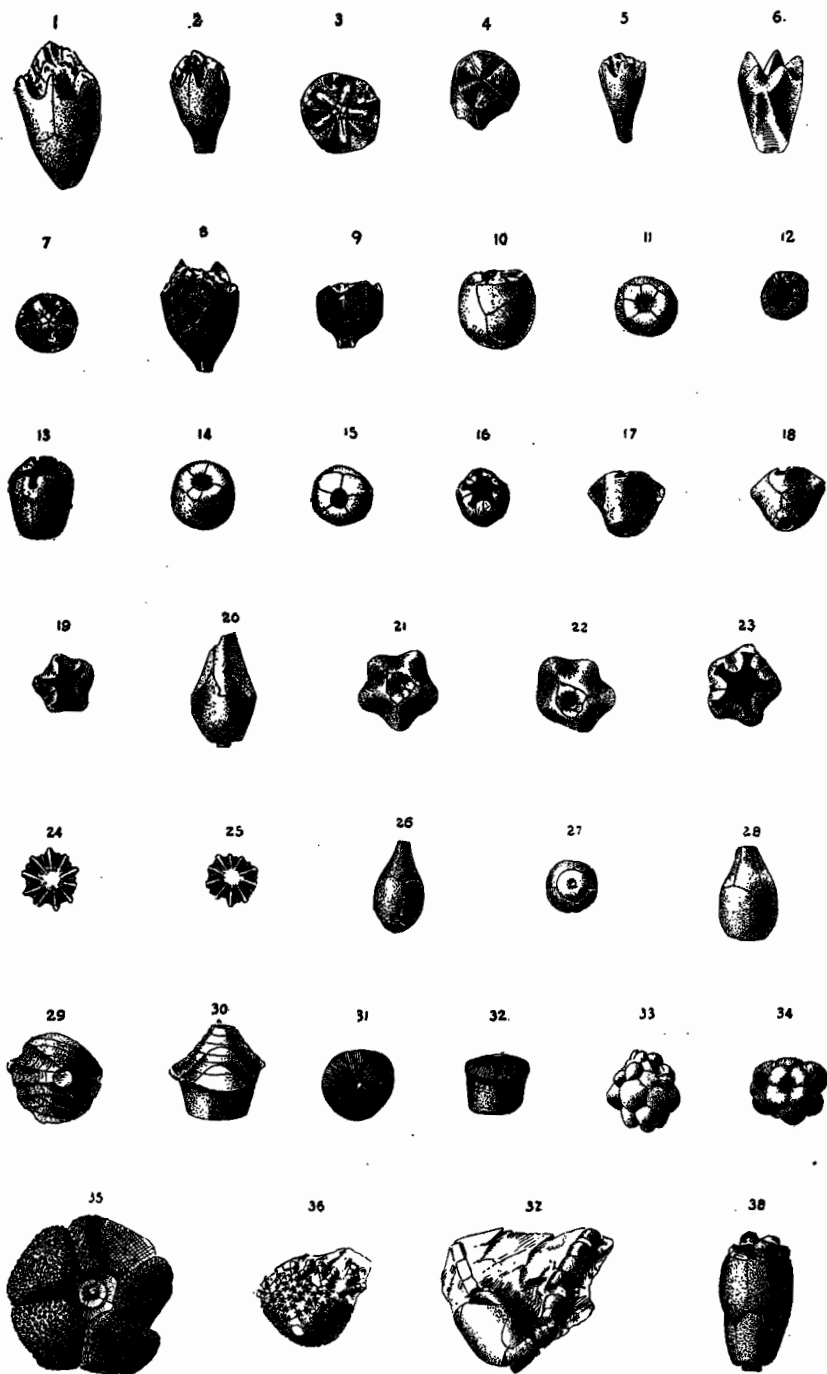


PLATE VII.

	Page.
<i>Alloocrinus benedicti</i> , n. sp. Fig. 1, basal view of calyx and part of the arms	647
<i>Scaphiocrinus porrectus</i> , n. sp. Fig. 2, side view, showing part of the arms and column	652
<i>Eucalyptocrinus subglobosus</i> , n. sp. Fig. 3, side view of an entire specimen	647
<i>Eucalyptocrinus ellipticus</i> , n. sp. Fig. 4, side view of nearly an entire specimen	648
<i>Eucalyptocrinus gorbyi</i> , n. sp. Fig. 5, side view of calyx; fig. 6, basal view	649
<i>Lecanocrinus tennesseensis</i> , n. sp. Fig. 7, view of azygous side of calyx; fig. 8, basal view	651
<i>Eucalyptocrinus eirodi</i> , n. sp. Fig. 9, side view of the calyx a little elevated at the top, so as to show the columnar cavity at the base; fig. 10, basal view of the same specimen	650

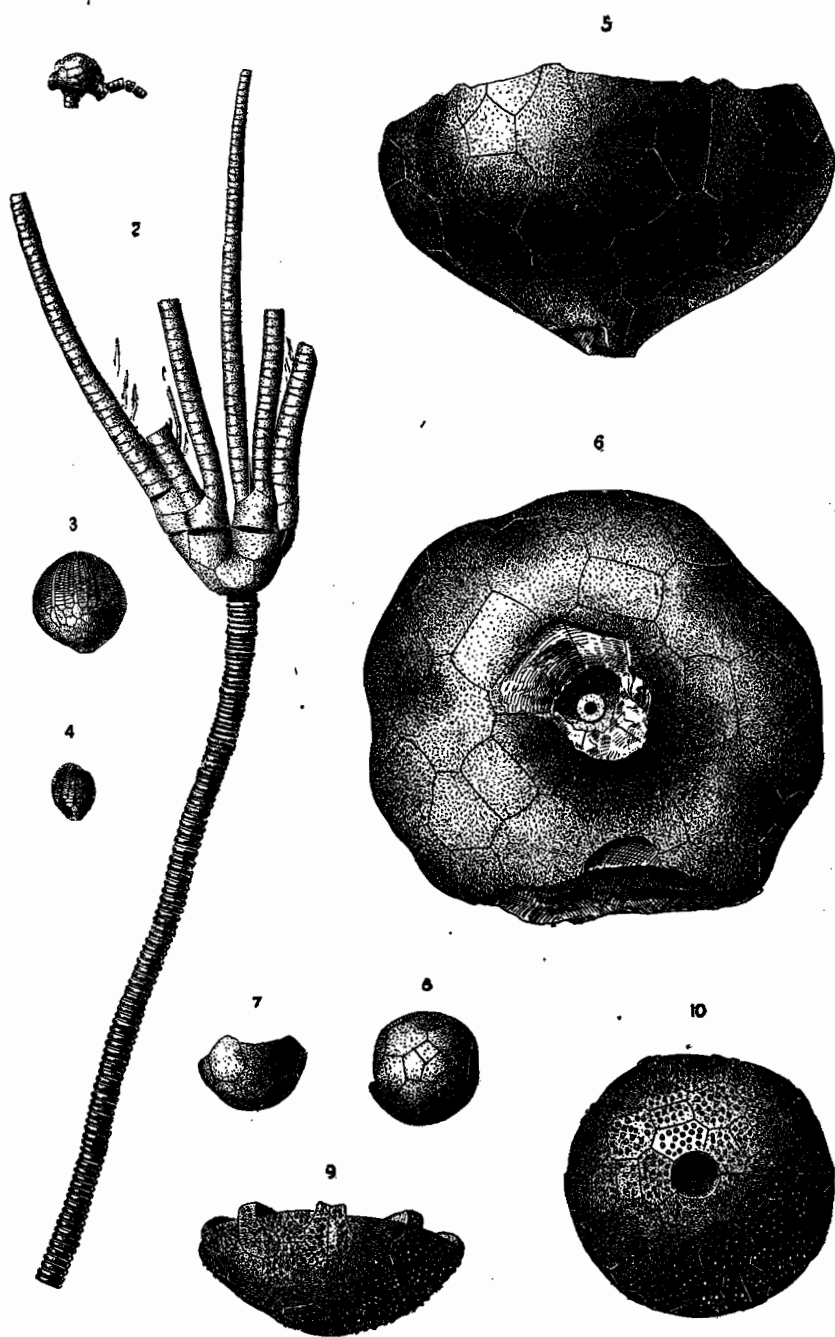


PLATE VIII.

	Page.
<i>Batocrinus agnatus</i> , n. sp. Fig. 1, symmetrical side; fig. 2, azygous side, specimen depressed	663
<i>Poteriocrinus boonvillensis</i> , n. sp. Fig. 3, side view; fig. 4, azygous view	652
<i>Agaricocrinus indianensis</i> , n. sp. Fig. 5, symmetrical view	663
<i>Poteriocrinus agnatus</i> , n. sp. Fig. 7, symmetrical side; fig 7, azygous view of the same specimen, which is injured at the azygous area	653
<i>Zeacrinus commaticus</i> , S. A. Miller. Fig. 8, a specimen eroded on the azygous side, showing part of the proboscis and what is supposed to be part of the convoluted organ	654
<i>Agaricocrinus gorbyi</i> , n. sp. Fig. 9, azygous view, a piece of a column in the azygous area	664
<i>Agaricocrinus splendens</i> , Miller & Gurley. Fig. 10, vault, with azygous area on the right.	665
<i>Agaricocrinus dissimilis</i> , n. sp. Fig. 11, side view of a vault, showing three arm openings in one radial series, the series on the right of the illustration is on the left of the azygous area and has four arm openings.	665
<i>Dichocrinus blairi</i> , n. sp. Fig. 12, specimen with arms and part of column, but having the calyx flattened.	646

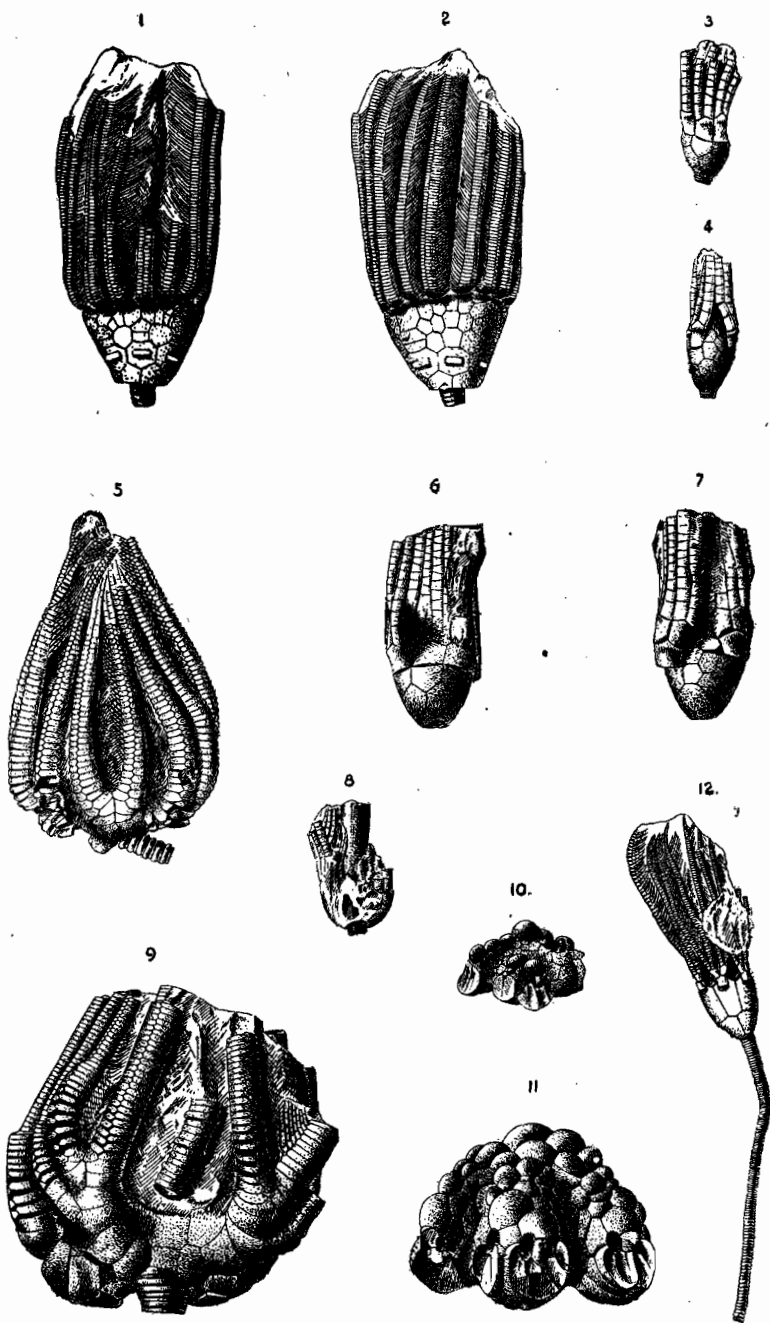
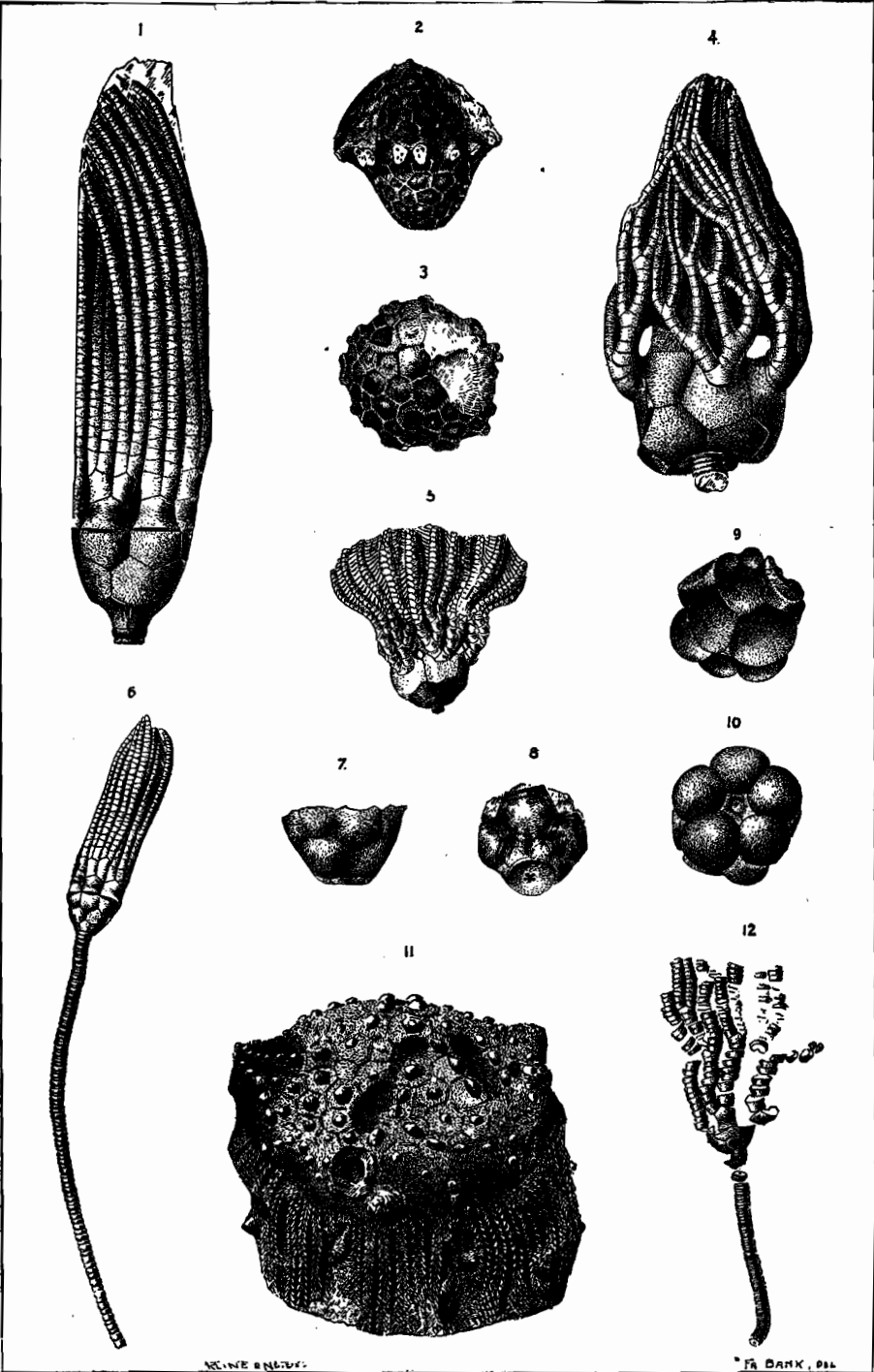


PLATE IX.

	Page.
Poteriocrinus coryphæus, n. sp. Fig. 1, view opposite the azygous side showing one ray with two arms and another with four. The specimen is somewhat flattened.	654
Saccocrinus gorbyi, n. sp. Fig. 2, lateral view, the azygous area being on the right; fig. 3, summit view, the outline of the plates being destroyed on the right. The specimen is a cast.	656
Cyathocrinus gurleyi, n. sp. Fig. 4, showing azygous plate and arms, the arms are torn from the opposite side so as to expose the proboscis, and two holes are shown, at the top of the calyx, in the illustration	657
Platycrinus alabamensis, n. sp. Fig. 5, side view; calyx flattened . . .	660
Poteriocrinus amœnus, n. sp. Fig. 6, view opposite the azygous side, showing one ray with four arms and one with two arms having single brachials, and one with two arms having two brachials	655
Cyathocrinus benedicti, n. sp. Fig. 7, view showing azygous plate . . .	658
Cyathocrinus sp. Fig. 8, view showing the basals and subradials	659
Eupachycrinus tumulosus, n. sp. Fig. 9, azygous view of calyx; fig. 10, basal view with azygous side below	680
Goniasteroidocrinus tuberosus, Lyon & Casseday. Fig. 11, side view, showing the vault and pendulous arms, exposing the arm furrows . . .	661
Scaphiocrinus sampsoni, n. sp. Fig. 12, view of a specimen as it appears on a slab, showing azygous side, arms and column somewhat fractured .	656



INDEX TO PLATES.

PLATE X.

	Page.
<i>Alloprosallocrinus gurleyi</i> , n. sp. Fig. 1, lateral view; fig. 2, basal view.	668
<i>Eretmocrinus lyonanus</i> , n. sp. Fig. 3, side view, showing azygous plates; fig. 4, basal view, part of two of the plates being broken away	669
<i>Batocrinus spergenensis</i> , n. sp. Fig. 5, side view; fig. 6, basal view; the specimen is slightly compressed	670
<i>Batocrinus decoris</i> , n. sp. Fig. 7, side view; fig. 8, basal view; some of the plates in the azygous area are anchylosed, and therefore not indicated	671
<i>Batocrinus mediocris</i> , n. sp. Fig. 9, lateral view, showing the ray having seven arms, including the small double arm	672
<i>Batocrinus gorbyi</i> , n. sp. Fig. 10, side view, with part of the arms removed showing calyx, vault and part of the proboscis.	673
<i>Batocrinus crawfordsvillensis</i> , n. sp. Fig. 11, side view, showing top of vault, and proboscis broken off; fig. 12, azygous view	674
<i>Batocrinus boonvillensis</i> , n. sp. Fig. 13, showing the right lateral series.	675

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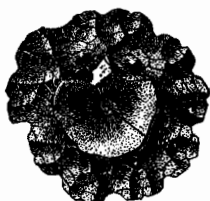
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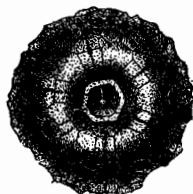
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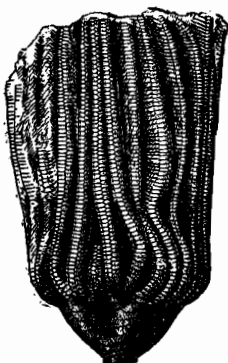
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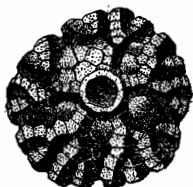
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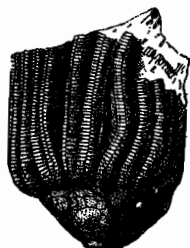
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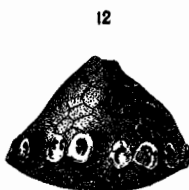
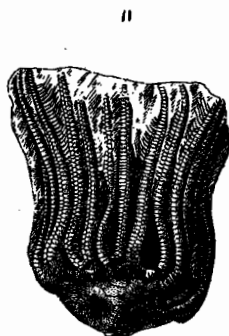
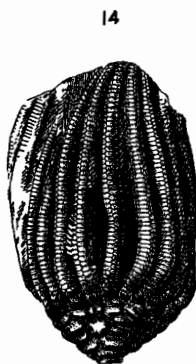
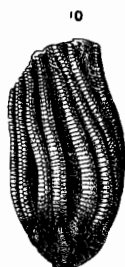
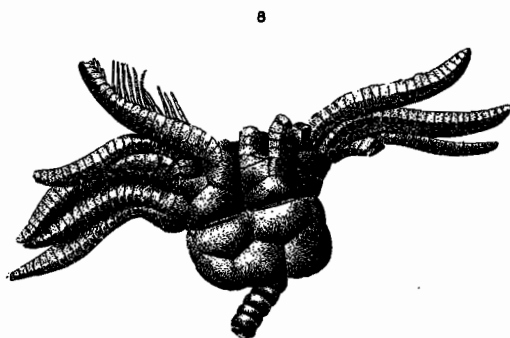
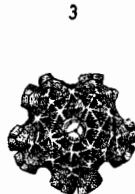
12



INDEX TO PLATES.

PLATE XI.

	Page.
<i>Blairocrinus trijugis</i> , n. sp. Fig. 1, summit view; fig. 2, side view; fig. 3, basal view;	679
<i>Pisocrinus campana</i> , n. sp. Fig. 4, side view; fig. 5, summit view	642
<i>Myelodactylus gorbyi</i> , n. sp. Fig. 6, side view; fig. 7, showing the circular pore in the outer whorl and the lines indicating the connection between the whorls and places of passage of the radiating pores. The two lower dark spots represent fractures	682
<i>Eupachyrcinus harii</i> , n. sp. Fig. 8, view opposite the azygous area	681
<i>Batocrinus gurleyi</i> , n. sp. Fig. 9, azygous view of calyx and vault; fig. 10, symmetrical view of specimen with arms	676
<i>Batocrinus venustus</i> , n. sp. Fig. 11, side view, showing arms; fig. 12, showing calyx and vault	677
<i>Batocrinus pulchellus</i> , n. sp. Fig. 13, side view of calyx and vault; fig. 14, side view, showing arms.	678

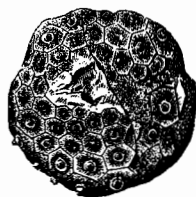


INDEX TO PLATES.

PLATE XII.

	Page.
<i>Eocidaris blairi</i> , n. sp. Fig. 1, flattened specimen, mouth central; fig. 2, specimen depressed in the opposite direction, or laterally, showing spines.	683
<i>Onychaster asper</i> , n. sp. Fig. 3, large specimen, covered with the outer integument of small plates and broken down spines; fig. 4, a smaller specimen, with part of the outer integument preserved and having the arms abruptly bent toward the ventral side; fig. 5, a still smaller specimen, showing the infolding arms, with part of the integument removed.	684
<i>Onychaster confragosus</i> , n. sp. Figs. 6 and 7, dorsal views of two specimens	684
<i>Onychaster demissus</i> , n. sp. Figs. 8, 9 and 10, three views of different specimens	685
<i>Cyathocrinus labyrinthicus</i> , n. sp. Fig 11, shows part of the large arm and numerous smaller ones; fig. 12, shows part of the larger arm, and the one on the left, wrapping around the calyx; fig. 13, shows the large first radial opposite the azygous area, which bears the larger arm; fig. 14, shows some of the numerous arms	659
<i>Scaphiocrinus gorbyi</i> , n. sp. Fig. 15, side view, the specimen is depressed.	656
<i>Echinodiscus sampsoni</i> , n. sp. Fig. 16, outer part of the specimen destroyed; mouth in the interambulacral area on the left	686

1



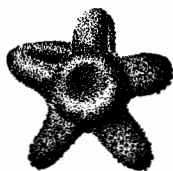
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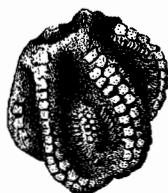
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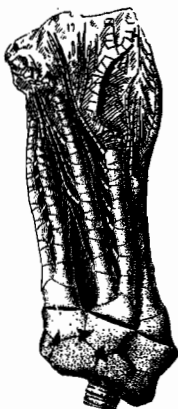
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15



14.



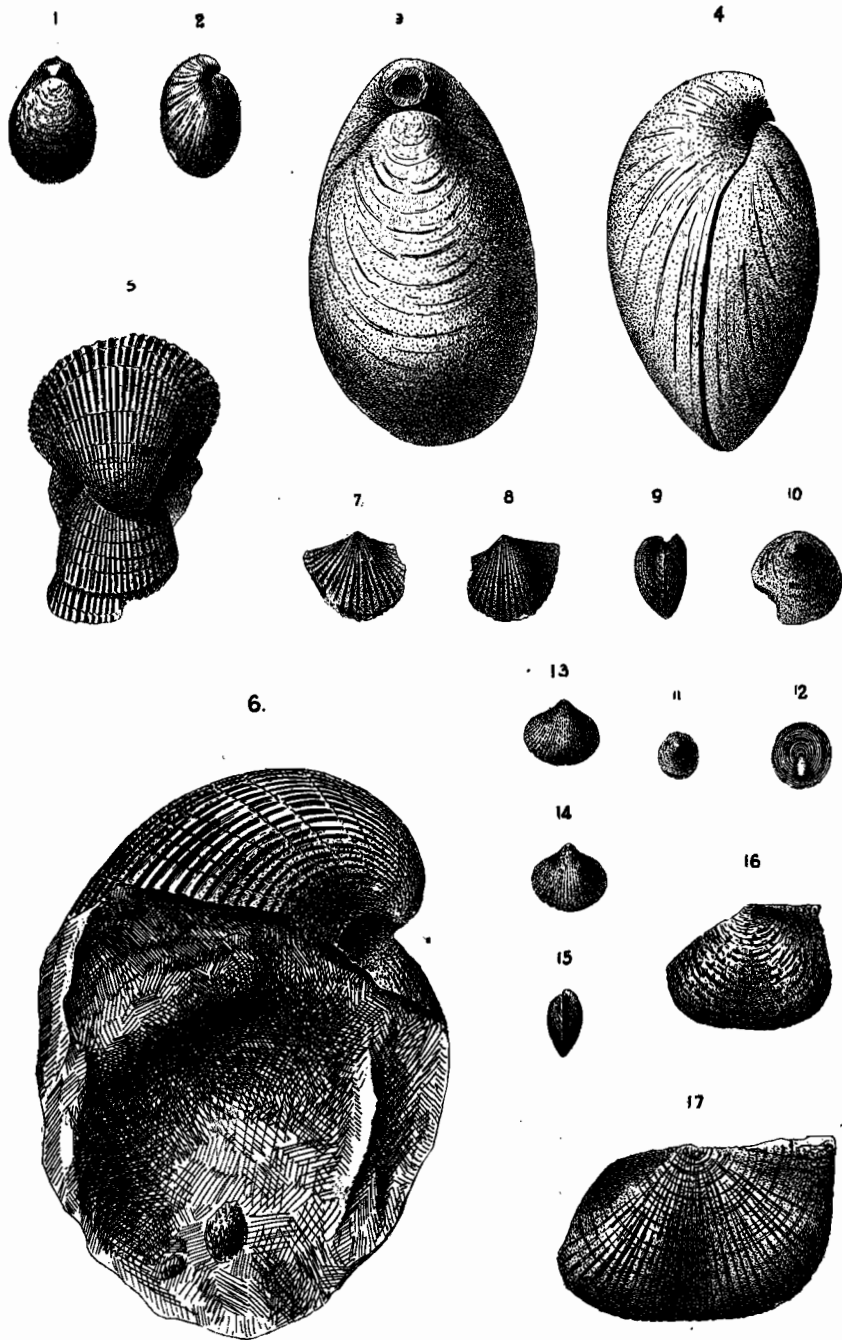
16



INDEX TO PLATES.

PLATE XIII.

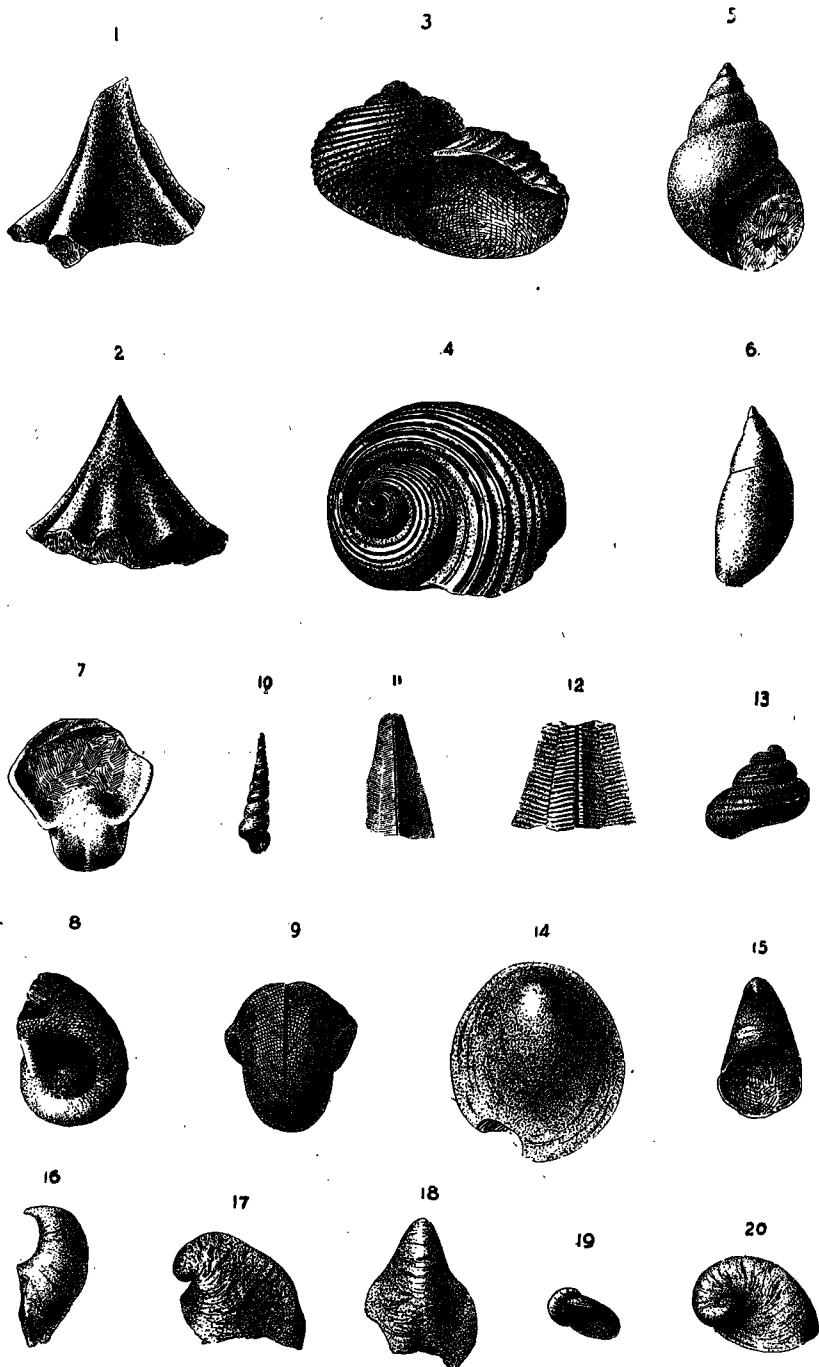
	Page
<i>Cryptonella ovalis</i> , n. sp. Fig. 1, dorsal view of a large specimen; fig. 2, side view of same	686
<i>Terebratula gorbyi</i> , n. sp. Fig. 3, dorsal view; fig. 4, side view of same. .	687
<i>Pentamerus colletti</i> , n. sp. Fig. 5, dorsal view of a fragment showing beaks and the narrowness of the species; fig. 6, side view of a specimen crushed in front.	687
<i>Orthis benedicti</i> , n. sp. Fig. 7, ventral view; fig. 8, dorsal view; fig. 9, lateral view	688
<i>Discina sampsoni</i> , n. sp. Fig. 10, cast of a large dorsal valve; fig. 11, smaller dorsal valve with shell only slightly exfoliated; fig. 12, cast of the ventral valve, showing concentric lines and longitudinal slit. It should be reversed on the plate so as to have the slit above	690
<i>Nucleospira indianensis</i> , n. sp. Fig. 13, dorsal view; fig. 14, ventral view; fig. 15, profile or lateral view	689
<i>Productus Blairi</i> , n. sp. Fig. 16, a cast showing the external markings of the dorsal valve, the shell being exfoliated; fig. 17, cast of the interior of the ventral valve, the shell being exfoliated	689



INDEX TO PLATES.

PLATE XIV.

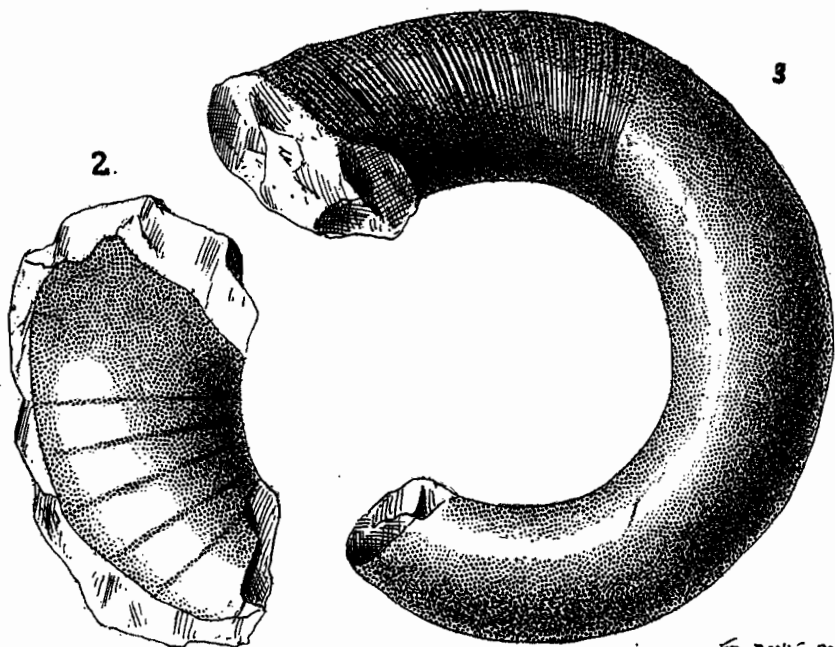
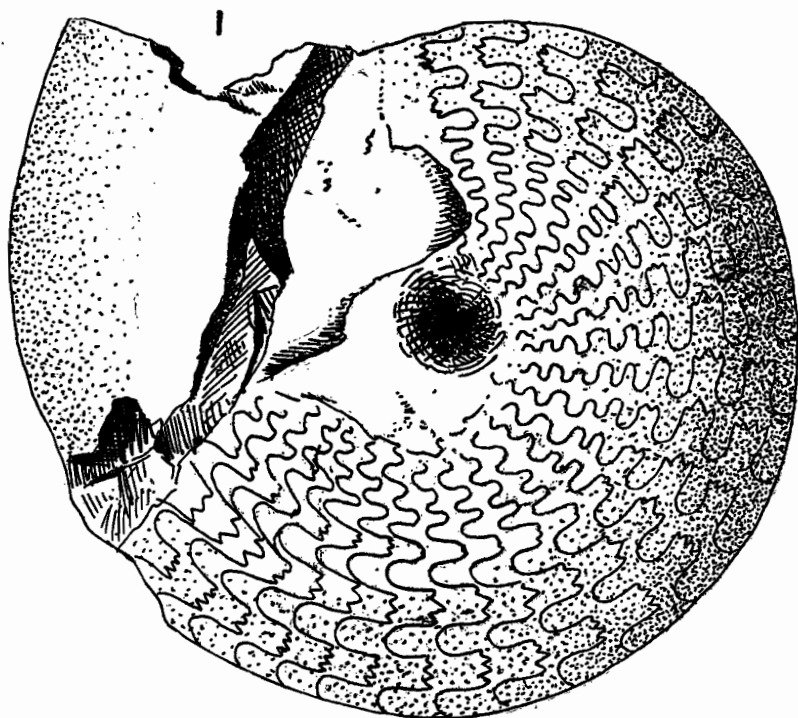
	Page.
<i>Platyceras pettisense</i> , n. sp. Fig. 1, lateral view of an internal cast . . .	691
<i>Platyceras missouriense</i> , n. sp. Fig. 2, lateral view of an internal cast. .	692
<i>Pleurotomaria harii</i> , n. sp. Fig. 3, front view, showing aperture and height of shell; fig. 4, summit view, showing surface furrows	693
<i>Macrochilina blairi</i> , n. sp. Fig. 5, front view	694
<i>Subulites benedicti</i> , n. sp. Fig. 6, posterior view.	694
<i>Bellerophon gorbyi</i> , n. sp. Fig. 7, front view; fig. 8, side view; fig. 9, dorsal view	694
<i>Aclisina bellilineata</i> , n. sp. Fig. 10, front view	695
<i>Conularia sampsoni</i> , n. sp. Fig. 11, natural size; fig. 12, part of same magnified two diameters	690
<i>Pleurotomaria sedaliensis</i> , n. sp. Fig. 13, lateral view	693
<i>Tryblidium indianense</i> , n. sp. Fig. 14, apical or dorsal view	695
<i>Platyceras boonvillense</i> , n. sp. Fig. 15, posterior view, showing aperture and apex; fig. 16, lateral view	692
<i>Platyceras nasutum</i> , n. sp. Fig. 17, lateral view; fig. 18, anterior view . .	692
<i>Platystoma broadheadi</i> , n. sp. Fig. 19, front view; fig. 20, summit and lateral view of a large specimen.	696



INDEX TO PLATES.

PLATE XV.

	Page.
Goniatites gorbyi, n. sp. Fig. 1, lateral view, showing part of the body chamber	700
Phragmoceras missouriense, n. sp. Fig. 2, lateral view	699
Straparollus blairi, n. sp. Fig. 3, part of the last whorl, showing some of the surface markings	696

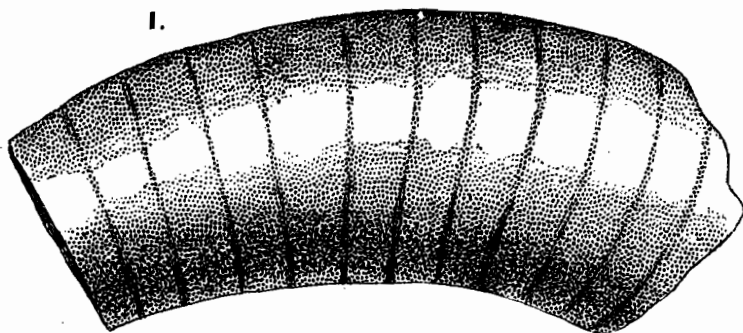


INDEX TO PLATES.

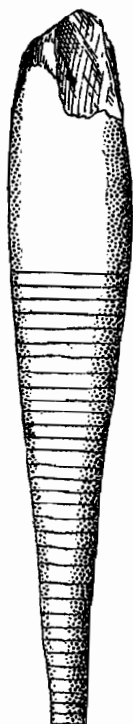
PLATE XVI.

	Page.
Cyrtoceras nashvillense, n. sp. Fig. 1, side view.	697
Orthoceras harii, n. sp. Fig. 2, specimen compressed in the central part, making it appear somewhat fusiform	697
Solenochilus rockfordense, n. sp. Figure 3, side view; plate XVII, fig. 1, dorsal view, showing siphuncle. Both illustrations rather smaller than the specimen	699

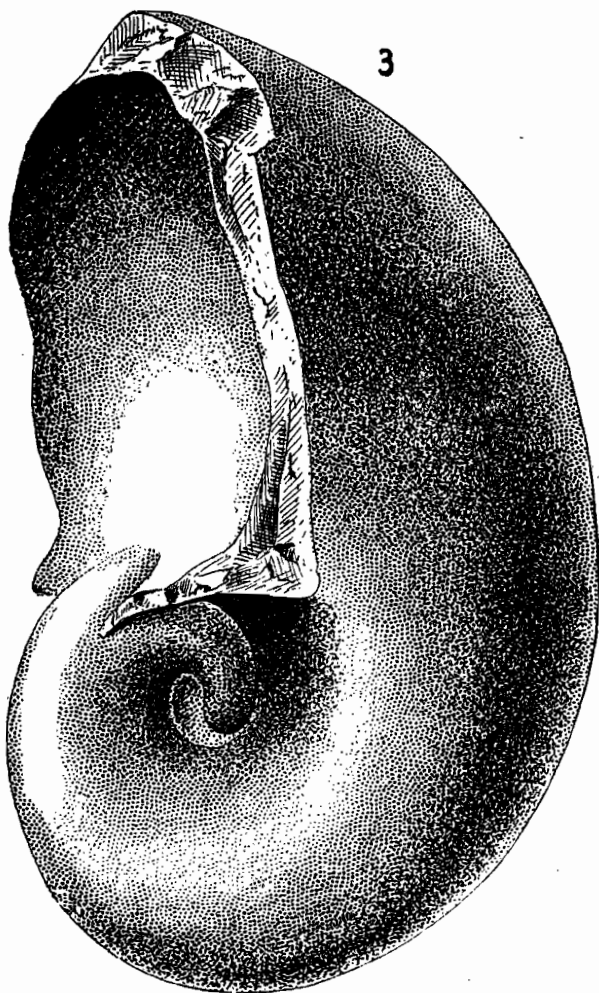
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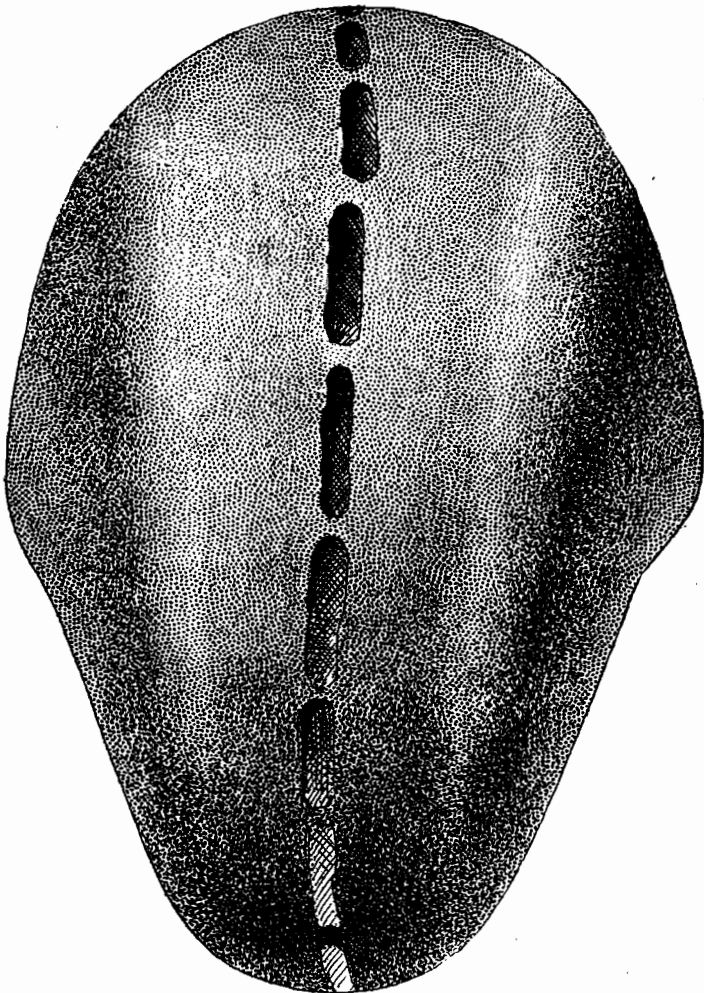
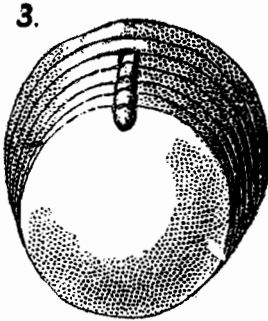
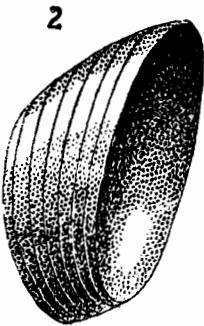
3



INDEX TO PLATES.

PLATE XVII.

	Page.
Cyrtoceras saffordi, n. sp. Fig. 2, side view; fig. 3, showing siphuncle. .	698
Solenochilus rockfordense, n. sp. Fig 1, dorsal view, showing siphuncle .	699



INDEX TO PLATES.

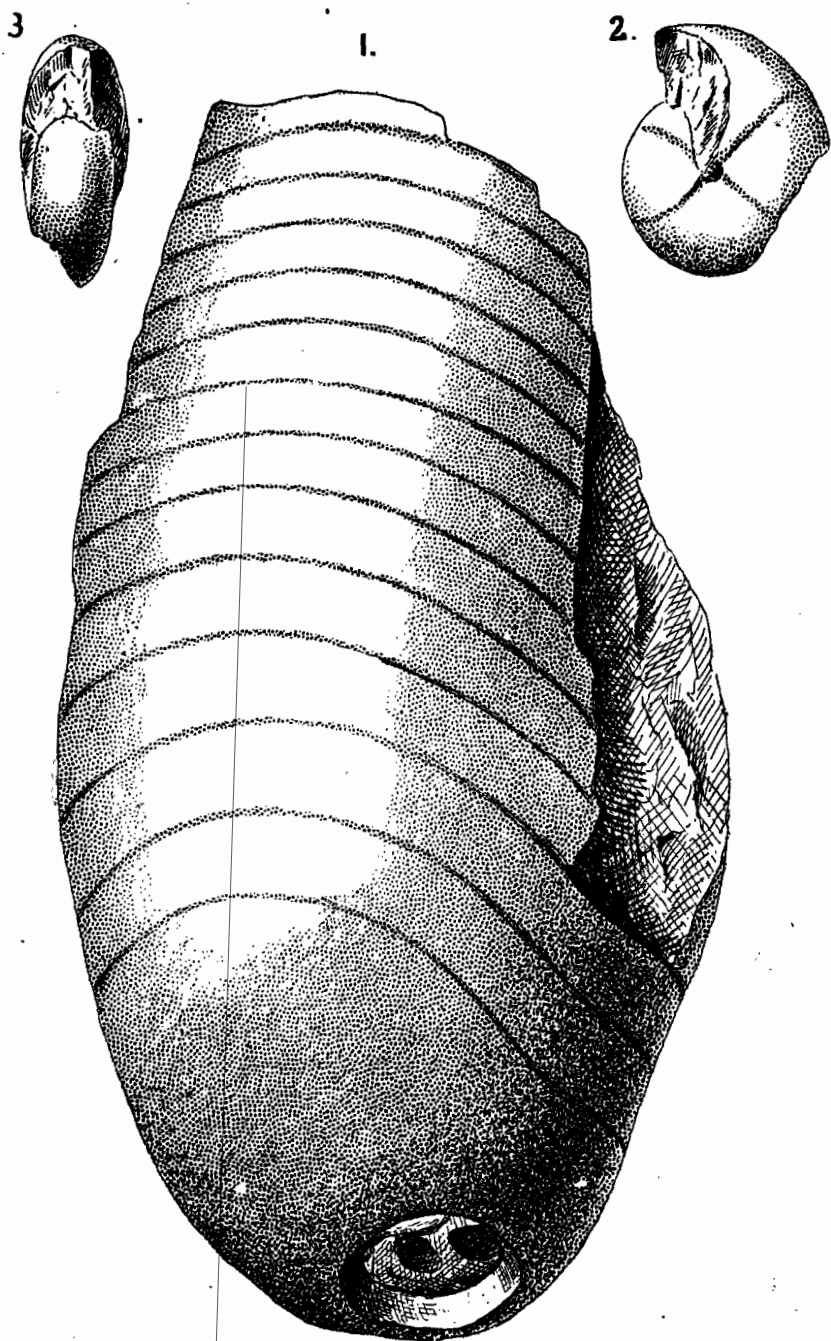
PLATE XVIII.

	Page.
Cyrtoceras indianense, n. sp. Fig. 1, specimen from St. Paul; fig. 2, specimen from Hartsville	698
Goniatites brownensis, n. sp. Fig. 3, side view; fig. 4, dorsal view, showing part of a septum	700



PLATE XIX.

	Page.
Gomphoceras clarki, n. sp. Fig. 1, showing siphuncle and curving speta.	698
Goniatis indianensis, n. sp. Fig. 2, side view; fig. 3, dorsal view of broken specimen.	700



INDEX TO PLATES.

PLATE XX.

	Page.
Schizodus harii, n. sp. Fig. 1, interior of left valve; fig. 2, left valve; fig. 3, cardinal view	701
Grammysia blairi, n. sp. Fig. 4, view of the two valves	703
Aviculopecten sculptillis n. sp. Fig. 5, left valve	702
Cypricardeila gorbyi, n. sp. Fig. 6, right valve; fig. 7, cardinal view . . .	702
Pterinopecten sedaliensis, n. sp. Fig. 8, right valve, with the posterior wing broken off; fig. 9, an entire specimen	703
Conocardium indianense, n. sp. Fig. 10, view of the ventral or under side from point of alation to the posterior end	704
Conocardium parvulum, n. sp. Fig. 11, side view, small piece broken from the posterior end. Magnified two diameters.	704
Conocardium exiguum, n. sp. Figs. 12 and 13, side views of two different specimens. Magnified two diameters	704
Conocardium elrodi, n. sp. Fig. 14, view of the ventral or under side, with the alation in front. Magnified two diameters.	705

