

# PALÆONTOLOGY.

BY S. A. MILLER.

## SUBKINGDOM PROTOZOA.

### CLASS PORIFERA.

#### FAMILY RECEPTACULITIDÆ.

##### RECEPTACULITES ELRODI N. SP.

*Plate I, fig. 1, lateral view; fig. 2, summit view; fig. 3, view of the tumid side; natural size.*

The illustrations will convey a good idea of this species, which is founded on a single specimen. It is a solid, arenaceous cast, not quite perfect at the base, and having a small piece chipped from one side.

Body somewhat pear-shaped in outline, one side much more tumid than the other, contracted toward the base and rounded toward the summit, with a well defined concavity in the crown, slightly inflected toward the least tumid side, and exhibiting several pores or openings, something like the crown of the well-known *Astylospongia præmorsa*.

The surface is divided into quadrangular, or more or less rhombic, elevated areas, of unequal size, formed by sigmoidial and longitudinal furrows that cross each other in quincunx. The furrows are of three kinds; the principal ones commence at the base, curve, at first, gently to the right, then become nearly transverse, and then curve upward and reach the summit concavity after having passed nearly around the specimen. These furrows are crossed, on the tumid side of the fossil, by furrows less sigmoidial, and on the less convex side by longitudinal furrows. At each crossing of the furrows a small pore may be seen penetrating the internal part of the body.

The silica in our specimen is rather coarsely crystalline, and does not appear to preserve any other characters than those described. It probably came from a limestone matrix, as it is not an uncommon thing to find silicious fossils in limestone strata of the Upper Helderberg Group at the locality in which it was discovered. It might be referred by some, on account of its form, to the genus *Ischadites*, but if that genus has a

character that distinguishes it from *Receptaculites*, it consists in the single central summit aperture, while this species has a concave summit containing several apertures. I know of no species with which it might be confounded.

Found in the Upper Helderberg Group, near Hartsville, Indiana, by Dr. M. N. Elrod, in whose honor I have proposed the specific name. It is now in his collection.

## SUBKINGDOM CÆLENTERATA.

### CLASS ANTHOZOA.

#### SUBCLASS ZOANTHARIA.

#### FAMILY CYSTIPHYLLIDÆ.

##### CYSTIPHYLLUM GREENII N. SP.

*Plate I, fig. 4, a piece from the middle part of a specimen showing lateral expansions, cone within cone and vesicular structure, and rudimentary septa at the lower end; natural size.*

Corallum simple, conico-cylindrical, very much elongated, more or less curved, exterior irregularly constricted and throwing off, at irregular distances, funnel-like expansions, which, in some instances, are remarkably prolonged. Septa rudimentary, appearing only as striæ, composed of elongated cells on the inner side of the outer wall. Calyx deep, funnel-shaped. Composed of cellular tissue, which is irregular in form, generally large and arranged in layers from within outward. The largest vesicles are external. The epitheca is not preserved in our specimens, and no costæ are to be seen on the outer surface even where seemingly well preserved.

The corallum attached by an expanded base to some foreign object. The method of growth was, by calicular gemmation causing the corallum to consist internally of a series of inverted cones, the newer within the older ones, the budding subcentral, the cones less than a line apart internally, and a number of them apparently converging together and producing on the concave side of the corallum external prolongations or funnel-like expansions an inch or more apart.

A specimen before me, six and one-half inches in length, with an expanded base of attachment, a diameter above the base of half an inch and at the top of nine-tenths of an inch, shows none of these prolongations. It appears externally as a solid corallum for two inches from the base, though the granular and vesicular structure is apparent and the surface is slightly pitted, and above this the large vesicles appear on the

surface and the inverted cone structure becomes more and more apparent. The inference is that more than this length has been broken from the lower end of the specimen illustrated. I have three inches broken from the top of the specimen illustrated, and from these evidences it may be inferred that the fragment illustrated is part of a specimen two feet or more in length. Mr. Greene writes me that he has a specimen twenty-two inches long.

This species is distinguished by its method of attachment, extreme length, slow increase in diameter, lateral expansions at irregular distances, deep inverted conical calyces, rudimentary septa shown on the inner side of the outer wall, and large elongated vesicles. I do not know of any particular species with which it is necessary to make any comparison.

Found by G. K. Greene, in whose honor the specific name is proposed, in the Lower Helderberg Group, at the Falls of the Ohio, and now in his collection.

In the Thirty-fifth Report of the State Museum of Natural History of New York, Prof. James Hall named and briefly described fourteen new species of *Cystiphyllum*, without any illustrations. If one had all the types before him it would be much less work and require much less time to write original descriptions of them than it would to identify them from his names and descriptions, and it would require twenty times as much work to identify them from other collections as it would to write original descriptions. Such work, even by so eminent a palæontologist as Professor Hall, is a downright obstacle in the way of progress in learning, and ought not to be recognized. Indeed, unless he illustrates them in future, I very much doubt that any one will ever recognize all of them.

## FAMILY CYATHOPHYLLIDÆ.

### AMPLEXUS CINCTUTUS N. SP.

*Plate I, fig. 5, point of attachment upward, natural size; fig. 6, another specimen, natural size, base downward.*

Corallum simple, conico-cylindrical, elongate, slowly expanding, when complete more than six inches in length, curving more or less in the lower part, but substantially straight above, and profoundly constricted. Cup deep, margin thin. Longitudinal rays or septa very numerous in the outer wall, and in the expansions closely arranged, but most of them terminate within a short distance from the outer wall, the others approximate the center. Central part occupied by horizontal compact tabulæ, and spaces between the septa filled with coarse vesicular tissue. Exterior transversely wrinkled and when eroded showing small elevations at the junction of the cysts or vesicles with the septa; in either

case showing a somewhat finely fenestrated or rectangularly roughened surface.

The corallum expands rapidly from the base and soon throws out abruptly a horizontal flange around the cup; commencing again within this flange it contracts slightly, then slowly expands for a short distance, forming a concave ring, and then throws out horizontally another flange or expanded margin of the calyx. This method of growth is repeated as the coral increases in length. The distance between the abrupt dilations or expansions of the cup does not seem to depend upon the diameter of the corallum, but varies from two-tenths to eight-tenths of an inch, as shown in our specimens. The expansions terminate in very thin edges and frequently give a depth to the annulations or constrictions equal to the distance between the expansions. It does not seem to be properly articulated, but the extraordinary expansions correspond with the articulations in typical species of the genus.

Found by Dr. Howard, in the Niagara Group, at St. Paul, Ind., and now in the State Museum, at Indianapolis.

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*Plate I, fig. 7, natural size.*

This fan-shaped cast of some organism is on a blue limestone rock from the Niagara Group, at St. Paul, Ind., and belongs to the State Museum, at Indianapolis. It was collected by Dr. Howard. It appears from the fracture to have been attached to some other object, as shown in the upper end of the illustration. The surface is smooth, there is no ornamentation near the point of attachment, and it is radiately ribbed toward the margin. The circular margin of our specimen is broken and buried in the rock. The surface shows no pores or other structure. It will be noticed that the specimen constitutes nearly one-fourth of a circular plate and looks like a lady's fan partly spread out. A few years ago I saw the same organism from the magnesian limestone of the Niagara Group, at Chicago, Ill., and as I now recollect four of them formed a complete circle and constituted a single organism divided into four parts, and which had attached to some other object at the central part. It was suggested that it might be the operculum of some coral, but against this supposition is the fact that no coral has been found, either at Chicago or St. Paul, large enough for such an operculum, beside it does not resemble any known operculum. It is illustrated for the purpose of attracting attention to it, and with the hope and expectation that some one will be able to determine its relations. I have no knowledge as to what class in the animal kingdom it should be referred and, therefore, propose no name for it.

## FAMILY CYCLOLITIDÆ.(?)

## MICROCYCLUS BLAIRI, N. SP.

*Plate IX, fig. 27, a large specimen; fig. 28, a smaller one.*

Corallum very short, thin or discoid. Periphery sharp. Under side nearly flat and covered with a concentrically wrinkled epitheca. Upper side very slightly elevated centrally and abruptly bent down at the margin to the sharp periphery. Septa thick, one-half of them extend from the margin a little more than two-thirds of the distance to the center; and the other half, being intercalated or produced by bifurcation, extend from the margin one-fourth or less than one-fourth the distance to the center. In a small specimen there are about fifteen of the longer septa and very few of the shorter ones, some of which are indistinct, even at the margin; but in a large specimen there are about twenty-five of the longer septa and the same number of the shorter ones. The central area is smooth and nearly flat or has a small central tubercle. The fossette is shallow, slightly indents the smooth central area, and becomes obsolete before reaching the margin. Breadth of one of the largest specimens, .50 inch; height, .07 inch.

This species is comparatively thinner or shorter than *M. discus*, the septa approach more nearly to the center, and the fossette is wholly different, for in that species it is well defined and extends from the center to the margin. I have no confidence in the reference of this genus to the family *Cyclolitidæ*, for it probably belongs to an undefined family.

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

## FAMILY FAVOSITIDÆ (?).

## STRIATOPORA GORBYI, N. SP.

*Plate VIII, fig. 1, natural size, showing ramose method of growth, distribution of cells, and some rosettes of chalcidony on the lower part.*

Corallum ramose, solid, terete, and attaching, by a widely expanded, thin base, to some other object.

The type specimen branches in two equal parts within seven-tenths of an inch from the base; each division immediately branches again, one division rising nearly perpendicularly; and again within a very short distance each lower branch throws off a perpendicular ascending one, and again a bifurcation takes place in like manner, while the lower limb is gradually curving downward until it is nearly horizontal with the first division. The perpendicular ascending branches bifurcate at irregular distances and at varying angles, but there is a general disposition to throw off nearly horizontal branches, from which arise nearly perpendicular ones, or those ascending at angles varying from 75 to 90 degrees.

The cell apertures are distantly distributed over the base and lower part of the branches, but occupy nearly the whole surface of the smaller and higher branches; that is, they gradually approximate in the younger stages of growth. On the base the apertures are funnel-shaped and surrounded by slightly elevated margins, more or less distant from each other. On the branches they assume more and more the shape of a funnel, cut diagonally from one side of the top to near the pipe, which form becomes more and more elongated in ascending the branches. On the smaller branches these elongated half funnel-shaped cell mouths are separated only by narrow ridges and linear margins. The cell mouths are of unequal size and irregularly distributed over all parts of the corallum. They never alternate in regular order on any branch. The striae are not visible in the apertures, on our specimen, and if they ever had an existence, as is quite probable, they were very delicate and have been obliterated.

Only two species, in this genus, have been described, from rocks of the same age, one, *S. huronensis*, from a mere fragment of a specimen, and the other, the type of the genus *S. flexuosa*. As the whole manner of growth and form of the cell apertures, in this species, is quite distinct from both, no comparison with either is necessary. The rosettes shown in the illustration are chalcedonized spots, which, of course, have nothing to do with the structure of the coral. The genus is usually classed in the Family Favositidæ, but I am by no means satisfied with the classification.

Found by Dr. Howard in the Niagara Group, at St. Paul, Indiana, and now in the State Museum at Indianapolis. The specific name is in honor of Prof. S. S. Gorby.

## SUBKINGDOM ECHINODERMATA.

### CLASS CRINOIDEA.

### ORDER CYSTOIDEA.

### FAMILY HOLOCYSTIDÆ.

### HOLOCYSTITES AMPLUS, N. SP.

*Plate II, fig. 1, dorso-lateral view, natural size. Base broken off and specimen injured on the antero-lateral side.*

Body very large, elongate-subovate. Plates convex, very unequal in size and irregular in form, having from four to nine sides and a diameter from one to five-tenths of an inch. Owing to this diversity they are not disposed in ranges. All the plates are perforated by numerous pores.

The ambulacral orifice is situated centrally upon the apex of the summit and in the center of a triangle formed by three prominent arm bases. One of these arm bases is opposite the most tumid side of the specimen, and what appears to be the mouth is situated laterally outside the triangle. The plates are broken at this place and hence the mouth can not be described.

Our specimen has a diameter through the tumid side of two and one-half inches, and laterally about two and a quarter inches. The lower end is broken away leaving preserved about three inches in length. The length broken off can not be determined because we do not know whether the species was sessile, free or attached by a column and roots to some other object. If the plates in our specimen were thrown into ranges, there would be about eleven or twelve, and if the specimen were complete, it would show two or more additional ranges.

This species resembles *H. ventricosus* more than any other one heretofore described. It may be distinguished by its shorter and more ventricose form and smaller plates. The summit of *H. ventricosus* is unknown, but it is believed to be quite different from this species, because that which is preserved in the type specimen does not show the rounding in toward three large arm bases, which is a feature in this species.

Found near Madison, Indiana, in the lower part of the Niagara Group.

#### ÆTHOCYSTITES, N. GEN.

[*Ety. athes*, unusual; *kustis*, bladder.]

This genus consists of the bodies of elongated, subelliptical cystoidea of undetermined family affinity. Probably they do not belong to any defined family. There are only three ranges of plates. In the first range there are only three plates; they form an obconical cup commencing from a small column. In the second range there are evidently five elongated plates, though none of our specimens show the entire circlet. The third range consists, as near as can be determined, of five much shorter plates. The plates are ornamented with wrinkles, and bear tubular ridges radiating from a central point, in the middle range, and which follow the longitudinal sutures or center of the first and third ranges, and have porous connection with the interior of the body. The plates do not possess pores after the manner of *Holocystites* or *Caryocrinus*, and no pores have been determined, except as above stated. Type, *Æ. sculptus*.

*ÆTHOCYSTITES SCULPTUS*, N. SP.

*Plate II, fig. 2, side view, natural size.*

This species, as well as the genus, is founded upon three specimens, one is illustrated, another shows the three basal plates, but no other characters not shown in the figure, and the other one is an imperfect cast on one side, and shows only part of two plates on the other.

The general form is subelliptical, being somewhat pointed at the lower end and more rotund above. It is very evident it possessed a column, because the facet for its attachment and the perforation are distinct. The three basal plates form an obconical cup, as high as wide, truncated below for a small round column. The plates are longitudinally wrinkled, and have a tubular ridge, from each upper angle to a smooth rim at the base; these run down the center of each plate and down each side of the longitudinal sutures. They connect with radiating tubular ridges, in the second range, notwithstanding they cross the transverse sutures. Pores pass through the plates from the beds of the canals, at varying distances from each other, which are open where the surface is eroded. The mouths of these canals or the outer orifices are not preserved.

As stated in the generic definition, I suppose there are five plates in the second range, and they have a length nearly equal to that of the first and third ranges. I will define a single plate, which is shown in the illustration. It is hexagonal; greatest length, 1.03 inches; diameter at the lower lateral angles, .70 inch; diameter at the upper lateral angles, .56 inch. The lateral sides are straight and converge a little upward. The plate is convex, and the summit of the convexity is below the middle, at which point there is a tubercle, from which a raised ridge radiates to each of the four lateral angles and to the lower angle, making five ridges. These ridges enlarge in their extension toward the angles; erosion has shown they are tubular a short distance from their commencement, and are connected with the internal economy of the animal by connecting pores. The three that radiate below connect with like tubular ridges in the first series of plates, and the two that radiate upward connect with like ridges in the central part of each plate, in the third series, which reach the summit. Between the two upper radiating ridges the plate is concave, the most so at the summit of the plate. Between the upper and lower radiating ridges the plate bears longitudinal wrinkles, which connect with like wrinkles on the plates above and below. Laterally between the radiating ridges the plate is transversely wrinkled, and the wrinkles connect with like wrinkles on the adjoining plates.

The plates in the third range are longitudinally convex or subangular in the central part and depressed at the sutures. Surface longitudinally wrinkled. Summit unknown.

Found by Dr. Howard, in the Niagara Group, at St. Paul, Indiana, and now in the State Museum, at Indianapolis.



## FAMILY STRIBALOCYSTIDÆ.

## STRIBALOCYSTITES GORBYI, N. SP.

Plate II, figs. 3, 4 and 5, lateral, summit and basal views; figs. 6, 7 and 8, azygous, summit and basal views of a smaller specimen.

Body globose, plates convex, sculptured, pores numerous; sutures beveled. Basals, four, unequal, longitudinally angular in the central part; deep columnar cavity, pierced by a small round orifice for the columnar canal. Six plates in the second series of unequal size, radiately sculptured, two pentagonal, two hexagonal and two heptagonal. The heptagonal plates are the larger plates in the series. The azygous plate is hexagonal, the plate on either side is heptagonal, the one opposite the azygous plate is hexagonal, and the one on either side is pentagonal. Eight plates, in the third series, of unequal size and not in line by reason of curving over the heptagonal plates in the second range.

The central summit plate bears a spine and is surrounded by six small convex plates, in the larger specimens, but in the smaller specimens there is no central summit plate, but five plates cover the summit, instead of seven, as represented in the larger specimens. Among some fossils such a difference would be valued as of specific importance, but among Cystideans it can hardly be so regarded. The mouth is prominent and excentric. Three pairs of pores pierce the top between the third range and the central summit plates, and there are two or three extra plates which are pierced at each pair, making about thirty-two plates in all.

This species is distinguished from *S. tumidus* by the sculptured plates, construction of the summit, arrangement of the orifices and porous character of the plates. These differences may be regarded as of generic importance, but I have treated them as only of specific value, because the fossils agree in the number and arrangement of the three ranges of plates. No pores were detected in the plates of *S. tumidus*; nevertheless, minute ones may exist, while in this species they are very distinct. In *S. tumidus* there is an ambulacral orifice in the center of the summit, while in this species, at the corresponding place, there is a spinous plate, or abutting plates, and no ambulacral orifice. The mouth, in this species, is surrounded with six plates, two of which, adjoining the third range, are very small, while in *S. tumidus* the plates separating the third range from the mouth are large. The three pairs of pores on the top is a character not represented in *S. tumidus*.

Found by Dr. Howard in the Niagara Group at St. Paul, Indiana, and now in the State Museum at Indianapolis.

## ORDER AGELACRINOIDEA.

## FAMILY AGELACRINIDÆ.

## AGELACRINUS BLAIRI, N. SP.

*Plate II, fig. 9, magnified two diameters.*

This is a small species founded upon a single specimen that is on the arms of a *Batoerinus*. It is a little injured at the margin, but otherwise almost perfect. The body is circular, moderately and evenly convex above, and conforms to the arms of the *Batoerinus* below. The disc or outer rim is composed of numerous squamiform imbricating plates; those on the margin are the smaller ones, and they increase in size toward the inner part of the rim. The plates in the disc are proportionally smaller and more numerous than they are in *A. cincinnatiensis* or *A. pileus*. The arms are slender, depressed nearly even with the surface of the body, radiate from the central part of the body toward the rim in nearly straight lines, four of them curving slightly to the right and the other curving slightly to the left. They are composed of interlocking plates, without, so far as can be discovered, any small intercalated ones. The aperture is in the central part of the area between the sinistral and dextral arms. The interbrachial areas are covered with a few rather large imbricating plates. The arrangement of the plates at the summit is peculiar, but they are so minute and the sutures are so obscure that it is very difficult to determine their disposition.

This species is so different from all others that have been defined that no comparison is necessary. 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.

## ORDER BLASTOIDEA.

## FAMILY STEPHANOCRINIDÆ.

## STEPHANOCRINUS CORNETTI, N. SP.

*Plate II, fig. 10, shows the length of a specimen, but it is much eroded and broken away; fig. 11, summit of another specimen; fig. 12 shows the surface ornamentation, but it is broken at both ends.*

This species is remarkable for its great length. The three basal plates form a solid, truncated, obpyramidal body more than a half inch in length, and about two and a half times as long as the greatest diameter. It is hexagonal in transverse section, but unequal sided. The surface is transversely lined. The five radial plates are longer, including the radial limbs, than the basals, and expand a little more rapidly. Transversely, they are hexagonal in the lower part, with unequal sides, and

have a suture in the middle of each side, and a central longitudinal ridge in each plate. Toward the top each side becomes more and more convex until obtuse angles are formed at the sutures. They are very deeply excavated above for the reception of the ambulacral structure. The surface is longitudinally lined in the flat areas, and transversely lined on the angular ridges. The summit is only slightly convex over the ambulacral areas. There is one thin, wedge-shaped plate in each interambulacral area, one of which is truncated by a round anal opening. The ambulacral opening is large, pentagonal, and covered with five plates. The ambulacra have a small central ridge.

The slender form, extreme length, long radial limbs and surface ornamentation will distinguish this form from all other species.

Found in the Niagara Group, at Madison, Indiana. The specimens represented by figures 10 and 11 belong to Mr. J. F. Hammell, and figure 12 to Prof. Geo. C. Hubbard. The specific name is in honor of Dr. W. T. S. Cornett, a geologist and naturalist of Madison, Indiana.

## ORDER PALAEOCRINOIDEA.

### FAMILY PLATYCRINIDÆ.

#### PLATYCRINUS CADUCUS, N. SP.

*Plate II, fig. 13, natural size.*

Calyx small, bowl-shaped, wider than high; plates convex, sutures beveled, surface granular. Column large. Basals low; upper faces concave for the reception of the first radials. First radials wider than high; slightly expanding above; articulating facets for the second radials about three-fourths the width of the plates and sloping downward and outward in the central part of the plates; upper faces slope laterally from the articulating facets to the sutures, for the reception of the small interradials. Second radials short, axillary. There are two secondary radials in each series, the second one of which is axillary. One of the inner arms in each series bifurcates again on the second plate, which gives to each series five arms, or twenty-five arms in the species. The arms are rather large in proportion to the size of the calyx, and consist of a double series of interlocking plates following one or two cuneiform plates resting on the axillaries.

This seems to be a smaller species than *P. æternalis*, the calyx is less angular, there are only twenty-five arms instead of thirty, and fewer cuneiform plates in the arms, before the commencement of the double interlocking series. It need not be compared with any other defined species.

Found by F. A. Sampson, in the Keokuk Group, at Boonville, Missouri, and now in his collection.

## PLATYCRINUS CHOUTEAUENSIS, N. SP.

*Plate II, fig. 14, basal view; fig. 15, first radial magnified two diameters.*

Species large. Calyx broadly bowl-shaped, being twice as wide as high; plates thick; sutures beveled; surface roughly granular. Some of the granules coalesce in lines, as seen on the best preserved plates, but the more common ones are so worn as to be nearly smooth; edges of the plates denticulated to hold the plates in place and give strength to the body.

Basals form a low pentagonal, saucer-shaped cup or disc, with a rather large columnar depression, which is radiately furrowed for the articulation of the column. First primary radials a little wider than high, sides slightly expanding from below, but straight or slightly contracted above; most convex at the articulating facets which are quite prominent. Articulating facets for the second radials transversely elliptical, with a protruding outer rim, occupying more than two-thirds the width of the plates and having the lower line at the middle of the plates. The facet is deep, has a transverse articulating ridge in the central part, with a serrated edge below it, and an elongated pit on each side of the ambulacral notch. Each plate has a deep ambulacral notch, acutely angular below, and on each side of this notch on the upper face there are two facets for abutting plates; hence, two secondary plates or one secondary and one tertiary plate united with the first radials in this species. First interradials not large. Arms unknown.

The general form, articulating facet, deep ambulacral notch and double articulating facets above, will distinguish this from all other described species.

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

## PLATYCRINUS COLLETTI, N. SP.

*Plate II, fig. 16, basal view, natural size; fig. 17, first radial magnified two diameters.*

Species medium size; calyx saucer-shaped; height to width, about as three to five; plates not very thick; sutures beveled; surface covered with tubercles, which, when well preserved, run together and give it a rough and shaggy appearance.

Basals form a low pentagonal saucer or disc, with a medium sized columnar depression surrounded with a rim that extends a little below the end of the attaching column. First primary radials nearly one-fourth wider than high; sides straight and rapidly expanding from below to the upper lateral angles; most convex at the articulating facets, which have a slightly projecting rim nearly perpendicular to the diameter of

the calyx, and are only slightly excavated within it. A facet is rather more than a half circle, occupies about one-half the width of a plate, and is located centrally in the upper half of a plate and bears a slightly concave depression, indicating the place for the ambulacral furrow. Each superior lateral angle of a plate is truncated from the margin of the facet to the suture for the reception of the interradials. First interradials large. Arms unknown.

The general form, surface ornamentation, articulating facets and large interradials, will distinguish this from all other described species.

Found by R. A. Blair, in the Chouteau limestone, near Sedalia, Mo., and now in my collection. The specific name is in honor of Prof. John Collett, late State Geologist of Indiana.

### FAMILY RHODOCRINIDÆ.

#### RHODOCRINUS BENEDICTI, N. SP.

*Plate II, fig. 18, lateral view; fig. 19, summit view; fig. 20, basal view, natural size.*

Species small; calyx globular, rounding over to the base of the arms; diameter in the central part greater than the height to the arm bases; sutures distinct; plates convex, some of them being angular in the center or of a low pyramidal form. Basals small, forming a slightly depressed flattened pentagonal disc about twice the diameter of the column. Subradials, the larger plates of the body, highly convex in the central part, with ridges extending to each adjoining plate. First radials nearly as large as the subradials, heptagonal, convex, and having less conspicuous ridges extending to the adjoining plates than characterize the subradials. Second radials smaller than the first, convex, pentagonal. Third radials about as large as the second, pentagonal or hexagonal, axillary, and supporting on each upper sloping side two tertiary radials, the second one bearing an arm, which gives to the species ten arms. In one of our specimens there are only two primary radials in one of the series which is probably abnormal.

Regular interradials, ten; the first one truncates a subradial, the last three or four are quite small. Azygous interradial area much like the regular areas, and having only one or two more small plates. One intersecondary radial in each series. Vault convex or tumid and covered with numerous small highly convex plates. Column round and composed near the head of alternately thicker and thinner plates. Columnar canal small and round. This is a marked species that will not be confounded with any hitherto described.

Found by A. C. Benedict, in the Keokuk Group, in Harrison County, Ind., and now in his collection. The specific name is in his honor.

## FAMILY ACTINOCRINIDÆ.

## ACTINOCRINUS SEDALIENSIS, N. SP.

*Plate III, fig. 1, azygous side view of a calyx somewhat injured in the middle part; fig. 2, cast of the azygous side of another specimen; fig. 3, cast of the vault of the same specimen, only part of the outlines of the plates can be distinguished.*

Calyx large, elongated, urn-shaped, deeply depressed between the arm-bases, giving the upper part a subpentagonal outline; plates thick and tumid; sutures distinct; surface without sculpturing or other ornamentation.

Basals three, pentagonal, standing somewhat upright, very thick and tumid in the lower third, and together forming a low, bowl-shaped cup. The tumid plates give the base a somewhat truncated aspect. First primary radials large, longer than wide, tumid in the central part, three hexagonal and two heptagonal. Second primary radials about one-third the size of the first, longer than wide, tumid in the central part, hexagonal. Third primary radials about two-thirds the size of the second, longer than wide, some of them octagonal, the form of the others not determined. Only a single small secondary radial can be distinguished in our specimens, and no tertiary radials. The structure is such at this place, I am half inclined to think the species may belong to *Stegano-crinus* rather than *Actinocrinus*, and this view would have support in the structure of the vault.

First regular interradials, hexagonal, larger than the second primary radials, followed by two smaller plates, hexagonal and heptagonal. There are three plates in the third range, in some areas, which separate the third primary radials, and four in others. Above the third range the plates continue over the vault without any line to distinguish the interradials from those of the vault. The first azygous plate is in line with the first primary radials, rather smaller, hexagonal, and followed by two hexagonal plates, each of which is as large or larger than a second primary radial; there are three plates in the third range and six in the fourth, which separate the third primary radials. Above the fourth range the plates graduate into those of the vault without any line to distinguish them.

Vault convex, covered with tumid, polygonal plates, depressed toward the interradial areas and having prominent rounded ridges directed to the arm openings. Proboscis is subcentral, the first plates of which are rather large and thick.

The cast of the calyx of this species is distinguished by being more pointed below, an appearance resulting from the removal of the thick, tumid basals and first primary radials. The vault shows more abrupt depressions of the interradial spaces, and each ridge directed toward

the arm-openings bears a central depression that is not shown when covered with the plates. There were evidently only ten arm-openings to the vault, but the ambulacral passages were so large, they indicate very robust arms, which may have divided immediately above the part preserved in our specimens.

This species is distinguished from all others by its large, elongate form and smooth, tumid plates.

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

#### DORYCRINUS ELEGANS, N. SP.

*Plate III, fig. 4, azygous view of calyx; fig. 5, summit view of calyx.*

Calyx medium size, somewhat obconoidal, most rapidly expanding toward the arm bases, truncated below; vault depressed convex; sutures well defined, slightly beveled; plates convex; surface granular.

The basals are thick, subpentagonal, nearly perpendicular to the column, and project half their length below the point of attachment, so as to leave a rather deep, round columnar pit; column less than half the diameter of the base. First primary radials larger than the second and third together, a little wider than long, slightly expand from the base to the upper lateral angles; three hexagonal and two heptagonal. Second radials quite small, quadrangular, and nearly twice as wide as high. Third radials larger than the second, expand from the base to the upper lateral angles, twice as wide as high, three of them pentagonal; the one on each side of the azygous area being slightly truncated at its upper lateral angle by a regular interr radial plate gives these two a regular hexagonal outline, and each bears upon its upper sloping sides two secondary radials. First secondary radials are about one-half wider than high and of unequal size and shape, some being quadrangular and others pentagonal by reason of abutting two interr radials. Second secondary radials more than twice as wide as high, pentagonal and hexagonal, and supporting on the upper sloping sides single tertiary radials. There are four tertiary radials in each radial series, and twenty arm openings to the vault.

Regular interr radials, three in each area; the first one about two-thirds as large as the first radials, rather longer than wide, and having eight or nine sides; those having nine sides abut against a first secondary radial. The other two are small, more or less elongated—in some areas nearly equal in size, in others very unequal. They are separated from the vault plates by the tertiary radials. The first azygous plate is longer than wide, heptagonal, larger than a first radial, and supports three plates in the first series, three in the second series, and above this, as shown by our specimen, a single elongated plate separates the tertiary

radials and extends to the thickened protuberance surrounding the azygous or anal opening. The plates in the first series are somewhat smaller than the first regular interradians, and the middle one shorter and smaller than the lateral ones. The plates in the second series are not half as large as those in the first, and the middle one is proportionally still more reduced. The elongated plate occupies a rather deep sinus between the tertiary radials, and may consist of two or three plates which are ankylosed in our specimen.

The vault is slightly elevated above the arm openings, flat on top and covered with convex, polygonal plates of unequal size. A rather large, subcentral plate is surrounded by four plates of about the same size, two small plates and one side of the thickened protuberance surrounding the aperture. The number of plates in this thickened protuberance can not be ascertained from our specimen. From the distal sides of the four large plates surrounding the central one, as above described, one or two elongated plates separate the radial series. Between these there are four plates covering the subtriangular space between each angle formed between the large plates and the four arm openings. The one in the angle is the larger one; the two lateral ones are highly convex or tumid, and these are separated by a smaller plate.

The arms are unknown, but if there were two arms springing from each arm opening, as is usual in this genus, there would be forty arms.

Collected by F. A. Sampson, in the Burlington Group, near Sedalia, Missouri.

ACTINOCRINUS (?) CHOUTEAUENSIS, N. SP.

*Plate III, fig. 9, azygous view; fig. 10, summit view; fig. 11, basal view, all natural size.*

This species clearly belongs to the family *Actinocrinidae*, and is as nearly related to *Actinocrinus* as to any other genus in the family, though it appears to be as far removed in structure from that genus as *Dorycrinus* or *Eretmocrinus*. The vault is essentially different from other genera, and for that reason there are authors who would not hesitate to make it the type of a new genus; but I am convinced they have laid too much stress on this part of some fossils, beside I have only a single specimen and the establishment of a new genus may be safely left to the future.

Calyx medium size, obpyramidal, moderately truncated below, pentagonal above, secondary radials directed outward; columnar cavity deep; vault slightly convex; sutures well defined, beveled more or less; plates tumid; surface granular, not sculptured.

Basals three, thick, tumid, sharply rounded into the columnar cavity, pentagonal, twice as wide as high, project more than half their length below the point of columnar attachment, leaving a deep, round columnar



pit. Column less than half the diameter of the base. First primary radials very large, tumid, as long as wide, very moderately expanding from the base to the upper lateral angles; three hexagonal and two heptagonal. Second radials about half as large as the first, hexagonal, tumid, a little wider than high. Third radials smaller than the second, pentagonal, twice as wide as high, expand from the base to the upper lateral angles, and bear upon each of the upper sloping sides, a single secondary radial. Secondary radials, short, directed outward from the calyx at an angle of forty-five degrees, pentagonal, and bear upon each of the upper sloping sides tertiary radials which support the free arms. Arm openings to the vault twenty.

Regular interradians, four in each area; the first one rather larger than the second primary radials, tumid, hexagonal, and supports two interradians on the superior sloping sides. The two in the second range are each larger than a third primary radial, hexagonal, and support between the upper converging sides the fourth interradian, which separates the radial series and unites with the plates of the vault. First azygous plate in line with the first primary radials, hexagonal, longer than wide, and supports two plates in the second series, one of which is hexagonal and the other heptagonal; these are followed by four plates in the third series, which are succeeded by a single plate that separates the radial series and unites with the plates of the vault, adjoining the azygous opening.

The vault is depressed convex, being elevated only the thickness of the plates over the radial areas, and depressed somewhat in the interradian areas. The central plate is small, pentagonal, and surrounded by the five larger plates of the vault, one of which, on the azygous side, is much larger than the others, and to which the radial series are directed. Outside of this ring of five tumid plates a single subspinous radial dome plate is followed, in each radial series, by two subspinous radial plates, one of which is located above each double series of arm openings, at the margin of the vault. The interradian dome areas are depressed and covered with two plates, followed by one that reaches the superior interradian in the calyx. The large plate, as shown in the illustration, may include part or all of the azygous opening, but the azygous opening appears to be small and located immediately below it. The specimen is a little defective at this place, and hence I am not overconfident that the azygous opening is shown correctly in the illustration. The radial channels being directed to this large plate shows that it can not represent any part of the azygous opening unless the vault in this species is constructed differently from all other known crinoids. It shows no indications of sutures or divisions of any kind, and, hence, while it is so different from all other crinoids, as I have interpreted it, nevertheless I think the illustration is correct.

In *Agaricocrinus*, by way of example, the central dome plate is the largest plate in the body, and the radial series are directed to it; in this species the central dome plate is small, and the largest plate of the body is between it and the azygous orifice and the radial series are directed to it. As this species possessed no proboscis, those who think one is essential to an *Actinocrinus* must refer it to an undefined genus.

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

#### AGARICOCRINUS SAMPSONI, N. SP.

*Plate III, fig. 8, natural size; the specimen is on a slab in high relief.*

The calyx is slightly concave in the region of the basal plates, extending to the middle part of the first primary radials; it then gradually rounds over on the radial series, but rapidly curves into the interradiar areas. The calyx is, therefore, nearly flat, except as to the sunken interradiar fields, which gives it a remarkably strong pentalobate aspect. The surface of the plates is smooth.

The basal plates expose an hexagonal ring surrounding a small, round column, composed of thin plates with radiately lined faces. The first radial plates are the largest plates in the body; width greater than length; three hexagonal and two heptagonal. Second radials very short and very difficult to determine in the type specimen. Third radials short, pentagonal, and on each upper sloping side support a single secondary radial. Secondary radials very wide, thin, and arch around toward the vault, pentagonal, and support upon each upper face a double series of arm plates.

There are ten very large arms arranged in five pairs, which are united by the first two adjacent plates in each pair. Each arm consists of a double series of plates, alternately arranged and united in the middle of the dorsal side of the arm by a zigzag suture. The arms are directed almost or quite horizontally from the calyx, and though they may have been more or less flexible toward the distal ends, it does not appear they ever could have curved upward at or near the calyx on account of the great depth of the arms from the dorsal to the ventral side.

The first regular interradians rest on the upper lateral sides of the first primary radials and curve upward toward the vault, so that the succeeding interradians, if any exist, which is very doubtful, are remarkably small and not visible in a basal view of the calyx. The first azygous plate is in line with the first primary radials and of the same form and of the same length, but a little narrower, heptagonal, and supports upon each upper lateral side a single interradiar, and upon the superior face either a single or a double plate that curves upward to the vault.

This species is remarkable for the proportionally large arms, very short second primary radials, small secondary interradials and its general form.

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

AGARICOCRINUS BLAIRI, N. SP.

*Plate III, fig. 12, summit view; fig. 13, lateral view of calyx; fig. 14, basal view of calyx, all natural size.*

Species medium size. Calyx very low, moderately concave in the region of the basals and primary radials, then gradually rounds over on the radial series, but rapidly curves into the interradial areas. The concavity at the place of attachment of the column extends deeper or higher than the dorsal side of the first arm plates. The outline of the top of the calyx is subquadrate rather than subpentagonal, for the lateral sides are nearly straight, but slightly expand from a shorter, nearly straight azygous side, while the side opposite thereto is the longer one and arched from the lateral angles; plates smooth or granular.

Basals small, extending so slightly beyond the column they are hard to distinguish in a basal view. First radials moderately large, length equaling the width; three hexagonal and two heptagonal. Second radials nearly as large as the first, quadrangular, about one-half wider than long. Third radials pentagonal, more than twice as wide as high, inferior lateral sides rapidly diverging, and superior sloping sides supporting single secondary radials. Secondary radials wide, thin, arch around toward the vault, pentagonal, and support upon each upper face a double series of arm plates, except the ray opposite the azygous side, which supports a single series of arm plates only, on each side.

There are nine arm openings to the vault and only nine arms in this species. There are two arms for each radial series, except the one opposite the azygous side, which has only one. The arm plates preserved show the arms consisted of a double series of short plates, united by the usual zigzag suture.

The first regular interradials rest on the upper lateral sides of the first primary radials and curve upward toward the vault. They do not appear to reach the two plates shown in the interradial areas on the vault, but the connection appears to be cut off, at least in some of the areas, by the arm plates coming in contact with each other. The first azygous plate is in line with the first primary radials and of the same form and length, but only half as wide; it is followed by three plates in the second range, the middle one being quite narrow and having nearly straight sides; and these are followed in the third range by

two elongated plates that separate the radial series and unite with the vault plates.

Vault low, convexity very little more than the thickness of the plates, and covered with numerous slightly convex, polygonal plates. The large, tumid plates that usually extend from the arms to the summit, in this genus, do not characterize this species. A moderately large, tumid plate occupies the center and the small azygous orifice adjoins it, a rather large plate separates each of the four double series of arm openings, otherwise the plates are small and therefore quite numerous.

The depressed short body, subquadrate outline of the calyx, small plates of the vault and nine arms are features that distinguish this species from all others.

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

#### BATOCRINUS DIVALIS, N. SP

*Plate III, fig. 6, azygous side of calyx and vault, showing part of two radial series; fig. 7, showing calyx and arms, specimen somewhat crushed, and the sutures of a few plates destroyed, natural size.*

Species large. Calyx depressed, shallow, saucer-shaped; each radial series bears a low angular ridge from the basal plates to the free arms. There are eighteen arm bases with the openings directed horizontally. Surface smooth.

Basals three, forming a pentagonal disc, very little larger than the column. First primary radials nearly twice as wide as long, upper faces slightly arcuate, for the reception of the second radials. Second radials quadrangular, twice as wide as long, greatest length in the central part, as both the upper and lower faces are slightly convex. Third radials about twice as wide as long, and supporting on the upper slightly sloping sides the secondary radials. Secondary radials two in each of eight series, and four in each of the other two series. In the two series opposite the azygous area there are no tertiary radials, but two free arms arise from the last plate in each. There are two or three tertiary radials in each of the sixteen series, from the last of which two free arms arise, making thirty-two arms from four of the primary radial series, and four from the other one, or thirty-six arms in all. The arms consist of a double series of plates from the beginning, the inner ones being very short, until the arms are fully separated. Arms long, strong, and bear coarse pinnules.

First regular interradians, decagonal, larger than any other plates in the calyx, and rest between the lateral sloping sides of the first primary radials; and between the second and third primary radials and the first

secondary radials. It is followed by two small plates in some of the areas, and one in others, which unite with plates of the vault. The azygous area has one plate in line with the first primary radials, which is followed by three plates, and these by three, the middle one reaching the plates of the vault. Vault convex, a little depressed in the interradial areas, covered with convex polygonal plates, and supporting a sub-central proboscis.

This species is distinguished from all others by the depressed calyx, angular ridge on the radial series, interradials connecting with the plates of the vault, and by having thirty-six arms.

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

#### BATOCRINUS.

In 1854 Samuel A. Casseday described the genus *Batocrinus* and the species *B. icosidactylus* and *B. irregularis*, in the German language in Abdruck a. d. Zeitschr. d. deutschen geologischen Gesellschaft Jahrg. 237, and also illustrated both species. The work has never been translated into the English language, nor his figures reproduced. Through the kindness of Victor W. Lyon, of Jeffersonville, Indiana, I have been permitted to copy the illustrations, and have been furnished with a manuscript translation of the entire article, which I take great pleasure in making part of this palæontological report. I have changed the numbers of the figures on the plate to make them conform to the other numbers, or what he called "Figur 1, 1a, 1b, 1c, und Figur 3," I have marked 1, 2, 3, 4, 5, and his fig. 2, 2a, 2b, 2c, I have marked 6, 7, 8, 9. The translation may also be called a liberal one to conform to the present system of nomenclature; though I believe nothing is omitted from the article. The translation is as follows:

"DESCRIPTION OF A NEW GENUS OF CRINOIDS FROM THE MOUNTAIN LIMESTONE OF NORTH AMERICA, BY MR. CASSEDAY, OF LOUISVILLE, KENTUCKY.

(The fossils are from the Warsaw Group.)

"The number of Crinoids distributed through all the Western States of North America, in the Palæozoic beds is astonishing, it probably surpasses that of the continent of Europe, and will for a long time offer an extremely rich field of the most varied interest and greatest instruction to the researches of the Geologist and Palæontologist. Since the report of Prof. Troost to the Legislature of Tennessee, containing 16 new generic names with 88 new species, at least 15 new species have been found

in Kentucky, Indiana and Illinois, although but few portions of these States have been examined. Of these a considerable number have been described by Prof. Yandell and Dr. Shumard, and will shortly be published by the Smithsonian Institution.

"In the following pages I give the description of one of the numerous hitherto unknown forms of American Crinoids, which I propose to distinguish as a new genus, under the name of *Batocrinus* (Etymology, *batos* and *krinon*). The principal locality of this Crinoid is twenty-five English miles from New Albany, Indiana, at the foot of Spurgen Hill, in a railroad cut. Considerable masses of limestone were blasted off and were knocked into fragments and distributed along a new road, where they had been exposed to the atmosphere for about four years. The limestone gradually disintegrated and brought to light an immense number of fossils, almost completely separated from the rock, amongst which were the remains of the *Batocrinus*, most of them almost completely preserved. Other specimens of the genus I found at another place in the neighborhood, but according to my researches, it is wanting at Salem, and only reappears on the same railroad between Cooperstown and the White River. A Crinoid resembling the *Batocrinus* is found seven English miles further on, near Bedford. These beds belong to the Carboniferous System, which is probably similar to that of Scottsville, in the neighboring Kentucky. I distinguish two species of the genus *Batocrinus*."

#### I. *BATOCRINUS ICOSIDACTYLUS*.

*Plate IV, figs. 1, 2, 3, 4 and 5.*

"The column of this Crinoid I can only describe from memory, since I have brought no specimens of it with me to Europe. It is small and has a five-sided alimentary canal; its joints are throughout of about the same thickness and character. The calyx is depressed conical, and at the place of attachment of the arms sharply separated by a ring from the upper cover or vault. The base at the extremity of the column is cup-shaped and hollow, showing radiating striæ of the last joint of the column. There are three basal plates, two of which are somewhat larger than the third. After these, six pieces form a closed circle, five of them are regular radial plates of the first order (first primary radials), the sixth is an irregular interradiating plate (first azygous plate). On the upper concave side of each radial piece of the first order are placed the radial plates of the second order (second primary radials), of an almost quadrangular form; above these are the radial plates of the third order (third primary radials or axillary radials), of a transverse, five-sided shape, with an obtuse angled summit. Upon each axillary radial plate there are two small plates (secondary radials), each of which supports a plate pointed at its upper extremity (second secondary

radials). Upon these latter there are upon the sloping sides of the calyx two more longitudinal rows of commonly, three more rarely, two narrow distichal plates (tertiary radials), which immediately conduct to the twenty arms.

“Between the radial plates of the second and third order, and between the lower distichal radial plates (second and third primary radials) there are interradiial plates all around, but the plates of the upper distichal radial rows (tertiary radials) join immediately together, so that the points of attachment of the arms form a closed circle at the border of the calyx. Thus on the side of the calyx five isolated interradiial fields are formed, the plates of which are not connected with those of the superior row of the calyx (not connected with the plates of the vault). We distinguish four small interradiial fields from an odd larger one at the side, where there is an interradiial plate already inserted between two radial plates of the first order (four regular interradiial areas and the azygous interradiial area). In the four smaller interradiial fields there is a large six-sided (eight-sided) interradiial plate which joins inferiorly to two radial plates of the first order, and fills the entire space between the radial plates of the second and third order. Above these are generally two smaller plates, one of which is a little larger than the other, inserted between the lower distichal radial plates (secondary radials); sometimes they are entirely wanting. In the odd larger interradiial field (azygous area), above the single odd interradiial plate of the first order, there are three other interradiial plates, a median and two lateral ones, placed on the three upper sides of the six-sided radial plate of the first order. Above the median interradiial plate there are sometimes one or two small rudimentary plates.

“On none of my specimens were the arms preserved. Among about fifty specimens there was but one abnormal, with twenty-one arms, instead of the regular number, twenty.

“The superior cover of the calyx is highly conical and covered with numerous strong spines, which afford a very prominent distinguishing mark of the species. It is prolonged above into a large tube of double the length of the calyx. It is likewise covered with strong spines.

“The sculpture of the surface consists, on the plates of the cover of the calyx, of fine, close, almost microscopic granulated lines, starting from the center and becoming more prominent toward the border. On the spines they become circular; I could not observe the very rarely preserved sculptures on the lower side of the calyx.

“Fig. 1 represents the complete calyx with the tubular prolongation of the cover, as seen from the side. Fig. 2 is a view of the calyx as seen from below. Fig. 3 gives an analysis of the composition of the calyx up to the arms. The isolated interradiial fields are surrounded by punctured lines. Fig. 4 shows the sculpture of the plates on the cover

of the calyx magnified. Fig. 5 represents the single odd interradial plate of the first order with three interradial plates above it.

“BATOCRINUS IRREGULARIS.

“Plate IV, figs. 6, 7, 8, 9.”

“This species agrees with the *B. icosidactylus* in the general proportions of shape, and in the composition of the calyx. It is distinguished by the following marks: Instead of the twenty arms of the *B. icosidactylus*, it has but eighteen, which is caused by one of the five radial fields being developed differently from the four others, which are equal, while of the four equal radial fields, as in *B. icosidactylus*, each encloses four arms by a double distichal division, in the *B. irregularis* the one lateral field has only a simple double row of distichal radial plates, and in consequence receives but two arms. The two-armed radial field is always opposite the larger interradial field. Figures 8 and 9 explain this different development of the radial fields. Figure 9 shows the composition of one of the four equal radial fields. Figure 8 the composition of the single odd radial field in *B. irregularis*. The latter figure could not be drawn exactly from nature in its detail, but it is correct for the manner of its composition and the number of plates.

“Another difference between the two species is shown in the development of the odd interradial field. In *B. irregularis* there are above the lower interradial plate of the first order five others of a six sided form of which three are interradial plates of the second order, and two interradial plates of the third order. They are so arranged that the median one of the three interradial plates of the second order is completely surrounded by the five other plates of the interradial field. Figure 7 explains this arrangement and is to be compared with the corresponding part of the odd interradial field of the *B. icosidactylus* in figs. 3 and 5. This difference in the odd interradial field is constant and makes a good character for the distinction of the two species.

“The two last of the distichal radial plates, which, in this species, also form an almost completely closed circle, are of a different shape from those of the *B. icosidactylus*. They are curved and unsymmetrical in *B. irregularis*, while in the other they are nearly regular and symmetrical.

“The species on the superior cover of the calyx, and its tubular prolongation are not so prominent as in *B. icosidactylus*; they commence at the exterior border of each plate, rise very gradually and are at last developed into a sharp, but not very prominent point. This gives this species an exterior aspect very different from the *B. icosidactylus*. None of my specimens have the surface well enough preserved to give any exact information as to the sculpture of this species.



“The genus *Batocrinus* is by the composition of its calyx nearest allied to the genus *Actinoocrinus*, the type of which is in the Carboniferous limestone formation, subject to so many various modifications. The composition of the base of three plates, the constantly equal composition of the radial fields, and especially the presence of a single large interradial field, commencing already with an interradial piece inserted in the circle of the first radial plates, are to be depended upon for the common distinguishing mark of a series of genera forming the natural family of the *Actinoocrinidæ*. The genus *Melocrinus* classed with this family by F. Roemer in the explanation of the genus *Dorycerinus* (Archiv f. Naturgesch. Jahrg. XIX. Bd. I, p. 207 bis. 218) does not belong to it, since it has neither the characteristic composition of the base, nor the odd interradial field. I think this genus is more closely allied with *Ctenocrinus* and other Devonian forms. By the tubular prolongation of the cover of the calyx, at the end of which the mouth is situated, *Batocrinus* connects more closely with the genus *Actinoocrinus*, in its narrower limits, than with *Amphortocrinus*, in which the mouth is lateral and below the summit of the cover of the calyx. From both these genera, and in general from, all other *Actinoocrinidæ*, *Batocrinus* is distinguished by the singular circumstance that the interradial fields are not connected with the cover of the calyx, crossing through the five groups of arms, but are separated above, the distichal radii connecting again above the interradial fields so that the arms rise at the border of the cover, as it were, in a closed ring. By this peculiarity of the structure, *Batocrinus* seems to me to be more independently established and still more recommended to acceptance than the genus *Dorycerinus* established by Mr. Roemer, which really is only distinguished by several extremely long spines on the cover of the calyx, that is, only by a very striking external ornament from *Amphoraocrinus*. The long spines of *Dorycerinus*, with the corresponding base of the calyx, and some other isolated plates, I found tolerably numerous about five hundred yards from the locality of *Batocrinus*, although I never was so fortunate as to obtain a complete specimen of the crinoid.”

STEGANOCRINUS BENEDICTI, N. SP.

Plate IV, fig. 10, azygous view; fig. 11, opposite side; fig. 12, summit of same specimen, natural size.

Calyx large, subpyramidal, truncated below; plates highly convex, sculptured; sutures distinct. Arms very robust and directed laterally at right angles to the calyx. The lower part of the arm extensions are remarkable for their height and width, and transversely, have a subquadrate outline.

Basal plates short, thick, truncated below so as to form a subpentagonal outline, the outer angles being slightly nodose. First radials large,

about as wide as high, very convex, two heptagonal and three hexagonal, transverse angular ridge in the central part of each, from which three or four angular ridges extend to the basal plates below, two or three to the second radial, and one to each adjoining the lateral sides. Second radials hexagonal, about half the size of the first radials, highly convex, with a transverse angular ridge in the center, from which an angular ridge extends to each adjoining plate. Third radials wider than long, heptagonal, two interradians abutting on each side, directed almost horizontally or at right angles to the calyx, about two-thirds as large as the second radials, tumid, the swelling being transverse, and supporting on each of the upper or outer sloping sides a single, axillary, secondary radial, which is hexagonal, when it abuts two interradians on one side, in other cases it is pentagonal; it is tumid in all cases. There are three convex tertiary radials, the last one axillary in one of the rays in our specimen, and, as far as the other rays are preserved, they are constructed in the same way, hence there appears to be at least forty arms in the species before they leave their contact with the interradianal plates. It would have required a basal view to show these plates, hence they are not visible in the illustrations, but they may be inferred from the summit, as shown in figure 12, for they occupy the lower side of the wide extensions of the arm bases.

First regular interradians about the size of the second radials, hexagonal, highly convex, with an angular ridge radiating from the center of each to each adjoining plate. There are two plates in the second range, separating the third radials, and of about the size of the third radials; they are less convex, and show radiating ridges toward the inferior and lateral plates, but none to the superior interradians. There are three plates in the next range, in the area on the left of the azygous side, five in the area on the right, and four in each of the other areas. The arm extensions are thus placed at unequal distances from each other. These ranges are followed by irregular ranges of plates that separate the deep basal arm-extensions and connect with the plates of the vault. Indeed, the plates of the calyx and those of the vault graduate into each other so as to leave no distinct line of separation between them.

First azygous plate about the same size as a first radial, equally convex and sculptured in like manner. It supports two plates in the second series, each nearly as large as a first regular interradianal, hexagonal, highly convex, and with an angular ridge radiating from the center of each to each adjoining plate. These are followed by five moderately convex plates of nearly equal size that separate the third radials and form an arch over each of the two plates in the first range. Above these, numerous smaller plates separate the high basal arm-extensions and graduate into the plates of the vault.

Vault highly elevated to give depth to the arm-extensions, convex,

abruptly depressed into the interrarial areas, somewhat flattened over the radial extensions and covered with numerous convex, polygonal plates, some of which are tumid or subspinous, especially the large plate, in the angle, at the commencement of each interrarial area and those over the arm-openings above the third tertiary radials. The height of the vault, above the under side of the arm bases, is about equal to the height of the calyx to the same place, and, on account of the thickness of the basal plates, a cast would show a calyx shorter below the arm-extensions than the distance from that place to the top of the vault. The capacity of the body is greater above the under side of the arm-extensions than it is below, which gives a specimen a top-heavy aspect. The basal plates being transversely truncated below, our specimen will stand unsupported on a table in the position of figures 10 and 11. In fact, it will stand on either end or lay on either side, or in almost any other position in which it is placed, without support.

The proboscis is comparatively quite small and situated eccentrically on the azygous side. It is broken off in our specimen close to the vault, but, judging from appearances, it was short as well as small.

This is the first species in this genus described from the Keokuk Group, and it differs from all those described from the Burlington Group so obviously and materially that no comparison with any of them is necessary.

Found by A. C. Benedict in the Keokuk Group, at Canton, Washington County, Indiana, and now in his collection. The specific name is in honor of the collector.

#### SACCOCRINUS BENEDICTI, N. SP.

*Plate V, fig. 1, a large specimen; fig. 2, azygous side of a medium sized specimen.*

Species a little below medium size, but quite variable. Calyx urn-shaped, constricted below the arm bases, rather higher than wide; plates sculptured, very tumid; sutures deep and beveled.

The three basal plates form a moderately expanded cup, one-half wider than high. The expansion of the cup is most rapid from the basals to the second radials. First radials very large, height greater than width, three hexagonal, two heptagonal, very convex, margins beveled, face slightly, radiately sculptured and having a peculiar central pit. Second radials about one-third the size of the first, hexagonal, as high as wide, very convex, margins beveled. Third radials a little smaller than the second, axillary, and bearing upon each upper sloping side three secondary radials, the latter support the free arms. The secondary radials are directed almost horizontally to the axis of the calyx. There are only ten arm openings to the calyx; beyond this, the arms are unknown.

There are eight regular interradians in each area as follows: 1-2-2 and 3; the latter separate the arm-plates and connect with the plates of the vault. The first interradians are larger than the second radials, and the following ranges gradually decrease in size. There is one small intersecondary radial in each intersecondary space, but it has no connection with the vault. There are nineteen azygous interradians, as follows: 1-3-5-5 and 5, the latter separate the arm-plates and connect with the plates of the vault. The ranges of plates are not in line, but are irregularly disposed. The area is very wide between the arms, and the plates rise nearly perpendicularly and graduate into the proboscis, which is near the margin on the azygous side.

This species is so different in the number and arrangement of the plates, and in the surface ornamentation, from all other described species, that it is unnecessary to make a comparison with any of them.

Found in the Niagara Group, at St. Paul, Indiana, and now in the State Museum at Indianapolis.

#### SACCOCRINUS HOWARDI, N. SP.

*Plate V, fig. 3, side view; fig. 4, azygous view; fig. 5, summit view.*

A small species, quite distinct in general outline from any heretofore described. Calyx somewhat urn-shaped, higher than wide, broadly truncated at the base and only slightly expanding or almost subcylindrical above; plates tumid; sutures beveled.

The three basal plates form a short rim, squarely truncated below and beveled toward the sutures, which has a diameter about equal to two-thirds of the greatest diameter of the calyx. First radials moderately large, having a height equal to the greatest diameter, three hexagonal, two heptagonal, very tumid. Second radials two-thirds as large as the first, hexagonal, as high as wide, tumid. Third radials much smaller than the second, pentagonal, axillary, upper faces directed outward at an angle of seventy-five degrees from the axis of the body, and supporting upon each, three secondary radials, the latter support the free arms. The secondary radials are directed almost at right angles to the axis of the calyx. There are only ten arm openings to the calyx; beyond this the arms are unknown.

There are two tumid regular interradians in each area of about the same size, one following the other; above these the plates are quite small and graduate into the vault. There are no intersecondary radials. The azygous area is large in comparison with the others, and covered with twelve plates before they graduate into the plates of the vault. The first plate is in line with the first radials and a little smaller; it is followed by three plates, and these by three in the third range, and these by five in the fourth range, though they are not in line. The area

is very wide between the arms, and the plates rise nearly perpendicularly and then graduate into the plates of the vault. The vault is nearly level over the radial areas and abruptly depressed in the interradial spaces. It is only a little convex in the central part. It is covered with numerous small polygonal plates. The azygous opening is near the margin on the azygous side.

Found in the Niagara Group, at St. Paul, Indiana, and now in the State Museum at Indianapolis. The specific name is in honor of Dr. Howard, who collected all the St. Paul fossils described in this article.

#### CYLICOCRINUS, N. GEN.

(*Ety. kulix, ikos, a cup; krinon, a lily.*)

Calyx urn-shaped, truncated below. Basals three, expanded. Primary radials three by five, the first one very large, second one small, quadrangular, third small, pentagonal. Secondary radials two or more. Arms ten. Regular interradials consist of one large plate followed by very small ones between the arm-bases that connect with the vault plates. First azygous plate in line with the first radials, followed by three plates in the second and in the third ranges, which are connected with smaller plates that connect with the vault. The vault is convex and covered with minute plates, except the ambulacral grooves, which are open and have serrated edges as if protected by some kind of cilia. The primary radials resemble those in some species of Batocrinus, the azygous area resembles Saccocrinus. The vault is different from that in all other known genera of crinoids. Type, *Cylicocrinus canaliculatus*.

#### CYLICOCRINUS CANALICULATUS, N. SP.

*Plate V, fig. 13, side view; fig. 14, azygous view.*

Calyx urn-shaped, a little wider than high, base broadly expanded, middle part round, interradial areas depressed between the arms, giving the upper part a pentalobate aspect; plates smooth and very slightly convex.

The three basal plates are broadly expanded below in a pentagonal outline with the under surface flat, except a small hemispherical pit for the insertion of the column; they are abruptly contracted to the suture above. The first radials are very large, longer than wide, three hexagonal and two heptagonal; they form a cup only a little expanded at the top. Second radials small, quadrangular, about one-third wider than high. Third radials a little wider than the second, pentagonal, axillary and support on each upper sloping side three secondary radials, the last of which support the free arms. The secondary radial ridges are quite

convex and protuberant, while the interradial spaces are sharply depressed, which gives the calyx the pentalobate form in the upper part. There are no intersecondary radials, and hence the arms are grouped in five pairs.

There is one large regular interradial in each space that rests between the upper sloping sides of the first primary radials and extends as high as the top of the third radials, and is larger than the second and third radials together. It is followed by small plates that fill the narrow, deep sinus between the secondary radials and unite with the plates of the vault. The first azygous plate is in line with the first radials, and as large as any of them. It is followed by three plates in the second range and three in the third range, and above the middle one in the third range there is a plate of the same size preserved in our specimen, but the other plates in this area are not preserved and are, therefore, unknown.

The vault is convex, the radial areas raised in convex ridges, and the interradial spaces depressed. It is covered with minute convex plates, except the ambulacral grooves which are uncovered and expose serrations or places for the attachment of cilia or minute pinnules. The grooves from each pair of arms come together about half way from the arm bases to the summit of the vault. These ambulacral grooves were evidently never covered with plates, as in other palæozoic crinoids. Only one-half the vault is preserved in our best specimen, and hence the continuation of the azygous area and the presence or absence of a proboscis is unknown.

Found in the Niagara Group, at St. Paul, Indiana, and now in the State Museum, at Indianapolis.

#### BATOCRINUS COMPARILIS, N. SP.

*Plate V, fig. 18, a side view; fig. 19, azygous view; fig. 20, summit view with the proboscis broken off.*

This species belongs to that section of *Batocrinus* that will include *B. æquibrachiatus*, *B. trochiscus*, *B. brittsi*, etc. The lower part of the calyx to the top of the primary radials is bowl-shaped, it then rapidly expands to the arms. The vault is moderately convex near the outer margin, which gives to the calyx and vault a form somewhat like a wheel with a big hub; the radial series are subequal, and are separated by a slight sinus, in each interradial space, that becomes more conspicuous on the vault. The height of the calyx is about four-fifths the diameter at the arm bases. The plates are tumid; sutures distinct, but not beveled.

The basal plates are short, having a height about equal to one-fourth the diameter. The columnar cavity is hemispherical. First radials one-half larger than the second and third together, width greater than

height or about equal to the height of the first and second together; three hexagonal and two heptagonal; they expand and are very tumid. Second radials short, about twice as wide as high, quadrangular. Third radials about the same height, but a little wider than the second, pentagonal, axillary, and support on each upper sloping side two secondary radials, the second much wider than the first, on account of the expanded rim, and axillary. The second secondary radial supports on each upper sloping side two tertiary radials, the latter of which supports the free arms. There are twenty arm openings to the vault.

The first regular interradiial is as large as the second and third radials together, and very tumid; it supports two small plates in each interradiial area. There are four plates in the azygous area, the first one in line with the first radials, and of about the same size and equally as tumid; it is followed by two smaller tumid plates, and these by one.

Vault convex and covered with numerous tumid polygonal plates, the radial areas are most convex, and are covered with the larger tumid plates; the interradiial areas and intersecondary radial areas are a little depressed, and are covered with the smaller plates. The proboscis is central, but is broken off in our specimens.

This species is distinguished by its general form and by the number and arrangement of the tumid plates from all others heretofore described.

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

#### BATOCRINUS BRITTSI, N. SP.

*Plate V, fig. 21, side view; fig. 22, azygous view; fig. 23, summit view.*

This species belongs to that section of *Batocrinus* that will include *B. aequibrachiatus*, *B. trochiscus*, etc. The lower part of the calyx to the top of the first radials is subcylindrical; it then rapidly spreads until the secondary and tertiary radials are nearly at right angles with the central axis of the body. The vault rises slowly from these projecting plates, which produces a narrow rim or wheel-shaped projection at the arm openings; each radial series, however, is separated by a sinus in each interradiial space. The height of the calyx is only about half the diameter at the arm bases. The plates are moderately convex, and the sutures distinct, but not beveled.

The basal plates form a rim half the height of the diameter, the lower face is slightly beveled from a rim, above which there is a slight contraction. The columnar cavity is hemispherical and radiately lined for the attachment of the column. First radials very large, one-half larger than the second and third together, height and width about equal, three hexagonal and two heptagonal, moderately convex. Second radials small, nearly twice as wide as high, quadrangular. Third radials a little wider

and a little shorter than the second radials, pentagonal, axillary, and support upon each upper sloping side two secondary radials, the second much wider than the first, on account of the expanded rim, and axillary. The second secondary radial supports on each upper sloping side a single tertiary radial, which is notched for the ambulacral furrow. There are twenty arm openings to the vault.

The first regular interradial is nearly as large as the second and third radials together; it is followed, in some interradial areas, by one small plate, and in others by two small plates. The first azygous interradial is in line with the first radials, and somewhat smaller; it is followed by three plates in the second range, the middle one being much the larger of the three, and the second range is succeeded by two small elongated plates that rest on the upper sloping sides of the middle plate, in the second range, and unite over its apex.

The vault is highly convex over the radial areas and depressed in the interradial spaces, and covered with numerous convex polygonal plates. Proboscis central, but as it is broken off in our specimen, we know no more about it.

There is no described species that can be reasonably confounded with this one, and, therefore, it is unnecessary to draw any comparisons.

Found by F. A. Sampson, in the Burlington Group, at Sedalia, Missouri, and now in his collection. The specific name is intended as a compliment to the distinguished naturalist, Dr. J. H. Britts, of Missouri.

#### BATOCRINUS DECREPITUS, N. SP.

*Plate V, fig. 24, side view, showing the proboscis extending beyond the arms.*

This species belongs to that section of biturbinate *Batocrinus* including *B. gorbyi*, *B. boonvillensis*, *B. gurleyi* and a large number of other species, in the Keokuk Group. The calyx is of medium size among these biturbinate forms, obconoidal, truncated below, a little less than one-half wider than high; each radial series bears a rounded ridge from the basal plates to the free arms; arm openings directed upward; surface of the plates radiately sculptured.

Basal plates form a disc one-third wider than the column, which is contracted above so as to appear as an enlarged, rounded rim surrounding the column. First radials convex in the central part and radiately sculptured, a little wider than high and upper face slightly arcuate. Second radials nearly as high as wide, quadrangular. Third radials one-half wider than high, pentagonal, axillary, and support on the upper sloping sides the secondary radials. There are two secondary radials in each of the six series shown in our specimen, the second one pentagonal, axillary, and bearing on each of the upper sloping sides three tertiary radials, the last of which is axillary and bears the free arms.



Each tertiary radial supports two arms, which are composed of double series of interlocking plates. They are comparatively short, the distal ends are curled up like claws around the base of the proboscis. The three primary series, preserved, support twenty-four arms, and if the other two are like them, as appearances indicate, there are forty arms in this species.

Regular interradians, five in each area, the first one large, strongly sculptured: it is followed by three small, convex plates, each more or less tuberculated in the central part, and these by one which projects high between the tertiary radials. Azygous interradians much more numerous, but their exact number and arrangement can not be determined from our specimen. Vault moderately convex and bears a central proboscis, which is covered, as far as observed, with hexagonal plates. The proboscis is remarkably long and extends far beyond the distal ends of the arms and pinnules.

It is distinguished by the number of arms, radial ridges, sculptured plates, interradian areas and long proboscis; no other species is like it in any three of these characters.

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

#### ACTINOCRINUS BLAIRI, N. SP.

*Plate V, fig. 27, side view of calyx and part of the vault; fig. 28, part of the azygous side of another specimen showing slight sculpturing toward the sutures; fig. 29, basal view of same, slightly compressed.*

Calyx obconoidal and broadly truncated or like the frustum of a cone, without the usual depressions between the arms or lobes at the top of it. Plates convex and, where well preserved, show a little radiate sculpturing near the sutures.

Basals large, thick, twice as wide as high, and have a large concave depression below, which includes and surrounds the area occupied by the column. First primary radials large, convex, three hexagonal and two heptagonal, rather higher than wide. Second radials about half the size of the first, convex, hexagonal. Third radials heptagonal, smaller than the second, axillary, and bear upon the upper sloping sides single secondary radials. Secondary radials hexagonal and bear upon the upper sloping sides single tertiary radials, that bear the free arms. Twenty arm openings to the vault. The tertiary radials unite and cut off the connection of the regular interradians with the plates of the vault. Our specimens do not show whether or not they unite over the azygous area.

Regular interradians five, the first rather smaller than a second radial; it is followed by two smaller plates, and these by two still smaller ones; all of them are regularly convex, except some of them, near the margin,

show slight indentations. First azygous plate as large as a first radial; it is followed by two plates in the second range, three in the third range, and four in the fourth range. Above the fourth range the structure can not be determined, but I think there are one or two small plates, and the tertiary radials cut off the union of the plates with those of the vault. At least, what is preserved indicate such to be the case. Vault highly convex and covered with moderately convex plates. The proboscis is unknown.

This species is on the line which separates *Actinocrinus* from *Batocrinus*. It agrees with the latter in surrounding the regular interradi- al areas with radial plates, but it agrees with *Actinocrinus* in having an hexagonal plate for the second primary radial, and in having only two plates instead of three in the second range in the azygous area. There is no described species for which it can be mistaken.

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

#### ACTINOCRINUS BRITTSI, N. SP.

*Plate VI, fig. 1, showing plates, but broken off at the lower end; fig. 2, vault of same specimen; fig. 3, side view of cast; fig. 4, vault of same specimen.*

Calyx turbinate, depressed in the interradi- al areas between the arms, plates rather thin and beautifully ornamented with round ridges radi- ating from a small central tubercle on each plate; sutures very indis- tinct; the cast terminates in an obtuse point at the basal extremity.

Basals only moderately large and forming a subconical cup. First primary radials of the average size, three hexagonal and two heptagonal, about as high as wide. Second radials only a little smaller than the first, hexagonal, about as high as wide. Third radials a little smaller than the second, as wide or wider than high; some of them are heptagonal and others octagonal; when the intersecondary radial reaches the third radial it is octagonal, otherwise it is heptagonal; it is axillary and bears upon the upper sloping sides a single secondary radial, which is axillary and bears upon each of its upper sloping sides a single tertiary radial, which bears the free arms. There are twenty arm openings to the vault.

Regular interradi- als ten or more, depending on where you separate them from the vault plates. The first is rather smaller than either primary radial; in the next range there are two smaller plates, and in the third range two still smaller that separate the third primary radials; in the fourth range two quite small plates separate the secondary radi- als, and there are three or four small plates above these which separate the tertiary radials and unite with the plates of the vault. There are two or three intersecondary radials following each other and uniting

with the plates of the vault; in some cases the first one truncates the third primary radial, as shown in Figure 3, but in other cases it is cut off by the union of the secondary radials. The azygous area is only a little larger than the regular areas and contains only a few more plates. The first one is in line with the first radials and somewhat smaller; it is followed by two plates of about the same size as the second radials, and these by three in the third range, and three in the fourth range that separate the third primary radials; above this the area is contracted and there are only two small plates in each range until they graduate into the plates of the vault. The vault is flattened over the radial areas and depressed in the interradial spaces. It is covered by numerous small polygonal plates. Those at the commencement of each interradial depression are larger than the others and more convex. The proboscis is subcentral and quite small.

Found by R. A. Blair and F. A. Sampson, in the Burlington Group, at Sedalia, Mo., and now in the collection of both and in mine. The specimen illustrated in Figures 3 and 4 belongs to Mr. Sampson. The specific name is in honor of Dr. J. H. Britts, of Clinton, Mo.

#### ERETMOCRINUS PRÆGRAVIS, N. SP.

*Plate 6, fig. 5, azygous view; fig. 6, basal view.*

This is a ponderous, top-heavy, irregular, spinous species. The calyx is short, subquadrate in outline, the depression of the azygous interradius about equaling the projection of the arm bases opposite thereto. It is more than twice as wide as high, measuring to the arm openings. The plates are produced in wedge-shaped or transverse spines; sutures distinct, but not beveled.

Basals three times as wide as high and each bears two flattened spines. The column is large and the plates extend only slightly beyond it. First radials more than one-half wider than high, three hexagonal and two heptagonal. Second radials short and quadrangular in three of the radial series, but none appears to exist in the radial series opposite to the azygous area or in the series on the left of it. Third radials short, pentagonal, axillary, and bear upon each upper sloping side one or more secondary radials, except in the left lateral radial series, which is peculiar and may be described as follows: The first primary radial bears two second primary radials, these are each followed by a third primary radial, which is convex on its upper face and bears a plate having two spines, and which may be composed of two plates anchylosed together; these are each followed by two series of secondary radials; there are two plates in two of these series and three in the other two series which bear arms and give us four (or two) arm openings to the vault. This arrangement may be regarded as abnormal, but if so it will be seen that the

calyx is properly developed in this part so that it does not appear to have resulted from an injury. In the right lateral series there are two secondary radials supporting, on the upper sloping sides, two tertiary radials which bear arms giving us four (or two) arms in this series. The inner two openings, however, in both series, are much smaller than the outer two and the plates are small, indicating great inequality in the arms. The radial series opposite the azygous side is constructed in the same way except a small plate in the position of an intersecondary plate acts as a support to the two small plates that bear the small openings. The radial series on each side of the azygous area are each one-half larger than the series described. The secondary series most distant from the area is like those described, but those adjoining the area have only a single secondary plate, and it is followed by a tertiary series that has two arm holes, in the same manner as above described. There are, therefore, six arms in each of these series. I have now described these arm openings as they seem to me to be placed, but, nevertheless, if there is any other way to account for the small openings than to refer them to the ambulacral system, then the anchylosed plates would be single and the minute plates would be intersecondary radials through which these small pores would penetrate. This would give us only twelve arms for the species instead of twenty-four. I have never seen plates in the condition of these, in any other specimen, nor have I ever seen such small ambulacral openings, if such they be, or such pores, if that is what they are, in any other specimen. Looking at the specimen from below there appears to be only twelve ambulacral series, and no indications of these small pores representing ambulacral passages, but there is a tubercle below each one of the small pores that indicates a distinct plate and they are separated by a small plate, and a small plate intervenes on each side separating them from the large ambulacral passages. If they are pores and not ambulacral passages, then we have intersecondary radial areas filled with small plates commencing with the first secondary radial, while the regular interrarial areas are surrounded by the radial series and cut off from the vault plates, by the union of the second secondary radial plates.

There is only one interrarial plate in each regular area, but they are not of uniform size or shape; one has seven sides, another has eight, another nine, and the other ten sides. In the azygous area the first plate is in line with the first radials and rather larger than any of them. It is followed by three plates in the second range, and two in the third range that unite with the plates of the vault. The vault is enormously developed, twice as high as the calyx, and covered with polygonal plates, which are, externally, simple cones. The proboscis is subcentral, large and curved back a little from the azygous sides.

This is a remarkable species, so different from all others that no comparison is necessary with any of them. In the essential construction of the body it is a Batocrinus, but on account of the extraordinary development of the vault it is referred to Eretmocrinus, as that is the only character by which an Eretmocrinus is to be distinguished, if this is one, because the other character, usually relied upon—that is, an expanded base—this species does not possess.

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

#### BATOCRINUS BLAIRI, N. SP

*Plate 6, fig. 7, summit view; fig. 8, azygous view; fig. 9, view opposite the azygous side, one-half the length of the basals is broken off; fig. 10, basal view of another specimen to show basals not eroded.*

Calyx bowl-shaped, very rapidly expanding from the third primary radial, so as to direct the arms nearly at right angles to the axis of the body, leaving a sinus at the interradian spaces; wider than high; plates convex; sutures distinct.

Basals more than twice as wide as high, thick, truncated below, so as to give a basal diameter more than twice as great as the diameter of the column; column occupying a hemispherical pit. The plates bear a transverse angular ridge, which adds to their thickness and gives the base an hexagonal outline. First radials one-half wider than high, upper faces arcuate for the reception of the second radials. Second radials quadrangular, from two to three times as wide as high, differing in the different series. Third radials pentagonal, short, and about the size of the second radials, axillary, and each bearing two wide, short, secondary radials. The second secondary radial is axillary and bears two small tertiary plates that bear the free arms. There are twenty arm openings to the vault.

Each regular interradian area has one large interradian plate, that is followed by two small plates that separate the secondary radials and connect with the plates of the vault. The azygous area contains six plates. The first one is in line with the first radials and is the largest plate in the calyx; it is followed by three plates, the middle one of which extends high between the arms and is separated therefrom by a single plate on each side of the upper end of it. These three plates connect with the plates of the vault; vault moderately convex and covered with rather large, polygonal, convex plates; interradian space slightly depressed; proboscis large and central—it is broken off in our specimen, as shown in the illustration.

This species is distinguished by its general form from all others, beside no other described species has such an azygous area. The middle plate in the second range is peculiarly elongated.

Found by R. A. Blair and F. A. Sampson, in the Burlington Group, at Sedalia, Missouri. The specimens represented by figures 7, 8 and 9 belong to Mr. Sampson, the other is in my collection. The specific name is in honor of one of the collectors.

ACTINOCRINUS FOSSATUS, N. SP.

Plate VI, fig. 11, azygous view; fig. 12, side view.

Calyx obconoidal, about as high as wide, deeply sculptured; sharp, central, angular node on each plate; angles sunken, and a sharp angular ridge from each node to the node on each adjoining plate making the ornamentation stellate.

Basals short, constricted above, projecting below the end of the column and expanding to a thin edge, beveled at the sutures and notched in the middle of each plate so as to give the base an hexagonal stellate outline; columnar cavity rather shallow. • First radials wider than long, three hexagonal and two heptagonal, widening from the base to the lateral angles. Second radials hexagonal, wider than high, and about two-thirds as large as the first. Third radials a little larger than the second, some pentagonal, others hexagonal, axillary and support on each upper sloping side a single secondary radial. Secondary radials, axillary and support on each upper sloping side a tertiary radial. Tertiary radials axillary and support on each upper sloping side a small quaternary radial, which bears the free arms. There are forty ambulacral openings to the vault. All of the interrarial areas are surrounded by the radial plates, and none of them reach near the vault plates. There are five plates in each regular interrarial area, the first one large, followed by two smaller ones, and these by two in line, the upper one extending up between the tertiary radials, but not separating the quaternary plates. First azygous plate in line with the first radials and somewhat smaller, it is followed by two in the second range of about the same size as the first. There are three in the third range, and two small ones above, but they do not pass to the top of the tertiary radials. Vault very convex and elevated at the arm bases, the capacity is about equal to that of the calyx. It is covered with rather large polygonal plates, each of which terminates in a long spine. Proboscis central.

This species has some resemblance to *Actinocrinus hurdiannus*, which has only twenty arms, but I do not know of any forty-armed species with which to compare it.

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

## BLAIROCRINUS ARROSUS, N. SP.

Plate VII, figs. 1 and 2, basal views of two specimens; figs. 3 and 4, summit views of the same two specimens; fig. 5, side view, a little inclined, to show the plates surrounding the orifice.

Calyx a little convex and having a subpentagonal outline at the top, a little depressed between the arm bases; plates very deeply sculptured; radial ridges rounded; interrarial areas slightly depressed; arm openings directed horizontally; height of calyx and vault together only a little more than half the width; sutures indistinct.

Basals three, forming a flat hexagonal disc, extending only a little beyond the column; column round. First primary radials a little wider than high, three hexagonal and two heptagonal, central tubercle broad, and radiating ridges rounded. Second radials quadrangular, one half wider than high, radial ridge very coarse and transverse ridge very small. Third radials large, central tubercles broad and flattened on top; plates pentagonal, axillary and bearing on each upper side a single secondary radial. Secondary radials axillary and bear on each upper sloping side a single tertiary radial, which bear the free arms. There are twenty arm openings to the vault.

Interrarial areas subovate in outline, apparently excavated. Regular interradians three, one rather large plate followed by two that separate the secondary and tertiary radials. The first azygous plate is in line with the first radials and somewhat smaller; it is followed by two plates nearly as large and these by two smaller ones, that separate the tertiary radials. Vault gently rising from the ambulacral openings and having very little more convexity than the calyx, indeed, a side view of the calyx and vault is that of an ordinary convex lens. It is covered with large tumid plates. The orifice is near the azygous side surrounded by six rather large elevated plates. The elevation of these plates surrounding the orifice is shown in figure 5.

This species is different in outline from *B. trijugis*; it is not elevated above the arm openings as that species is, and it has altogether a different vault.

Found by R. A. Blair and F. A. Sampson, in the Chouteau limestone, at Sedalia, Missouri, and now in their collections and in mine. The two specimens illustrated are from the collection of Mr. Sampson.

## BLAIROCRINUS BULLATUS, N. SP.

Plate VII, fig. 6, side view; fig. 7, basal view.

Calyx very low, saucer-shaped, height one-fifth the width; plates deeply sculptured; radial ridges coarse, broadly rounded and having a broad node at the center of each plate; interrarial areas excavated; outline subpentagonal and depressed between the radial series; ambulacral openings directed horizontally; sutures indistinct.

Basals three, forming a thin almost flat hexagonal disc, nearly covered by a round column. First primary radials a little wider than high, three hexagonal and two heptagonal, central tubercle broad and lateral radiating ridges well defined. Second radials quadrangular, one-half wider than high, radial ridge large and central node prominent, transverse ridge obscure. Third radials very little larger than the second, pentagonal, axillary, and bearing on each upper sloping side a single secondary radial. Secondary radials axillary and bear upon each upper sloping side a single tertiary radial, which bear the free arms. There are twenty ambulacral openings to the vault, directed horizontally.

Interradial areas subovate in outline, apparently excavated. Regular interradials three, one large plate having a central tubercle and two small ones. The indistinct sutures and anchylosis of the plates in the interradial areas of all the species, in this genus, make it difficult to determine the number and outline of these plates. The first azygous plate is in line with the first radials and much smaller; it is followed by two much smaller plates and these by two still smaller. The vault is elevated by upright plates between the ambulacral orifices and also in the interradial areas. Above these plates the vault is very convex and stands nearly upright on the azygous side. It is covered with polygonal, large, tumid and spinous plates. The most prominent spines are over the radial areas. The vault terminates in a short proboscis almost straight above the azygous area.

This species is much like *B. trijugis*, in all its parts, except the vault and proboscis. It is true I have not distinguished as many interradial plates nor as many azygous plates, but that may be due to the anchylosis in the interradial areas. I have examined thirty or forty specimens, in this genus, and have not seen a single specimen in which the interradial plates could be satisfactorily determined, except in the single one that is the type of *B. trijugis*. The vault in this species is different in form, more convex, and covered with more tumid plates than it is in *B. trijugis*; the proboscis is differently located and differently constructed. These differences are so marked that there is no trouble in separating the two species.

Found by R. A. Blair and F. A. Sampson and by myself, in the Chouteau limestone, at Sedalia, Missouri. The specimen illustrated is in my collection.

#### AGARICOCRINUS GERMANUS, N. SP.

Plate VII, fig. 8, view of the vault; fig. 9, azygous side view; fig. 10, basal view.

This is a small species, at least the specimens examined are small. The calyx is nearly flat, a circular depression having a defined rim indicates the place for the attachment of the column, the radial areas are a



little rounded and the interradial areas are slightly concave. The surface is granular.

The basals are small and extend but little beyond the cicatrix for the column. The first radials are nearly as long as wide; they curve into the basal depression abruptly from a low angular ridge about the middle of the plates, which marks the limit of the basal depression. Second radials quadrangular, about two and a half times as wide as long. Third radials of unequal size, short, some much wider than others, pentagonal, and support upon the outer sloping sides the secondary radials. There are ten openings to the vault and consequently ten arms; the radial series differ somewhat in size and hence there may be a difference in the size of the arms.

Regular interradial areas narrow and occupied by a single plate. The first azygous plate is in line with the first radials and of about the same size; it is followed by three plates, the middle one of which curves over and unites with the plates of the vault. Vault low, the convexity is not more than the thickness of the plates. Between and above the ambulacral orifices in each radial series there is a large tumid plate as shown in figure 8; the other vault plates are only slightly convex. The interradial spaces are a little concave and filled with the smaller plates. The subcentral orifice is comparatively large. The central plate is very little larger than those surrounding it.

This species is related to *A. sampsoni*. We can not compare the vault or the arms to show the differences. This is a smaller species than that one. The radial series in that species are uniform in size; in this species the radial series opposite the azygous side is larger than either of the others, and viewed from the base the right lateral series is larger than the one on the left. In that species the first radial series are gently rounded into the basal cavity, in this an angular rim defines the basal depression. The second radial plate in that species is shorter than it is in this one. It is shorter, in fact, though it is a larger species. In that species the arms are deep, in this, judging from the appearance at the base, they are shallow.

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

AGARICOCRINUS CHOUTEAUENSIS, N. SP.

Plate VII, fig. 11, summit view; fig. 12, lateral view; fig. 13, basal view with part of the column.

This is a medium sized species. The calyx has a rather deep central concavity, which includes nearly the whole of the first radials and is sharply defined. The radial series are broadly rounded and interradial spaces more narrowly depressed; radial series very unequal, surface granular, column round.

Basals form a pentagonal disc a little larger than the end of the column. First radials abruptly and almost wholly depressed into the basal cavity, nearly as long as wide. Second radials quadrangular, very unequal in size. Third radials pentagonal, very unequal in size and support on the upper sloping sides the secondary radials. A single secondary plate supports the regular interlocking series of the arm plates. There are ten openings to the vault and consequently ten arms in this species. The plates are thick and, therefore, show the arms are deep.

Regular interradial areas narrow and occupied by a single plate. The first azygous plate is in line with the first radials, but it is much longer and extends as far as the superior lateral angles of the third radials; it is followed in direct line with four more elongated plates that reach the azygous orifice; the other two azygous plates are elongated and give width to the azygous area. The vault is conical and terminates in a large conical plate, on the azygous side of which there is a small anal orifice. The plates are convex and polygonal. A small pointed plate separates the ambulacral orifices in each series.

This species is so different from *A. germanus* that no comparison with it is necessary. It is distinguished from *A. sampsoni* by the abrupt basal cavity, the azygous area, and by the great inequality of the radial series.

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

## FAMILY CYATHOCRINIDÆ.

### CYATHOCRINUS MEEKANUS, SHUMARD.

In 1855, Shumard described *Poteriocrinus meekanus* in the Geological Survey of Missouri, page 188, from a single specimen, found at Mount Vernon, in Moniteau County, among loose debris at the foot of the bluffs, composed of both Chouteau and Encrinital limestone, and subsequent authors have generally referred it to the Burlington Group. R. A. Blair and F. A. Sampson have collected a large number of specimens belonging to this species, in the Chouteau limestone, in Pettis County, Missouri, and hence it does not belong to the Burlington Group, as no crinoid was ever known to pass from one Group of rocks to another. It is a Cyathocrinus and should be known as *Cyathocrinus meekanus*, from the Chouteau limestone.

### CYATHOCRINUS GORBYI, N. SP.

*Plate V, fig. 6, azygous view; fig. 7, side view; fig. 8, basal view.*

Calyx low, nearly twice as wide as high, subpentagonal in outline, basal plates depressed and subradials prominent, making the greatest diameter of the calyx through the subradials, below the level of the

basal disc; contracted toward the summit; plates sculptured; sutures distinct.

Basal plates form a flat pentagonal disc, with slightly concave sides, and having a diameter a little more than one and a half times the diameter of the column; they are depressed so as to be on a level with the middle of the subradials. Subradials convex, in the form of a five-sided pyramid, with the apex of each at the lowest part of the calyx. Each of the five faces of a plate are directed to an angle with the adjoining plates, and the angles of the pyramid extend from the apex to the middle of each of the five adjacent sides. The radials are smaller than the subradials, wider than high, subpyramidal, with a face on each directed toward each of the three angles formed with the subradials, and the angles of the pyramid extend from the apex to the middle of the two sides of the adjacent subradials, which produces an angular ridge from the apex of each subradial to the apex of each adjacent first radial. Articulating facet for the second radial in the form of a half circle occupying one-half the width of a plate and having a prominent outer rim. The facet is directed outward at an angle of forty-five degrees. The superior faces of the first radials on each side of the articulating facets slope a little to the sutures for the reception of the interradiar vault plates. Azygous plate a little smaller than a first radial, stands upright, and extends higher than the radials. It is truncated above and has upper lateral sides, so that it is succeeded by three plates. It is also subpyramidal and has an angular ridge extending from the apex to the subradial below, where it meets a corresponding angular ridge from the apex of the subradial.

This is a peculiar species, quite distinct from all heretofore described.

Found in the Keokuk Group, at Gosport, Ind., and now in the collection of Prof. A. C. Benedict, at Indianapolis. The specific name is in honor of the State Geologist.

## FAMILY POTERIOCRINIDÆ.

### SCAPHIOCRINUS LYONI, N. SP.

*Plate V, fig. 25, azygous plates are shown on the left.*

Calyx short, bowl-shaped or subcylindrical, deeply sunken below, one-half wider than high; plates convex, finely granular; sutures distinct.

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 and extending half the height of the calyx; they are longer than wide and quite convex in the central part. First radials wider than high, truncated the entire

width above, and separated from the brachial by a gaping suture, longitudinally convex and slightly constricted in the middle. Brachials longer than wide, axillary, constricted on the sides so as to form an angular ridge in the center. Arms ten, no division, composed of a single series of plates, laterally constricted, the first ones longer than those above, and alternately projecting at the upper ends for the attachment of the pinnules. Pinnules coarse and composed of long joints.

First azygous plate large, pentagonal, rests obliquely between the upper sloping sides of two subradials and the under sloping side of the radial on the right, abuts one side against the second azygous plate, and supports the third azygous plate on the upper slightly sloping side. Second azygous plate smaller and truncates a subradial. Third plate extends above the top of the calyx, and fourth and following plates arranged as in other species of this genus. Column pentagonal and composed of thicker and thinner pieces.

Found in the Keokuk Group, three miles east of Crawfordsville, Ind., and now in the collection of Prof. A. C. Benedict.

#### SCAPHIOCRINUS MANIFORMIS, N. SP.

*Plate V, fig. 26, lateral view.*

Calyx low, saucer shaped, moderately sunken below, more than twice as wide as high, plates convex, sutures distinct, not beveled.

Basals sunken in the columnar cavity and not visible in our specimen. Subradials moderately large, the lower margin curving into the basal depression and below the middle part curving abruptly upward and extending nearly half the height of the calyx; they are as long as wide and very tumid. Radials one-half wider than high, truncated the entire width above and separated from the brachial by a gaping suture, longitudinally convex and slightly constricted in the middle. Brachials longer than wide, constricted and rounded in the middle. Arms ten, no division, composed of a single series of very long round plates, alternately projecting at the upper end for the attachment of the pinnules. Pinnules coarse and composed of long joints. Azygous side not seen in our specimen. Column round and composed of rather long plates.

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

#### BARYCRINUS STELLIFERUS, N. SP.

*Plate VIII, fig. 6, azygous view; fig. 7, opposite view; fig. 8, basal view; fig. 9 interior of the calyx, all natural size.*

This is a moderately robust species. Calyx unsymmetrical, wider than high, sutures distinct, but not beveled, and have no depressions at the angles, plates very thick, remarkably convex and spinous.

The basals form a pentagonal disc twice as wide as the diameter of the column, the angles of the pentagon extend up moderately between the inferior sides of the subradials. Subradials large, three hexagonal and the two adjoining the azygous area heptagonal. The convexity of each is in the form of a four-sided pyramid having the apex on a horizontal plane with the basal disc, one of the pyramidal sides of each extends from the apex of a subradial plate to one of the sides of the pentagonal disc, producing a five-rayed star, as seen from below with the column in the center and the apex of each subradial at one of the points of the star. One of the sides of the pyramid is on the upper side of the plate and the other two are on the lateral sides, each side of the pyramid is somewhat concave, which makes its pyramidal surface more distinct and more clearly defines the pentagonal star below. The first radials are large, wider than high, the two lateral ones of equal size; the others of unequal size and each a little smaller than the lateral ones; all of them are heptagonal with a longitudinal sub-angular elevation in the upper central part, bifurcating and extending to the sides of the adjoining subradials; on most of these angular ridges there is a prominent tubercle. The upper face of each plate is concave for the reception of the second radial and the facet occupies nearly two-thirds of the width of a plate; the superior lateral sides are slightly concave for the reception of the interradials or vault plates. The second radial or first brachial is preserved in one of the rays of our specimen; it is quite thin and unites laterally with the interradials, as shown by the continuation of the concave facets.

The azygous area is occupied with three plates. The first two are pentagonal, rest upon the upper sloping sides of the subradials, below the under sloping sides of the first radials, the one on the right being the longer, each bears a central ridge directed from a first radial to the center of the subradial below, and each bears a prominent central tubercle. The third azygous plate rests between the other two and separates the first radials and bears a tubercle.

The summit of the calyx with arms and vault removed shows the remarkably thick plates and the pentalobate shape of the interior. I do not know of any species with which it is necessary to compare this one to make the definition clearer as I think it can not be mistaken for any other one.

Found by A. C. Benedict in the Keokuk Group in Harrison County, Indiana, and now in his collection.

## FAMILY MELOCRINIDÆ.

## MELOCRINUS ÆQUALIS, N. SP.

Plate V, fig. 11, view of two interradial areas, with the middle arm broken off close to the body, the outline of the basal plates is from another specimen; fig. 12, another interradial area on the same specimen.

Species small. Calyx obpyramidal, with the upper part strongly pentagonal, and having deeply sunken interradial areas; all the plates of the calyx, vault and proboscis tumid; sutures deep and radiately sculptured, within the beveled spaces, by a single ridge to each side of a plate, especially on the larger plates of the calyx. Arms directed nearly horizontally.

Basals four, equal, longer than wide, expanding very little, tumid, sutures deep. Primary radials three by five, the first one rather wider than a basal and of about the same length, two heptagonal and probably two more where the lower side abuts on two basals, the other one hexagonal. Second radials about the size of the first, hexagonal. Third radials a little smaller; they are octagonal and directed outward, at an angle of about forty-five degrees; the lower side of each rests on the upper side of a second radial, the inferior lateral, lateral, and superior lateral sides abut interradials, and the superior sloping sides support small arm plates, both of which form part of the covering for a single ambulacral orifice, which, at this place, is completely surrounded by five plates, viz: The two just mentioned on the lower part of the orifice, an interradial on each side and one vault plate on top. There are only five ambulacral orifices to the vault.

The interradial areas are alike, at least I have not been able to distinguish an azygous area in either of our specimens. The first interradial is nearly as large as a second radial, hexagonal, and rests between the upper lateral sides of the first radials, laterally between the second radials and supports upon the upper sloping sides two interradials. These are succeeded in the third range by three plates, situated between the arms, and these are followed by plates that graduate, without interruption, into the plates of the proboscis. The vault is almost wholly taken up with a central proboscis; indeed, it might be described as consisting of a proboscis with a slightly expanded base, the rays of which cover the commencement of the arm furrows. The proboscis is broken off in our specimens, as shown by the illustrations, but it, evidently, had considerable length. The column is unknown.

This is a marked species, distinct from any heretofore described, in its basal plates, equal sunken interradial areas, central proboscis, and tumid plates. *M. obconicus*, found in the Niagara Group, has no near relation to it, for the vault in that species is slightly convex, covered

with small plates, no proboscis, but having a small orifice at the summit above a wide azygous area; short basal plates; evenly expanded obpyramidal calyx, with flattened interrarial areas, and having sculptured plates. *A. obpyramidalis* has a subcentral small proboscis, secondary plates, ten ambulacral orifices, and is otherwise far removed from the species under consideration.

Found in the Niagara Group, at St. Paul, Indiana, and now in the State Museum, at Indianapolis.

#### GAZACRINIDÆ, N. FAM.

In this family there are five basals, no subradials, three by five primary radials, one or more secondary radials, arms composed of a single series of plates, interrarial areas almost alike, vault sustained by a specialized frame work.

#### GAZACRINUS, N. GEN.

(*Ety. gaza, treasury; krinon, lily.*)

Calyx obconoidal, basals five, one truncated by the azygous plate, primary radials three by five, secondary radials two by ten, arms composed of a single series of flattened plates, one plate in each radial area, vault sustained by a specialized frame work with ambulacral canals connecting the arms with a central orifice. Type, *Gazacrinus inornatus*.

#### GAZACRINUS INORNATUS, N. SP

*Plate V, figs. 9, 10, 15 and 16, views of different specimens; 9 and 10 show some of the arm plates, and the second and third radials are anchylosed; fig. 16, is an azygous view; fig. 17, shows the internal structure of the vault, the outer plates being removed.*

Calyx bowl-shaped or somewhat obconoidal and truncated below; there is an undefined constriction in the middle part of the basal plates, and another below the arms; diameter a little more than the height; plates convex, smooth; sutures not very distinct, and some of them anchylosed.

Basal plates longer than wide, lateral sides very slightly diverging and the upper sides steep, except one, which is truncated by the azygous plate; they form the frustum of a cone with angular notches at the larger end and a deep columnar cavity at the other. First radials much larger than the second and third together, about one-half wider than high, the two adjoining the azygous area hexagonal and the other three heptagonal. Second radials very short, quadrangular. Third radials short, wide, pentagonal, axillary, and bear on each upper sloping side two short secondary radials which support the arms. There are ten arms. They are composed of long plates, flattened laterally on the outside,

and furrowed on the inside, and appear to be compact when closed. The edges of the plates, so far as observed, are transversely serrated, on the inside, half the depth of the plates, a peculiarity I have never seen in any other crinoidal plate. There are three longitudinal furrows on the inside of each radial series, shown at the top of the secondary radials; this gives fifteen furrows at the top of the secondary radials, one in the middle of each plate, and the other at the suture, which is another peculiarity entirely new to me.

The secondary radials unite at the top of the calyx, cutting off the interradial areas. There is a single, large interradial in each regular area, resting between the upper sloping sides of the first radials and between the second and third radials and the under, short, sloping sides of the first secondary radials. The azygous plate is a little larger than the other interradials, and it truncates the top of one of the basal plates.

We have attempted to give some idea of the lower part of the frame work of the vault in figure 17. There is a central orifice; from this a triangular plate having a furrow on each side extends to each interradial series, and these furrows connect with the longitudinal furrows, in the secondary radials, at the top of the calyx above mentioned. Between these triangular plates the furrow in the suture above mentioned is surrounded with a plate and converted into a circular passage directed inward, higher than the furrows in the triangular plates above described. Between each of the points of the triangular plates surrounding the central orifice there is a small, furrowed plate. Between these small plates and the circular passage, higher than the furrows above mentioned, the plates are absent in our specimen. The covering of this frame work is not preserved in any of our specimens.

Found in the Niagara Group, at St. Paul, Indiana, and now in the State Museum at Indianapolis.

## FAMILY GLYPTASTERIDÆ.

### CYPHOCRINUS, N. GEN.

(*Ety. kypnos*, bowed down; *krinon*, lily.)

Calyx obconoidal or obpyramidal as high as the first interradials, then rapidly expands and curves downward until the periphery and ambulacral orifices are directed below a horizontal line. Basals five, forming a pentagonal disc. Subradials five, hexagonal, except one which is truncated by the first azygous plate; it is heptagonal. Primary radials three by five, three of the first ones heptagonal and the other two hexagonal; second radials quadrangular; third radials pentagonal and bear on the upper sloping sides secondary radials. Regular interradials



numerous, the first one large and resting between the short upper sloping sides of the first radials, it is followed in the second range by two plates and by three plates in succeeding ranges until they unite with the plates of the vault. Intersecondary radials present. First azygous plate large, truncates a subradial, and is followed by three or four plates in each succeeding range until they unite with the plates of the vault. Vault convex and covered with more or less numerous, plane, convex or spinous plates. A large spinous plate occupies the center of the vault and the anal orifice without any prominence is on the azygous side of it. Type, *Cyphocrinus gorbyi*.

CYPHOCRINUS GORBYI, N. SP.

*Plate VII, fig. 14, showing vault, central spinous plate and anal orifice slightly to one side of a direct line to the center of the azygous area; fig. 15, side view, part of the central vault spine is broken off; fig. 16, basal view.*

Calyx obpyramidal as high as the first interradials, then rapidly expands and curves downward until the periphery and ambulacral orifices are directed below a horizontal line. The radial series are angular and the interradial areas concave, sutures moderately distinct.

Basals small, forming a pentagonal disc only a little larger than the diameter of the column, which is pierced by a small, pentagonal, columnar canal. Subradials not large, hexagonal, except one, which is truncated by the first azygous plate; it is heptagonal and the larger subradial. First primary radials nearly twice as large as the subradials, one-half or nearly twice as wide as high, upper face more or less arcuate, the one on each side of the azygous area hexagonal, the other three heptagonal. Second radials short, twice as wide as high, quadrangular. Third radials very little larger than the second, pentagonal, axillary, and bear on each of the upper sloping sides five secondary radials, the last two of which are somewhat cuneate and the last one bears the free arms. Arms ten composed of a double series of interlocking plates and doubtless curved up over the vault, but they are not preserved in our specimens. Each of the ten ambulacral openings is divided transversely by a plate in the middle, the lower channel curves down on the inside of the secondary plates and the other is provided with a furrow that curves upward under the vault plates, the two in each radial series soon coming together and then continuing until the five come together at the central part of the vault.

There are nine regular interradials in each area, the first one large; it is followed by two plates in the second range, three in the third range and three in the fourth range, that unite with the plates of the vault. There are eleven plates in the azygous interradial area. The first one truncates a subradial; it is followed by three plates in the second range,

three plates in the third range and four plates in the fourth range, that unite at the periphery with the plates of the vault. There are six plates in each intersecondary radial area; one in the first range, followed by two in the second range and three in the third range, that unite at the periphery with the plates of the vault. The vault is convex, having a height equal to the height of the calyx; it rises rapidly over the ambulacral orifices, or radial areas, and is concave over the interradial and intersecondary radial spaces. There are three prominent spinous plates over each radial series; one over each ambulacral passage under the vault and one over the junction of the two passages belonging to each radial series; there is a large plate bearing a very large spine in the center of the vault; there is a slight swelling on the vault from this spinous plate down the azygous side; the anal orifice is, without any prominence, on this swelling on the azygous side of the spinous plate; it is subelliptical in outline on the specimen figured, and surrounded with nine plates. The plates in the interradial and intersecondary radial areas are plane and not spinous.

Found in the Niagara Group, at St. Paul, Indiana, and now in the State Museum, at Indianapolis. The specific name is in honor of Prof. S. S. Gorby.

#### FAMILY ICHTHYOCRINIDÆ.

##### ICHTHYOCRINUS GREENII, N. SP.

*Plate VIII, fig. 3, lateral view, natural size, column and part of the arms eroded.*

Body, with arms folded, somewhat pear-shaped. Calyx obpyramidal, truncated below; surface without ornamentation.

Basals three; short. Subradials one-half or nearly one-half wider than high, three hexagonal, two pentagonal. Primary radials, four in each series; they gradually widen without a corresponding increase in length, and, as will be seen in the illustration, they are not of the same size in the different series, and hence, instead of a straight suture between the series and quadrangular and pentagonal plates, we have a zigzag suture between the series and hexagonal and heptagonal plates by reason of the slight truncation at the angles. Secondary radials, four in each series; they are about the same length as those in the first series, but they are not quite as wide and do not increase in width as rapidly, and they do not abut laterally so as to produce quadrangular and pentagonal plates, but interlock more or less, and thus truncate the angles of the plates. Tertiary radials, five in each series; they are much smaller than the secondary radials, and, like the primary and secondary radials, do not regularly abut laterally so as to produce quadrangular and pentagonal plates, but more or less interlock and truncate

the angles, thus increasing the number of sides, as shown in the illustration. There are nine plates in the fourth series, but they are less than one-third as large as they are in the third series, because they are contracting toward the summit of the body. The plates in the fifth series are still smaller and more numerous and seem to bring their small ends together and infold them at the summit of the body.

There are no interradians. The column is composed of very thin plates, so far as preserved in our specimen. It is, probably, round, but our specimen is somewhat injured, so as to leave some doubt whether it is round or pentagonal. The small plates shown at the superior end of our specimen, where the arms are broken away, look as if they belonged to pinnules, and I can not otherwise account for them, though I believe no one has heretofore observed pinnules in this genus.

This species is so different from those heretofore described that no comparison is necessary.

Found by G. K. Greene in the Keokuk Group, at Muldrough Hill, Kentucky, and now in his collection. Mr. Greene has been for many years an ardent collector and worker in fossils, especially in the vicinity of Louisville, and we have remembered him in the specific name of this beautiful crinoid.

## CLASS BRACHIOPODA.

### ORDER LYOPOMATA.

#### FAMILY LINGULIDÆ.

##### LINGULA PARRISHI, N. SP.

*Plate VIII, fig. 2, cast having the lateral and front margins broken away; plate IX, fig. 1, a better preserved specimen having less of the lateral and front margins broken off, and preserving part of the external shell.*

Shell very large. Both of our specimens are inequilateral, having the umbonal ridge directed to one side of a median line, without showing any evidence of compression that could produce this character. The general form of the shell is subovate, compressed, front broadly rounded, sides more abruptly rounded to the frontal margin and gently curving to the beaks. Valves subequally convex; most prominent over the umbo, and flattened toward the margin.

Surface of both valves marked by fine, distinct, concentric striæ, and wide, shallow, concentric undulations. The beak of the best preserved valve in each of our specimens is acutely pointed, extends a little beyond the cardinal area and is distinctly separated from the beak of the other valve, and the concentric striæ are continued almost to the tip of it. The substance of the shell is rather thick and consists of an inner hard shelly layer and an outer less dense phosphatic layer.

No evidence of the peduncle is preserved in either specimen, and not a sign of a muscular scar can be seen, notwithstanding the apparent preservation of the cast, and the partially eroded shell in the other specimen where the scars of *Lingula* belong. There are no radiating lines on either the shell or the cast.

This species is so distinct from all others that have been defined that no comparison is necessary with any of them. I do not believe it is a true *Lingula*; but, notwithstanding the apparent inequality of the sides, in the absence of any knowledge of the muscular scars, it is referred provisionally to that genus on account of its general form, and the structure and composition of the shell itself.

Found in the Upper Coal Measures, in what is known as layer 85, at Kansas City, Missouri, and now in my collection. The specific name is in honor of W. J. Parrish, a prominent naturalist of that city.

LINGULA SEDALIENSIS, N. SP.

*Plate IX, fig. 2, dorsal valve, slightly broken at the beak and at the frontal margin, natural size.*

Shell rather below medium size, compressed, ovoid-subtrigonal in outline, a little longer than wide, the greatest breadth being near the anterior margin; front broadly rounded and rounding abruptly into the antero-lateral margins; sides converging in almost straight lines to a sharply pointed beak. Beaks acute, convex; umbones more gently convex, and valves flattened toward the front and antero-lateral margins.

Surface ornamented by distant, fine, concentric, elevated lines, free from wrinkles, and separated by flattened interspaces about three times their own width. These lines and interspaces arise anterior to the beak from the converging sides, as shown in the illustration. There are no radiating striæ. Though several specimens have been examined no traces of the muscular scars have been detected.

The general outline of the shell is much like that of *Lingula nebraskensis*, but it will be distinguished from that and all other species having a subovate or ovoid-subtrigonal outline, by the fine, distant, concentric, not lamellose or irregular, striæ, and by the manner in which they arise from the anterior part of the converging sides, and by the smooth interspaces.

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

## LINGULA GORBYI, N. SP.

*Plate IX, fig. 3, a large fragmentary specimen; fig. 4, a smaller, nearly perfect specimen, having only a small piece broken from the left side near the beak, natural size.*

Shell below medium size, compressed, subelliptical in outline, slightly narrower toward the beaks than at the front, sides regularly curving, front rather broadly rounded. Beaks subacute, not extending beyond the cardinal area; umbones more prominent and regularly convex, while the shell is flattened and terminates in sharp lateral and front margins. Muscular scars not observed.

Surface covered with very fine, close, concentric lines, free from wrinkles, and sometimes showing a few undefined concentric undulations, but they can not be distinguished on half the specimens examined. No radiating striæ.

This species will be distinguished from those having a similar subelliptical outline by the finer and more regular concentric striæ, and by the umbones rising higher than the beaks, while the beaks do not project beyond the cardinal area.

Found by R. A. Blair, in the Chouteau limestone, near Sedalia, Missouri, and now in my collection. The specific name is in honor of Prof. S. S. Gorby, State Geologist of Indiana.

## LINGULA VANHORNII, S. A. MILLER

In 1875 in Vol. 2 of the Cincinnati Quarterly Journal of Science, page 2, I described and illustrated *Lingula vanhornii* which I collected in the upper part of the Hudson River Group, at Versailles, Indiana. The figure, which is a wood cut, was used on page 351 in North American Geology and Palæontology. The specimen is almost perfect. It shows both valves, each of which is slightly exfoliated and discloses part of the muscular impressions. It is the only specimen belonging to the species that I have ever seen. In 1889, Mr. Ulrich described a related species from Covington, Kentucky, under the name of *Lingula proctori*, which has been frequently confounded with it and which I have seen labeled in different collections *Lingula vanhornii*. *Lingula proctori* occurs in rocks 500 to 600 feet lower, geologically, than those in which the type of *Lingula vanhornii* was discovered and about fifty miles distant. I will not here attempt to point out the distinctions between the two species, though the specimens of *L. proctori*, which have fallen under my observation, are much smaller than *L. vanhornii* and, as figured and described by Mr. Ulrich, there is greater inequality between the valves.

I loaned to Mr. Charles Schuchert, who was working on Brachiopoda for the New York Survey, the type of *Lingula vanhornii*. I did not lend the specimen to the State Geologist, but I lent it to Mr. Schuchert

to be used in the preparation of Vol. VIII of the New York Palæontology, if it should be of service to him in that regard, and, of course, no credit was to be given for it.

I now find in Vol. VIII, plate I, fig. 4, the valve of a small undescribed and unknown species illustrated as *Lingula vanhornii*, and comments in the text based upon it as if it were that species. It has no resemblance to *Lingula vanhornii* in size, shape or muscular impressions, nor is it reported to have been found in the same range of rocks. Why such erroneous statements are made in scientific matters is quite beyond my comprehension.

### FAMILY CRANIIDÆ.

#### CRANIA BLAIRI, N. SP.

*Plate IX, figs. 5 and 6, dorsal views of two specimens, the margins of both are imperfect.*

Shell above medium size or rather large, subcircular, depressed conical or having a height not exceeding one-fourth the diameter. Apex subcentral, obtusely pointed, inclined slightly toward the posterior part of the shell.

Surface ornamented by elevated, radiating striæ, that increase in number by intercalation, without bifurcation. They become coarser, more distant and sometimes irregular toward the margin. The apex is smooth in the older specimens, but probably on young shells the striæ reached quite to the tip. Ventral valve and muscular impressions unknown.

This species is more like *Crania crenistriata*, from the Hamilton Group of New York, than any other described species. It is, however, a larger shell, and has the apex farther removed from the center, and appears to be less conical, and to bear rather coarser striæ that are not crenated. The latter difference alone is enough to distinguish it.

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

#### CRANIA GREENII, N. SP.

*Plate IX, fig. 7, dorsal valve, the outer margin is not all preserved; a, posterior part of the shell.*

Shell large, subcircular, broadly convex, depressed posterior to the beak, height about one-third the diameter. Apex subcentral, obtuse.

Surface bears a few concentric, imbricating lines of growth, and is marked by irregular transverse striæ, some of which are deflected on the anterior side of the shell, and also by faint radiating lines that somewhat sculpture the surface, especially toward the margin. Lower valve and muscular impressions unknown.

The shells of this genus are often influenced or governed, in the forms they assume, by the surface of the foreign objects to which they adhere; and even the dorsal valves not unfrequently bear the wrinkles, lines, dots or ornamentation of the bodies to which they are attached. The transverse striæ above mentioned may represent the surface of the object to which this shell attached, though our specimen does not indicate such to have been the case. The specimen was found on a rock and not adhering to any other organism. In any event, the obtuse apex, posterior depression, and radiating lines will distinguish it from *Crania hamiltonia*, which otherwise it would seem most to resemble.

Found by G. K. Greene, in the Upper Helderberg Group, at the Falls of the Ohio, and now in his collection. The specific name is in honor of the collector.

#### ORDER ARTHROPOMATA.

#### FAMILY RHYNCHONELLIDÆ.

#### RHYNCHONELLA COLLETTI, N. SP..

*Plate IX, fig. 8, ventral view; fig. 9, cardinal view, natural size.*

Shell depressed, subcircular, transverse diameter fully equal to and often greater than the distance from the point of the beak to the front margin, while the convexity is less than half the length or breadth of the shell. The furrows are deep and the plications coarse when compared with other shells of the same size.

Ventral valve shallow, most prominent on the umbo, which forms a sort of mesial ridge, each side of which is flattened toward the lateral margins. Beak straight and slightly truncated at the end. A furrow arises near the beak and gradually deepens and widens in passing over the umbo. The ridge on each side of this furrow is deflected to the antero-lateral margin of the shell; it bifurcates, and the inner branch again bifurcates, and these plications pass into a deep sinus in front, that extends almost as high as any part of the mesial elevation on the dorsal valve; sometimes a central plication arises in the sinus at about the middle or anterior third of the shell and bifurcates as it curves upward toward the mesial ridge of the dorsal valve. There are, therefore, in the sinus, at the front where they terminate, between the antero-lateral plications, from six to eight folds. Three or four plications arise on each side of the umbonal ridge and curve to the lateral margins; they bifurcate, so there are about eight folds on each side behind the antero-lateral plication. The increase of plications is by bifurcation and not intercalation, except the single fold, in some cases, in the depth of the upturned sinus. There are, therefore, from twenty-four to

twenty-six folds at the margin of this shell. No concentric striæ are preserved, except a few imbricating lines of growth near the margin.

Dorsal valve shallow. Beak obtuse and slightly inflected beneath the beak of the opposite valve. Two strong plications arise at the beak, which are deflected to the antero-lateral margins of the shell, and at the umbo, in the furrow, an intercalated plication arises, which soon bifurcates and extends, with little or no convexity, to the front, where it meets the upturned sinus of the opposite valve; intercalated plications arise on each side of this central one, some of which bifurcate before reaching the upturned lateral sides of the sinus of the other valve. There are from six to eight folds between the antero-lateral plications, most of which are intercalations. The strong plications rising at the beak, and deflected to the antero-lateral margins, bifurcate outwardly toward the lateral margins, and about three plications arise on each side near the beak, which are directed laterally and bifurcate before reaching the margin of the shell, so there are about eight folds behind the antero-lateral one, which makes the same number that ornament the opposite valve. No concentric lines are shown in our specimens, except imbricating lines of growth near the margin.

This is a very marked species, resembling somewhat *Rhynchonella whitiana*, but more depressed and having more plications on the mesial fold, and in the sinus and on the sides, all of which arise in a different manner

Collected in the Niagara Group, at Wabash, Indiana, and now in the collection of A. C. Benedict. The specific name is in honor of the veteran geologist, John Collett, of Indianapolis

RHYNCHONELLA KOKOMOENSIS, N. SP.

Plate IX, fig. 22, ventral view; fig. 23, front view; fig. 24, dorsal view.

Shell rather below medium size and transversely subspheroidal in form. Two specimens give the following measurements: breadth, .48 inch; length, .40 inch; convexity, .36 inch; breadth, .44 inch; length, .38 inch; convexity, .36 inch. The furrows are shallow in front, where the folds appear as if shaved off, and near the beaks the shell becomes almost smooth, leaving the folds most conspicuous a little anterior to the middle of the valves.

Ventral valve deep, most prominent in the central area, from which it slopes in all directions. Beak pointed and closely incurved over the umbo of the opposite valve. Sinus not distinguishable posterior to about the middle of the valve, from which point-forward it is flat, wide and includes within the depression five plications which curve up nearly



as high as the mesial elevation on the dorsal valve. There are ten plications on each side of the mesial sinus, making twenty-five on this valve, none of which result from bifurcation.

Dorsal valve deep, most prominent at the anterior third of the mesial fold from which it rounds off laterally and posteriorly, but, arching slightly toward the front, it terminates abruptly. Beak pointed and incurved beneath the beak of the ventral valve. A distinct furrow extends from the beak to the front, on each side of which three plications form a flat mesial fold elevated toward the front above the lateral plications. There are nine plications on each side of the mesial fold, which makes the same number that ornament the opposite valve. No concentric lines are distinguishable on our specimens.

This is a marked species distinguished by its general form, mesial furrow on the dorsal valve and the number of plications in the mesial fold and sinus, from all other described species.

Found at Kokomo, Indiana, in the Waterlime Group, by Prof. A. C. Benedict and now in his collection.

#### FAMILY TEREBRATULIDÆ.

##### TEREBRATULA OCCIDENTALIS, N. SP.

*Plate IX, fig. 10, dorsal view; fig. 11, ventral view; fig. 12, profile view of a smaller specimen; fig. 13, cardinal view of same.*

Shell small, broadest near the middle, brachial valve most convex; front slightly truncated and having a short shallow sinus, more developed in some specimens than in others.

Ventral valve most convex in the umbonal region, rounded to the sides, a little flattened toward the front and usually marked with a shallow mesial depression. Beak prolonged beyond the beak of the opposite valve and truncated with a foramen of moderate size. Umbonal slopes rounded.

Dorsal valve most convex in the umbonal region, regularly curving to the sides and flattened toward the front.

Surface marked with concentric lines of growth. Shell structure beautifully punctate. The internal part has not been seen and hence, possibly, the species may belong to *Cryptonella*.

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

## FAMILY ATHYRIDÆ.

## ATHYRIS OTTERVILLENSIS, N. SP.

Plate IX, fig. 14, cardinal view; fig. 15, ventral view.

Shell small, subquadrate in outline, width greater than height, greatest width above the middle; cardinal extremities rounded; truncated in front where there is a slight mesial depression in both valves. Ventral valve rather more convex than the dorsal and most convex in the umbonal region, regularly sloping to the sides and having a wide shallow mesial depression in front. The beak projects a little beyond the beak of the dorsal valve. Dorsal valve most convex in the umbonal region, regularly sloping to the sides and flattened toward the front and having a wide shallow mesial depression. Surface of the shell nearly smooth and showing a few, distant, obscure, concentric lines of growth. The substance of the shell is minutely punctate. The internal structure is unknown.

Found by R. A. Blair, in Devonian rocks, which I regard as of the age of the Hamilton Group, three miles from Otterville, and seventeen miles west of Sedalia, Missouri, and now in my collection.

## ATHYRIS BRITTSI, N. SP.

Plate IX, fig. 16, dorsal view; fig. 17, ventral view; fig. 18, cardinal view.

Shell subcircular in outline, moderately convex, rounded at the cardinal extremities and slightly truncated in front.

Ventral valve a little less convex than the dorsal, most prominent in the umbonal region, regularly sloping to the sides and flattened toward the front or very slightly sinuous. Beak prolonged a little beyond the beak of the opposite valve and truncated by a small foramen.

Dorsal valve most convex in the middle part, from which it slopes nearly equally in all directions. Beak very slightly incurved beneath the beak of the opposite valve. Surface marked with concentric imbricating lines of growth.

This species is very much like *Athyris spiriferoides*, and may by some be regarded as a varietal form. It is distinguished, however, by the greater equality of the valves, more pointed and smaller beak of the ventral valve, which is less curved and has a much smaller foramen, and by the absence of the marked and prominent mesial elevation and sinus that characterize that species. These differences seem to warrant a distinct name, though the concentric imbricating surface lines are alike in the two species.

Found by R. A. Blair, in Devonian rocks, which I regard as of the age of the Hamilton Group, three miles from Otterville and seventeen

miles west of Sedalia, Missouri, and now in my collection. The specific name is in honor of Dr. J. H. Britts, a geologist and one of the most distinguished naturalists of Missouri.

### FAMILY ATRYPIDÆ.

#### ATRYPA MISSOURIENSIS, N. SP.

*Plate IX, fig. 19, ventral view; fig. 20, dorsal view; fig. 21, profile view.*

Shell small, subcircular, rather longer than wide, valves very moderately and nearly equally convex, cardinal extremities rounded.

Ventral valve most convex in the umbonal region, which is rather sharply rounded transversely, from which elevation the shell gently slopes to the front and the antero-lateral sides. Beak projects a little beyond the beak of the opposite valve, but is not incurved over it.

Dorsal valve rather more evenly convex than the ventral, without any defined mesial elevation, the greatest convexity being in the central part, from which it slopes nearly equally in all directions. Beak very small and extending slightly beyond the cardinal line, but not incurved.

Surface marked by numerous very fine radiating striæ that are crossed by a few concentric lamellose lines of growth.

This species is related to *Atrypa impressa* and *A. reticularis*, but the valves are more equally convex; there is no defined mesial fold or sinus, and the beaks are less incurved.

Found by R. A. Blair, three miles from Otterville and seventeen miles west of Sedalia, Missouri, in Devonian rocks, which I regard as of the age of the Hamilton Group, and now in my collection.

### FAMILY NUCLEOSPIRIDÆ.

#### RETZIA TRIANGULARIS, N. SP.

*Plate IX, fig. 25, dorsal view; fig. 26, profile view.*

Shell small, subtriangular, longer than wide, greatest width at the anterior third, posterior lateral sides nearly straight and diverging from the beak, making the posterior part of the shell laterally cuneiform, while the valves converge toward the front, making it cuneiform; valves very moderately and nearly equally convex.

Ventral valve most convex in the umbonal region, where it is narrowly rounded transversely, and from which elevation it gently slopes to the front. Beak long, straight, pointed and truncated with a small foramen.

Dorsal valve most convex in the umbonal region, where it is broadly rounded transversely, or slightly flattened centrally, and from which elevation it gently slopes to the front. Beak straight and obtusely pointed.

Surface marked with from fourteen to eighteen sharply angular plications, with intervening furrows of the same width. None of the plications bifurcate, and the increase is solely by implantation. No concentric lines visible on any of our specimens.

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

#### RETZIA PLICATA, N. SP.

Plate IX, fig. 29, ventral view; fig. 30, cardinal view; fig. 31, an interior showing part of the coils, some of them extending to the front margin.

Shell small, subcircular in outline, cardinal extremities rounded; valves about equally convex and nearly uniformly rounded in all directions. Beak of the ventral valve slightly incurved over the beak of the other valve and truncated with a rather large foramen. Surface marked with ten or twelve angular plications, which arise at the beak and increase in size toward the anterior and lateral sides. There is no increase by bifurcation or implantation. The intervening furrows are angular and about the same size as the plications. The older specimens show a few coarse, concentric, imbricating lines of growth near the front margin, but none are visible elsewhere.

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

#### RETZIA CIRCULARIS, N. SP.

Plate IX, fig. 32, ventral view; fig. 33, dorsal view; fig. 34, profile view.

Shell very small, subcircular in outline, cardinal extremities rounded; valves about equally convex and nearly uniformly rounded in all directions. The shell is smaller and the convexity much less than in *R. plicata* above described. Beak of the ventral valve small, pointed and incurved over on the beak of the other valve, and truncated with a small foramen. Surface marked with about sixteen rounded and subangular plications, which arise at the beak and increase in size toward the anterior and lateral sides. There is no increase by bifurcation or implantation. The intervening spaces are about the size of the plications. No concentric lines have been observed. The general form and the character of the plications will distinguish it from *R. triangularis*, and the number of plications, as well as the form, will distinguish it from *R. plicata*.

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

## CLASS PTEROPODA.

## FAMILY HYOLITHIDÆ.

## HYOLITHES LANCEOLATUS, N. SP.

*Plate IX, fig. 35, side view; fig. 36, transverse section.*

Shell elongate, lanceolate, obtusely pointed, transverse section narrowly subovate, one side rather more convex than the other. All the specimens examined have one lateral side sharp and the other rounded, and as this occurs both in the casts and in specimens having the shell preserved I think it is not the result of compression. Aperture not preserved in any of the specimens collected. Where the shell is preserved it is thin, solid, has a purple color and is apparently the same in composition as the shells of *Conularia* found in different groups of rocks. There is no ornamentation of the surface. The specimen figured has the shell on it, but is broken at the point and at the aperture; a cast, however, in my possession indicates that the specimen figured is nearly complete at both ends.

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

## FAMILY CONULARIIDÆ.

## CONULARIA INTERTEXTA, N. SP.

*Plate X, fig. 4, specimen broken and fragmentary, magnified about one and a half diameters; the longitudinal lines in the upper part should be inclined somewhat diagonally.*

Shell elongate, very slowly expanding, lateral surfaces apparently nearly flat with a small mesial elevation or ridge, angles rounded and having a longitudinal furrow. Surface covered with numerous closely crowded, transverse, crenate striæ hardly visible to the naked eye, but under an ordinary magnifier appearing as lines of granules separated by extremely slender, linear furrows. The lines do not arch forward even in crossing the small mesial ridge. The granules are alternate so as to throw them in diagonal lines across the lateral sides or in quincunx order. There are about twenty-five lineal furrows in the tenth of an inch, where the lateral surface is nine-twentieths of an inch wide and about twenty-two granules or crenulations in the same distance. The furrows and crenulations are more closely crowded toward the apex than above, and under a magnifying power of ten diameters no crenulations are visible in the furrows. This species is remarkable for the closely crowded minute furrows and crenulated striæ.

Collected by Prof. S. S. Gorby, in the Keokuk Group, at West Point, Indiana.

## CLASS GASTROPODA.

## ORDER BRANCHIFERA.

## FAMILY PATELLIDÆ.

## TRYBLIDIUM MADISONENSE, N. SP.

*Plate 9, fig 38, side view, natural size.*

Shell medium size; apex high and almost straight above the anterior line of the shell; the shell slopes from the apex and arches a little toward the posterior part of the shell, but laterally and in front it descends abruptly to the margin; transverse section ovate; surface marked with fine, close, concentric lines and a few coarser ones, all of which appear to indicate lines of growth, instead of surface ornamentation; internal scars unknown.

The high apex and anterior position of it seem to distinguish this species.

Found by J. F. Hammell, in the Hudson River Group, at Madison, Indiana, and now in his collection.

## FAMILY CYCLONEMIDÆ.

## HOLOPEA HUBBARDI, N. SP.

*Plate IX, fig. 39, front view, showing aperture and height of shell; fig. 40, summit view, showing surface markings.*

Shell a little below medium size, depressed conical; width a little more than the height; whorls three, moderately and uniformly ventricose, the last one constituting nearly the entire shell, or four-fifths of it; suture moderately deep; aperture subcircular; umbilicus well defined; surface with close, fine striæ, curving backward and indicating the growth of the shell.

The size, shape of the mouth and umbilicus will distinguish this species from all others that have been defined.

Found by J. F. Hammell and Prof. George C. Hubbard, in the Hudson River Group, at Madison, Indiana, and now in their collections and in mine. The specific name is in honor of Prof. George C. Hubbard, one of the collectors.

## FAMILY PLEUROTOMARIIDÆ.

## MURCHISONIA HAMMELLI, N. SP.

*Plate IX, fig. 41, front view, showing aperture somewhat injured; fig. 42, posterior view, natural size.*

Species a little below medium size; conoidal; height one-third more than the breadth; volutions four or five; suture very indistinct; umbilicus closed. The body whorl bears two furrows, two sharply angular revolving ridges, and one less angular and fading away toward the mouth. Above the body whorl there are only two angular revolving ridges on each whorl. The aperture is partly formed by the last whorl; the inner lip is thickened, the outer one is thin. The aperture and revolving angular ridges will distinguish this species.

Found by J. F. Hammell and Prof. Geo. C. Hubbard, in the Hudson River Group, at Madison, Indiana. The specific name is in honor of one of the collectors.

## CLASS CEPHALOPODA.

## FAMILY ORTHOCERATIDÆ.

## ORTHOCERAS CRIBROSUM, GEINITZ.

This species was described by Dr. H. B. Geinitz, in 1866, in "Carbon formation und Dyas in Nebraska," p. 4, plate I, figs. 5 and 5b, from the Upper Coal Measures, division 6 of the Nebraska City Section. A free translation of his definition is as follows:

"This most remarkable fossil is a fragment fifty-eight millimeters in length, five millimeters in diameter at the lower narrow, and thirteen millimeters at the upper broad end, increasing very regularly in size. The form of the shell seems to have been elliptical, but it has been pressed quite flat on one side. The shell is divided into chambers by many concave partitions which lie close together, so that we find on the lower part of it four or five in a length of five millimeters. We can not be certain of the position of the siphuncle, notwithstanding a transverse section has been made, but probably a small elliptical siphuncle laid near the margin.

"The layer on the outside surface of this fossil is very peculiar. It appears to be punctured by innumerable round pits, sieve-like, of equal size and without regular order. This has somewhat the appearance of certain encrusting corals and might readily be taken for such a covering, which seems to us unlikely, however, from the regular appearance of

the fossil. This punctured layer appears only on the outside surface, under which is the real mother of pearl shell."

Prof. F. B. Meek, in 1872, in the report on the Palæontology of Eastern Nebraska, reproduced the illustration of Geinitz, slightly reduced in size, on plate XI, figs. 18a, 18b, and said on page 234:

"This is another form I have not seen from the Nebraska rocks, but it is common in the Upper Coal Measures of Illinois, and also found in the same position in Iowa, Missouri, etc., and in the Lower Coal Measures of West Virginia. It is probably identical with the Upper Coal Measure species, *O. knoxense*, of McChesney, or some of the forms described, but not yet figured, by Professor Swallow, from the same horizon, unless the peculiar surface marking illustrated by Professor Geinitz is really the natural surface ornamentation of the shell. It is far more probable, however, that the pitting seen on Professor Geinitz's specimen is due to some accidental cause, such a style of marking being very unusual in this genus.

"In the Illinois specimens I have seen, these markings are nearly always on one side only, or more numerous and more strongly defined on one side than the other, while in other specimens differing in no other respect, I could see no traces of them. From these facts I am inclined to think they were produced by some minute parasites or boring animals, possibly on dead shells, as they were lying with one side exposed on the bottom of the sea."

More than one-third the length of the specimen illustrated by Dr. Geinitz consists of the lower part of the body chamber, and, judging from the illustration, there are nine or ten chambers in a length equaling the diameter of the shell as it approaches the body chamber. I have a fragment of an *Orthoceras* from the Upper Coal Measures, at Turner Station, near Kansas City, which I refer to Geinitz's species. It preserves no part of the body chamber. It has a length of 1.59 inches (40.4 mm.), a diameter at the larger end of .33 inch (8.33 mm.) and .15 inch (3.8 mm.) at the smaller end, tapers very regularly and gradually, and consists of very thin concavo-convex chambers enclosed in a shell that is covered with irregularly distributed round pits that do not pass through it. I see no reason to doubt that my specimen is an *Orthoceras cribrosum*, except that it is round instead of elliptical, in transverse section, and the small round siphuncle is absolutely in the center. As Geinitz's specimen was evidently compressed and did not preserve the siphuncle, I think his definition may be corrected in these respects and then it will include my specimen. I have little doubt that "the peculiar surface marking illustrated by Prof. Geinitz is really the natural surface ornamentation of the shell," because the surface of the shell is clearly distinguishable in my specimen between the pits, and the pits are as manifestly sunken in the substance of the shell;



there is no encrusting, bryozoum or coralline deposit; the pits are not pores, they do not pass through the shell; they are not confined to one side of the shell, but occur all around it; they have no resemblance to the work of any boring animals known to me, because they do not pass through the outer shell and none of them occur in the septa or partitions that separate the chambers. The species is distinct from *Orthoceras knoxense* of McChesney, if upon no other ground than that of the surface punctures or ornamentation; but the chambers are longer in proportion to the diameter in *Orthoceras knoxense*, where the septa are distant from each other about one-third the diameter in the type species, and fragments of larger specimens from other localities referred to the same species have septa varying in distance from each other from one-sixth to one-fourth their diameter and showing the chambers increase more in diameter than in length with age. In addition to all this, McChesney had specimens from Danville, Springfield, Peoria and Hall's Mill, in Knox County, Illinois, and he said "the surface is destitute of ornamentation and sometimes polished." Prof. Meek had not seen a specimen of *Orthoceras cribrosum* and the description he has given of parasitic injuries or borings he had seen on *Orthoceras knoxense* has no application to the surface ornamentation or pits on my specimen from Turner's Station, and, as I believe, no application to Geinitz's specimen from Nebraska City. There is no doubt that Prof. Meek had seen exactly what he says he had on Illinois specimens, because he never enlarged upon his observation, and I have as little doubt about his having correctly interpreted what he had seen, but I am equally as confident he had never seen a specimen of *Orthoceras cribrosum*. Another observation is pertinent here, to wit: *Orthoceras cribrosum* is found in the Carboniferous basin west of Missouri, and *Orthoceras knoxense* is found in the Illinois and Indiana basin, which is filled with a different geological deposit. The same species sometimes occur in the two basins, but generally they are distinct. It will be an interesting discovery to find any species of *Orthoceras* in the Indiana or Illinois Coal Measures, having such a pitted shell as occurs on *Orthoceras cribrosum*. I have a *Nautilus* also from Turner Station that possesses the same kind of pitted surface to the shell, and I can see no reason to suppose the pits have been the work of boring animals.

ORTHOCERAS COLLETTI, N. SP.

Plate X, fig. 1, natural size.

Shell large, among species from the Coal Measures, long, slowly and gradually enlarging from below upward. The diameter increases in our specimen from an inch to an inch and three-eighths in a distance of four inches. Transverse section circular; septa deeply concave, the concavity exceeding the distance between the septa, which are distant from

each other nearly one-fourth the diameter of the shell; along one side there is a small, narrow, longitudinal ridge extending the full length of the septate portion of the shell, a character which I have never observed in species of this genus, except on *O. fosteri* and the very closely allied *O. duseri*, from the Hudson River Group. Our specimen shows two inches of the body chamber without reaching the aperture; surface apparently smooth; siphuncle unknown, but supposed to be eccentric on the side bearing the longitudinal ridge.

This species is quite different in form from those which have been described from rocks of the same age, and it is unnecessary to compare it with Silurian species with which it may bear closer resemblance.

Found by Sid. J. Hare, in rocks belonging to the Upper Coal Measures, at Kansas City, Missouri, and now in my collection. The specific name is in honor of Prof. John Collett, late State Geologist of Indiana.

#### ORTHO CERAS GORBYI, N. SP.

*Plate X, fig. 2, dorso-lateral view, natural size.*

Shell about medium size, among species from the Hudson River Group, very long, slowly and gradually enlarging from below upward, and increasing in diameter only .04 of an inch in an inch in length; transverse section subcircular; septa very moderately concave, closely arranged, thirteen of them occurring in a distance equal to the diameter of the shell, where the diameter is 1.1 inches; surface marked by broad furrows or undulations that cross the shell at an angle of twenty or twenty-three degrees from the ventral to the dorsal side. The two specimens examined are casts, but one of them bears a few fine longitudinal lines that indicate the surface of the shell was so marked; body chamber and siphuncle unknown.

This species will be distinguished by its elongate form, close septa and inclined undulations.

Found by A. C. Benedict, in the Hudson River Group, in Franklin County, Indiana, and now in his collection. The species is named in honor of the State Geologist.

#### ORTHO CERAS FRANKLINENSE, N. SP.

*Plate X, fig. 3, side view, natural size.*

Shell about medium size among shells from the Niagara Group, elongate, gradually enlarging, increasing in diameter .07 of an inch in an inch in length; transverse section circular; septa very deeply concave and crossing the shell obliquely, with the inclination toward the siphuncular or ventral side; they are distant from each other one-seventh the

## FAMILY NAUTILIDÆ.

## STREPTODISCUS, N. GEN.

Meek & Worthen described the genus *Trematodiscus*, in 1861, in the Proceedings of the Academy of Natural Sciences of Philadelphia, on page 147, but the name *Trematodiscus* was preoccupied in 1860. In 1883 Hyatt proposed to substitute *Trematoceras* for *Trematodiscus*, because the latter was preoccupied by Haeckel and also by Eichwald, but he was also unfortunate in selecting a name, for *Trematoceras* was preoccupied by Whitfield in 1882, among the Cephalopoda. I now propose for Meek & Worthen's *Trematodiscus*, the generic name *Streptodiscus*, from *streptos*, twisted; *diskos*, quoit; adopting Meek & Worthen's definition, and that of Meek, in vol. IX, page 491, of Hayden's Survey, with his type, *Nautilus stygialis* of DeKoninck.

## STREPTODISCUS INDIANENSIS, N. SP.

Plate XI, fig. 1, lateral view, natural size.

Shell large, discoidal, slowly enlarging, exposing each whorl and perforated; umbilicus very broad, showing all the inner whorls and perforated in the center; volutions few, probably very little more than two, gradually increasing in size, coming in contact without embracing; transverse diameter a little less than the dorso-ventral diameter; volutions obtusely angular on the dorsal, ventral and lateral sides; transverse section subquadrangular, the longer sides directed toward the inner whorls.

Septa moderately concave, distant about one-third the dorso-ventral diameter and curve slightly forward in crossing the outer angle of the volutions; body chamber, as shown in our specimen, deeply notched on each side, and having a length to the notch of about two inches, the length on the outer angle of the whorl exceeding three inches.

Surface marked by wide, shallow, longitudinal furrows, which are most distinct on the inner lateral sides of the volutions, and these are crossed by numerous close, elevated, transverse lines that curve backward in crossing the outer angle of the whorls.

This species is distinguished by its large size, relative proportions, distant septa and transverse section.

Found in the Keokuk Group, at West Point, Ind., and now in the collection of Prof. S. S. Gorby.

## NAUTILUS TODDI, N. SP.

*Plate XI, fig. 2, lateral view, natural size, showing two radiating furrows; figs. 3 and 4, dorsal views, each showing a radiating furrow.*

Shell very small, globose; slowly expanding and consisting of more than two whorls (probably three or more). Umbilicus deep, funnel shaped, not disclosing the inner whorls. Volutions widely and deeply embracing; angular at the margin of the umbilicus and broadly rounded dorsally; transverse diameter twice as great as the dorso-ventral diameter; transverse section semicircular, except the concave furrow for the reception of the inner whorl.

Septa close, about sixteen in a distance equal to the transverse diameter of the volution. Two concave furrows radiate from the umbilicus and curve slightly forward in passing around the dorsum. One of our specimens shows three of these furrows. Sides delicately corrugated at the margin of the umbilicus, otherwise the surface is smooth. Part of our specimens are black, hard, and look as if polished, others are coated with iron pyrites. Body chamber and siphuncle unknown.

This species will be distinguished by its small size, short septa, form of the umbilicus, transverse section and smooth surface. Probably it is not a true Nautilus, but for want of more complete specimens it is referred to that genus. I have in my collection some small specimens of Nautilus from Perrysville, Indiana, and also from Danville, Illinois, that I think are somewhat near the species described, but my specimens are not good enough to define, though they are proportionally shorter in the transverse section of the whorls and distinct from this species in the surface ornamentation.

Found in the Upper Coal Measures at the Rosedale coal shaft, in Wyandotte County, Kansas, and now in my collection. The specific name is in honor of D. H. Todd, an active collector and prominent geologist of Kansas City, Missouri.

## METACOCERAS CAVATIFORME, HYATT.

*Plate XI, fig. 5, lateral view, natural size; fig. 7, dorsal view.*

Shell medium size. Umbilicus wide, deep, showing nearly all of each whorl and perforated. Volutions about three, increasing rather rapidly in size, moderately embracing, transversely subelliptical in the beginning, but becoming more and more subquadrate toward the aperture, with the growth of the shell; transverse diameter, in the early growth of the shell, twice as great as the dorso-ventral, but becoming, in mature shells, toward the aperture, less than one-half greater, greatest transverse diameter at the margin of the umbilicus, which is obtusely

angular, the shell abruptly rounding into the umbilicus and being flattened on the sides and sloping toward the dorso-lateral margin; the greatest convexity of the whorls is from the margin of the umbilicus to the next inner whorl. A row of nodes around each dorso-lateral margin become more and more conspicuous with the growth of the shell; there are about seven nodes to eight septa. The dorsum is slightly convex and the ventrum correspondingly concave. (Hyatt reverses the use of these words.)

Septa moderately concave, appearing on the surface as arching gently backward on the sides and then forward on the dorso-lateral margins and backward on the dorsum; these sigmoidal flexures on the surface have no resemblance to saddles and lobes, but result from the subquadrate, transverse outline of the volutions; if the volutions were round, the septa would show the usual straight outline of ordinary septa in Nautiloid shells. Septa separated in the early growth of the shell about one-fourth the transverse diameter, but toward the aperture in mature shells becoming less than one-fifth the transverse diameter. Siphuncle small, round and near the dorsal side. Surface apparently smooth.

This species is congeneric with *Nautilus planorbiformis* and *N. sangamonensis* of Meek & Worthen, and as nearly related to the former as to the latter, though in that species the siphuncle is central, the younger shell rounded and the septa proportionally more distinct, and the whorls more numerous and more slowly enlarging than in this species, and of course differing in the transverse section. The species can not be confounded with each other on specific characters.

Meek suggested that his two species with such forms as *N. occidentalis* of Swallow should probably form a distinct subgenus of *Nautilus*, but he did not propose a name for the subgenus. He regarded *N. quadrangulus* of McChesney (he misspelled it *quadrangularis* in Pal. Up. Mo. and I did the same in North American Geol. and Pal., p. 444, probably both typographical errors), as a synonym for *N. occidentalis* and *N. nodocarinatus* as a mere variety of it. He also regarded *N. biserialis* of Hall as a synonym for *N. occidentalis*.

Hyatt, however, founded his genus *Tainoceras* on McChesney's species *N. quadrangulus*, and ascribed to it characters quite different from those belonging to *N. planorbiformis* and to this species. Hyatt also founded his genus *Metacoceras* on *N. sangamonensis*, which species was founded on a single specimen, consisting of about half of one volution, and, so far as I am informed, the only specimen of the species then known. His definition of *Metacoceras* is as follows:

"*Metacoceras*, nobis, includes Silurian and Carboniferous species, with broad ventral, lateral and dorsal lobes, but no annular lobes; siphon near the ventrum or central; whorls quadrate; sides with one row of nodes along the external border; umbilical shoulders, smooth

but gibbous. The type has this part of the whorls elevated into a ridge. The forms are evidently transitions from the genus *Plectoceras* to *Mojsvaroceras*. Type *Meta. (Discus) sangamonense*, M. et W., Geol. Sur. Ill., vol. II, page 29." (Proc. Bost. Soc. Nat. Hist., vol. XXII, p. 268.)

It is quite incomprehensible why he should say the genus "includes Silurian and Carboniferous species" when he actually founded the genus upon the description of a single coal measure fragment and failed to mention any other species that might by any possibility be related to it. He says there are "lateral and dorsal lobes," but there are no such characters, because the septa are regularly arched. The external apparent flexures are wholly due to the subquadrangular shape of the volutions, and any round volution of a Nautiloid shell, if carved to a like subquadrate outline, will show the same kind of apparent flexures of the septa on the external surface. In short, what he said of the proposed genus is either erroneous or is too general to amount to the definition of a single generic character; and yet, if Meek had suggested a generic name after defining the species, it would have been adopted without hesitation and *N. planorbiformis* would have been the type. Under all the circumstances I think it is best to retain the name *Metacoceras*, with *M. sangamonense* as the type, rather than add a synonym to the list of generic names, though it is very doubtful whether Hyatt's definition brings it within the rules of nomenclature. The genus, so far as known, is confined to the Upper Coal Measures.

Found in the Upper Coal Measures, at Kansas City, Mo., and now in my collection.

The above description was written and illustrations drawn before I received a copy of the second annual report of the Geological Survey of Texas, 1891, wherein Hyatt describes the species under the name of *Metacoceras cavatiformis*, the ending of the specific name doubtless a typographical error, and also describes *M. dubium*, *M. hayi* and *M. inconspicuum*. He gave four figures of *M. cavatiforme* and his description is so different in method from mine that I quote the whole of it as follows:

"The flat sides in *M. cavatiformis* incline outwards very slightly, the umbilical shoulders are rounded, and the abdomen narrower than the dorsum; there is a row of elongated nodes along either edge of the abdomen, and the central zone of the abdomen is depressed; there are slight swellings or crests on either side of the central depressed zone along the abdomen of the casts examined, but these did not have tubercles.

"The whorls differ markedly from other species of this genus, and, in fact, it resembles *T. cavatum* closely in general aspect. It differs from

this, however, in the proportionally narrower abdomen, and the umbilical shoulders are also narrower and more abrupt. The great differences are, of course, in the absence of abdominal tubercles, and in the sutures, the peculiar broad abdominal saddles of *T. cavatum* being absent. There is a shallow abdominal lobe on the impressed zone of the dorsum; the involution does not extend beyond the lateral lines of nodes; the living chamber is probably not much over one-fourth of a volution in length, judging from the length of that in the original specimen in my collection, which has the chamber complete on the venter; the siphuncle is situated above the center. There is also a specimen in Prof. Newberry's collection, at Columbia College, New York, from Kansas City, Missouri, with an entire living chamber which is even slightly shorter than one-fourth of a volution in length.

"The young, as shown above in the figure of a specimen (figs. 30, 31) from Dr. Newberry's collection, reported to have come from Miami County, Illinois, is of an entirely different appearance from the later stages, with an almost round whorl, sutures nearly straight, or with only a slight abdominal saddle; shell smooth, and umbilical perforation large, showing that they were true *Cyrtoceratites* throughout the first whorl, which was not completed until the shell had reached a considerable size. The amount of involution of the younger whorls by the living chamber is exaggerated in the side view of this specimen (fig. 31), and is better indicated in the front view of the same. The resemblance of the young whorl in outline to that of the genus *Temnocheilus* can be readily seen in the last figure, in which the front view of the first part of the second whorl is shown. On this second whorl a single row of tubercles appears on either side, and these complete the resemblance to *Temnocheilus*."

I do not know what he refers to by "*T. cavatum*," but suppose he refers to a fossil he described in the same paper under the name of *Tainoceras cavatum*.

#### SOLENOCHILUS BLAIRI, N. SP.

*Plate XII, fig. 2, lateral view, natural size, except the body chamber appears contracted toward the aperture, because less than half the circumference is preserved at that place.*

Shell very large, especially the body chamber, gradually expanding, and consisting of between two and three whorls; umbilicus deep, perforated; volutions in contact, but not embracing; broadly rounded on the sides and more abruptly rounded dorsally and ventrally; transverse diameter about one-fourth less than the dorso-ventral diameter; the inner side of the whorls being more abruptly rounded than the outer side, a transverse section is subovate rather than subelliptical; septa distant, on the outside of the whorls, full half the transverse diameter

and more than one-third the dorso-ventral diameter; body chamber very large, long, consisting of half a volution and constituting more than three-fourths of the shell. The artist in drawing the body chamber followed the specimen, but less than half the circumference being preserved toward the aperture; the illustration does not show the increase in size as the aperture is approached. Our specimen is a cast; the whorls are well preserved, but none of the shell; the siphuncle is exposed at the middle of the outer margin of the whorls, and evidently came in contact with the shell; it is small and round.

Found by R. A. Blair, in whose honor the specific name is proposed, at Pin Hook Bridge, six miles from Sedalia, Missouri, in the middle part of the Chouteau limestone, and now in my collection.

### FAMILY GONIATITIDÆ.

#### GONIATITES GREENII, N. SP.

*Plate X, fig. 5, two dorsal views; fig. 6, lateral view, all magnified three diameters.*

Shell minute, discoid, volutions more than four, very slender and hardly embracing, dorsum round. Transverse section of a volution nearly elliptical. Umbilicus wide, shallow, showing the entire width of each volution. Siphuncle very small and near the inside of each whorl. Our specimen reveals only the septate portion and probably that is incomplete, and hence the body chamber and aperture are unknown.

The septa are moderately close and very deeply sinuous. They are beautifully undulated and have some resemblance in a lateral view to those in *G. hyas*, but the undulations are more graceful. There are three lobes and three saddles on each side, all of them are linguiform, being regularly rounded at the ends, and the superior ones being longer than the inferior ones or those nearer the umbilicus. The dorsal lobe is dart-shaped and acutely pointed and resembles the dorsal lobe in *G. rotatorius* and *G. ixion*. All other lobes and saddles are linguiform.

This is a handsome little species quite distinct in the undulations of the septa and the general form and shape of the volutions from all hitherto described.

Found by G. K. Greene, in the Knobstone Group, near New Albany, Indiana, and now in his collection.



## CLASS LAMMELLIBRANCHIATA.

## ORDER ASIPHONIDA.

## FAMILY MODIOLOPSIDÆ.

## MODIOLOPSIS DYCHII, N. SP.

*Plate VIII, fig. 4, cardinal view; fig. 5, left valve, natural size.*

Shell medium or below medium size, narrowly and obliquely elongate-ovate or obliquely subelliptical in outline; widest at the posterior end of the hinge; posterior extremity cuneate; length more than twice the height; inflated on the sides; Modiola-like in dorso-ventral section. Valves strongly convex, the convexity constituting a subangular ridge from the beaks to the postero-basal extremity. Basal margin arcuate, sides above contracted, greatest concavity near the middle. Anterior end produced, nasute, angular, gently curving to the basal margin. Hinge-line straight, oblique, less than half the length of the shell. Beaks anterior, extending beyond the hinge line, appressed, pointed, angular. Umbonal region prominent, subangular in front, gradually swelling and becoming gibbous in the middle and curving to the posterior basal extremity of the shell. Posterior margin from the end of the hinge broadly rounded and produced in a subacute point near the basal margin. A shallow undefined depression is directed from the umbones to the middle part of the contracted basal margin. Shell thin and surface marked with fine concentric striæ and stronger sublamellose lines of growth.

This species is distinguished by its oblique hinge line, oblique subelliptical outline, contracted and sinuous basal margin, small appressed angular beaks, subangular and gibbous umbonal region, and alation at the posterior end of the hinge line. There is no described species with which it is liable to be confounded.

Found in the upper part of the Hudson River Group, at Lebanon, Ohio, by Dr. D. T. D. Dyche, a well-known collector and student of palæontology, in whose honor I have proposed the specific name.

## CLASS CRUSTACEA.

## ORDER PHYLLOCARIDA.

## FAMILY PINACARIDÆ.

## MESOTHYRA GURLEYI, N. SP.

*Plate IX, fig. 37, post abdomen, natural size.*

This species is founded on the cast of a post-abdomen, which is on an arenaceous slab. Caudal plate subquadrangular in outline, highly convex and somewhat flattened above. It is produced in a long, sharply

pointed telson, which bears an angular axial ridge strongly marked for one-third the length behind the caudal plate. The lateral spines are a little longer than the telson, but they are broad and flattened or lanceolate, on the dorsal side, and longitudinally furrowed. The caudal plate is about .3 inch in length; the telson about 1.2, and the lateral spines about equal to the length of the caudal plate and telson or about one and a half inches.

The cast is so different from the described species, that no comparison with any of them is necessary. There can be little doubt that it belongs to the genus *Mesothyra*, though occurring in rocks higher than that genus has heretofore been known.

Found in the Kinderhook Group, at Le Grand, Iowa, and now in the collection of Wm. F. E. Gurley, of Danville, Illinois, in whose honor I have proposed the specific name.

#### MACROCARIS, N. GEN.

(*Ety. makros, long; karis, shrimp.*)

Carapace bivalve, united dorsally with a strong ligament. Valves long, narrow and ornamented with anastomosing striæ. They are pointed on the dorsal side in front and on the ventral side at the posterior end, while in the middle part the dorsal and ventral sides are subparallel. Abdomen consisting of twelve or more segments, which very slowly taper from the fourth or fifth to the post-abdomen. Post-abdomen consisting of a short, expanding plate with a central ridge or line of division.

The genus *Strigocaris* is known only from the carapace valves and the posterior ends are subtruncated from the ventral side to the dorsal side, while in this genus the posterior ends of the valves are subtruncated from the dorsal to the ventral side. There is no other genus with which it is necessary to make any comparison. Type *M. gorbyi*.

#### MACROCARIS GORBYI, N. SP.

*Plate IX, fig. 43, interior of carapace valves and four abdominal segments; fig. 44 four and part of another abdominal segment and the post abdomen slightly broken at the end; fig. 45, eight abdominal segments and the post-abdomen; fig. 46, a tooth found in the same rocks that may possibly belong to the internal masticatory apparatus.*

Carapace valves narrow, thick, elongate, length about three and a third times the height, moderately convex; anterior end acutely pointed at the dorsal side and obliquely rounded into the ventral margin, which is subparallel with the dorsal to the end of the valves; posterior end obliquely rounded backward from the dorsal ligament and terminating in a point at the posterior ventral extremity. Surface marked from the anterior to the posterior end with numerous more or less anastomosing

fine striæ. Length of our specimen from the antero-dorsal extremity to the postero-ventral extremity, 1.35 inches; height, .4 inch. The dorsal side is nearly straight, possibly slightly arched.

The abdomen is composed of at least twelve somites, if the specimens illustrated belong to the same species, of which there can be but little doubt. The specimen illustrated showing the carapace valves has four somites, which I suppose to belong to an anterior enlargement of the abdomen, from the organic matter at the sides of the segments. The first and fourth segments are longer than the other two. Fig. 45 shows a specimen with eight segments of nearly equal length and which very gradually taper to the post-abdomen, which consists of a short expanding plate with a central ridge. The matrix in which the specimen occurs is a claystone, and the outline given in the figure represents rock different from the rest of the stone. It appears as if the animal had been buried in mud and animal matter had produced a semiclaystone before fossilization took place, which is preserved, to some extent, after passing through the process of fossilization. The post-abdomen is turned a little on the side which makes it appear a little narrower than it really is. The central ridge is very distinct. The post-abdomen shown in figure 44 has the outer test destroyed so it does not show the central ridge. Figure 46 is a conodont that I suppose belonged to the masticatory apparatus of a crustacean. Associated with it on the same slab are other forms different from the one figured which I suppose belonged to the same apparatus. I have not given this fossil a name, because I think too many names have been given to such forms, about which, so little is known.

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

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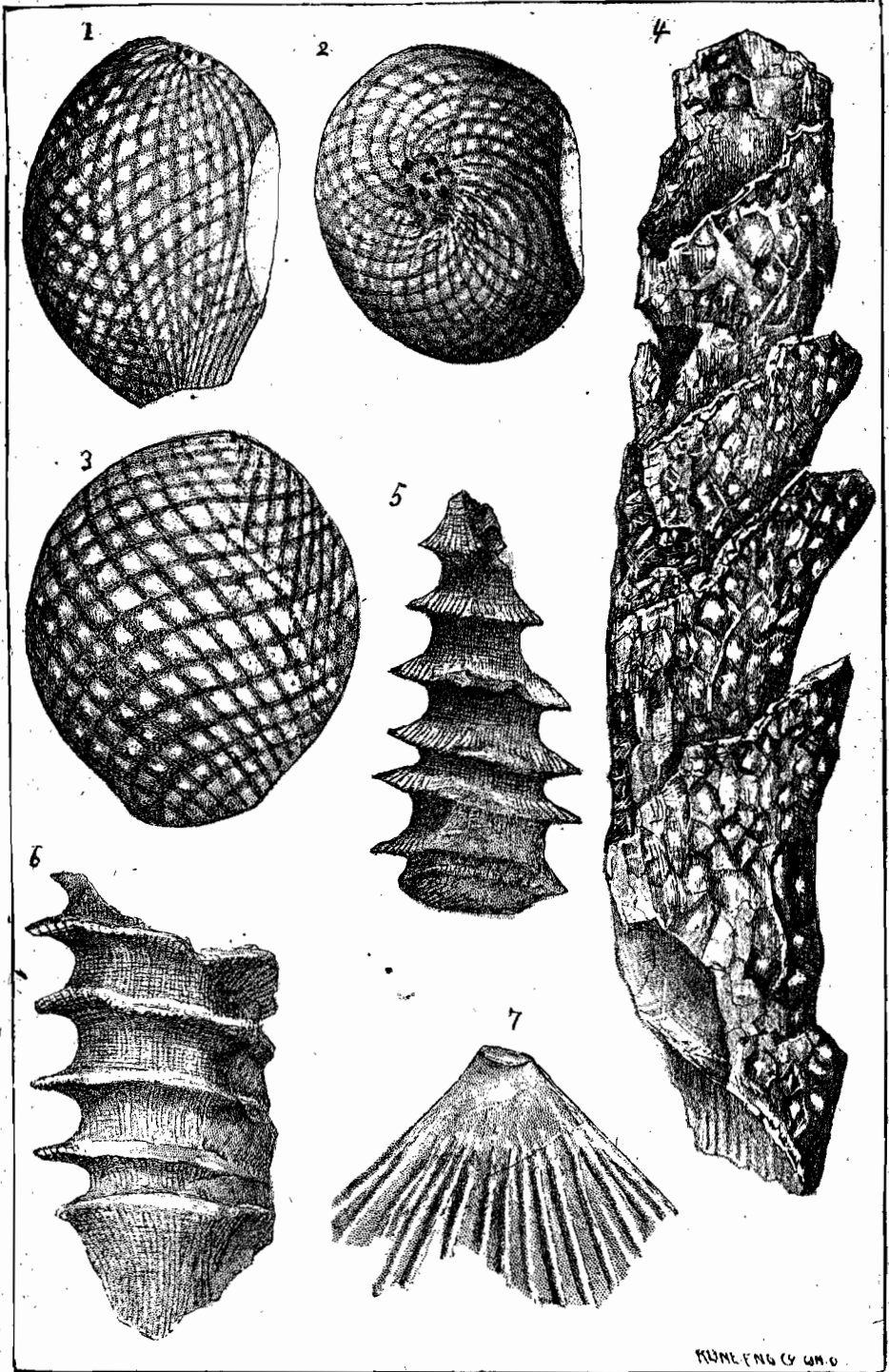
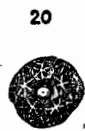
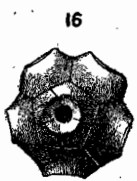
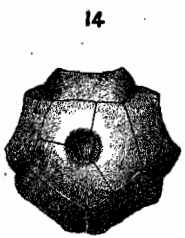
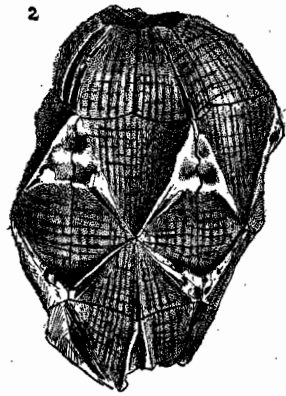
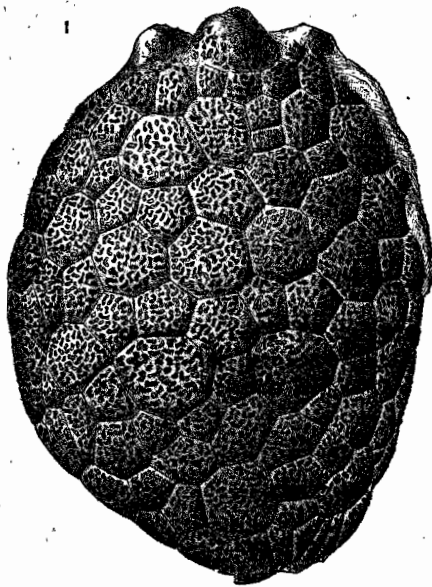
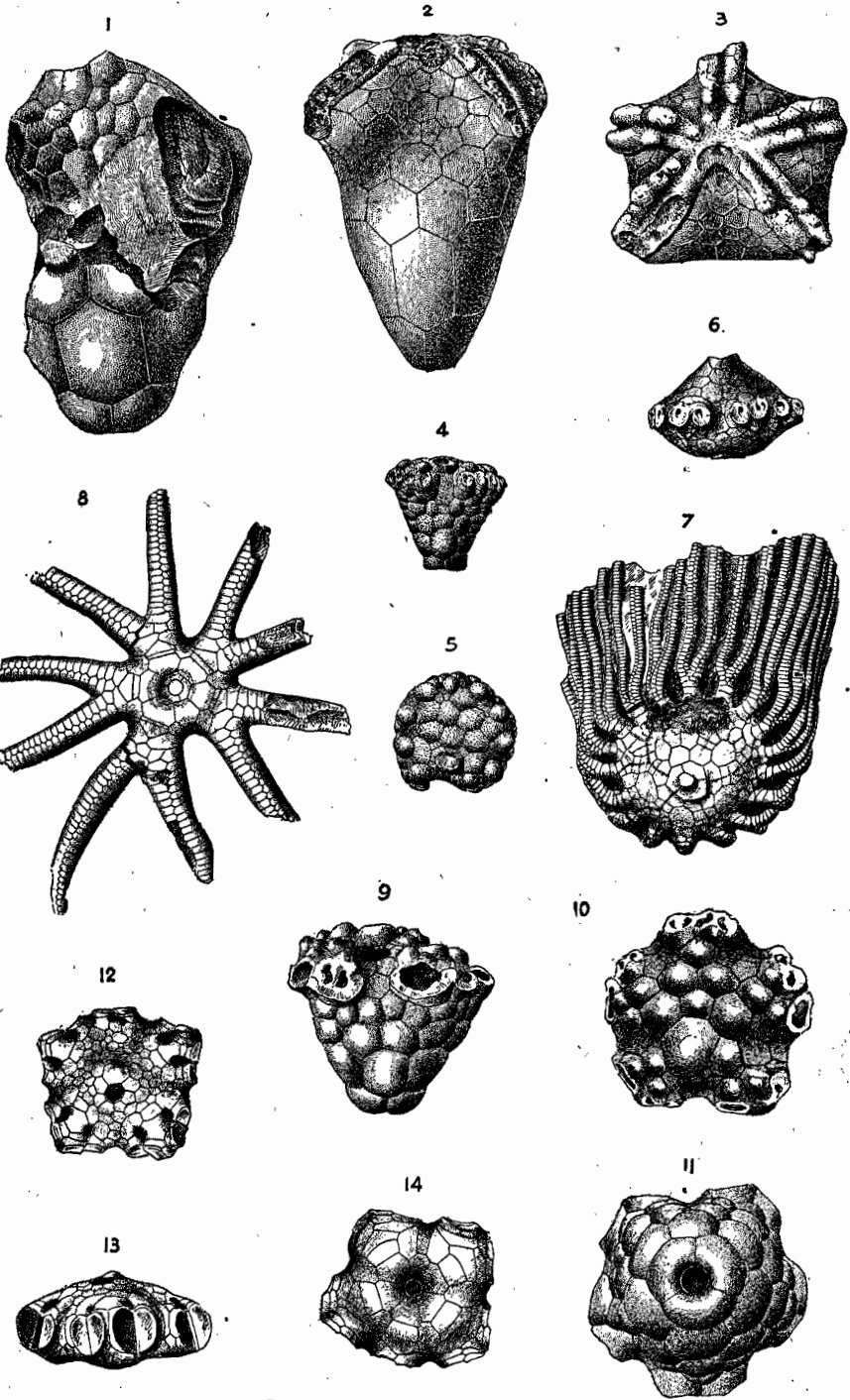


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Fig. 16, basal view, natural size; Fig. 17, first radial magnified two diameters.		
RHODOCRINUS BENEDICTI, N. SP.		269
Fig. 18, lateral view; Fig. 19, summit view; Fig. 20, basal view, natural size.		



.PLATE III.	PAGE.
<i>ACTINOCRINUS SEDALIENSIS</i> , N. SP.	270
Fig. 1, azygous side view of a calyx somewhat injured in the middle part; Fig. 2, cast of the azygous side of another specimen; Fig. 3, cast of the vault of the same specimen, only part of the outlines of the plates can be distinguished.	
<i>DORYCRINUS ELEGANS</i> , N. SP.	271
Fig. 4, azygous view of calyx; Fig. 5, summit view of calyx.	
<i>BATOCRINUS DIVALIS</i> , N. SP.	276
Fig. 6, azygous side of calyx and vault, showing part of two radial series; Fig. 7, showing calyx and arms; specimen somewhat crushed, and the sutures of a few plates destroyed; natural size.	
<i>AGARICOCRINUS SAMPSONI</i> , N. SP.	274
Fig. 8, natural size; the specimen is on a slab in high relief.	
<i>ACTINOCRINUS</i> (?) <i>CHOUTEAUENSIS</i> , N. SP.	272
Fig. 9, azygous view; Fig. 10, summit view; Fig. 11, basal view, all natural size.	
<i>AGARICOCRINUS BLAIRI</i> , N. SP.	275
Fig. 12, summit view; Fig. 13, lateral view of calyx; Fig. 14, basal view of calyx, all natural size.	





	PAGE.
PLATE IV.	
BATOCRINUS ICOSIDACTYLUS, CASSEDAY.	278
Figs. 1, 2, 3, 4 and 5.	
BATOCRINUS IRREGULARIS, CASSEDAY.	280
Figs. 6, 7, 8 and 9.	
STEGANOCRINUS BENEDICTI, N. SP.	281
Fig. 10, azygous view; Fig. 11, opposite side; Fig. 12, summit of same specimen, natural size.	

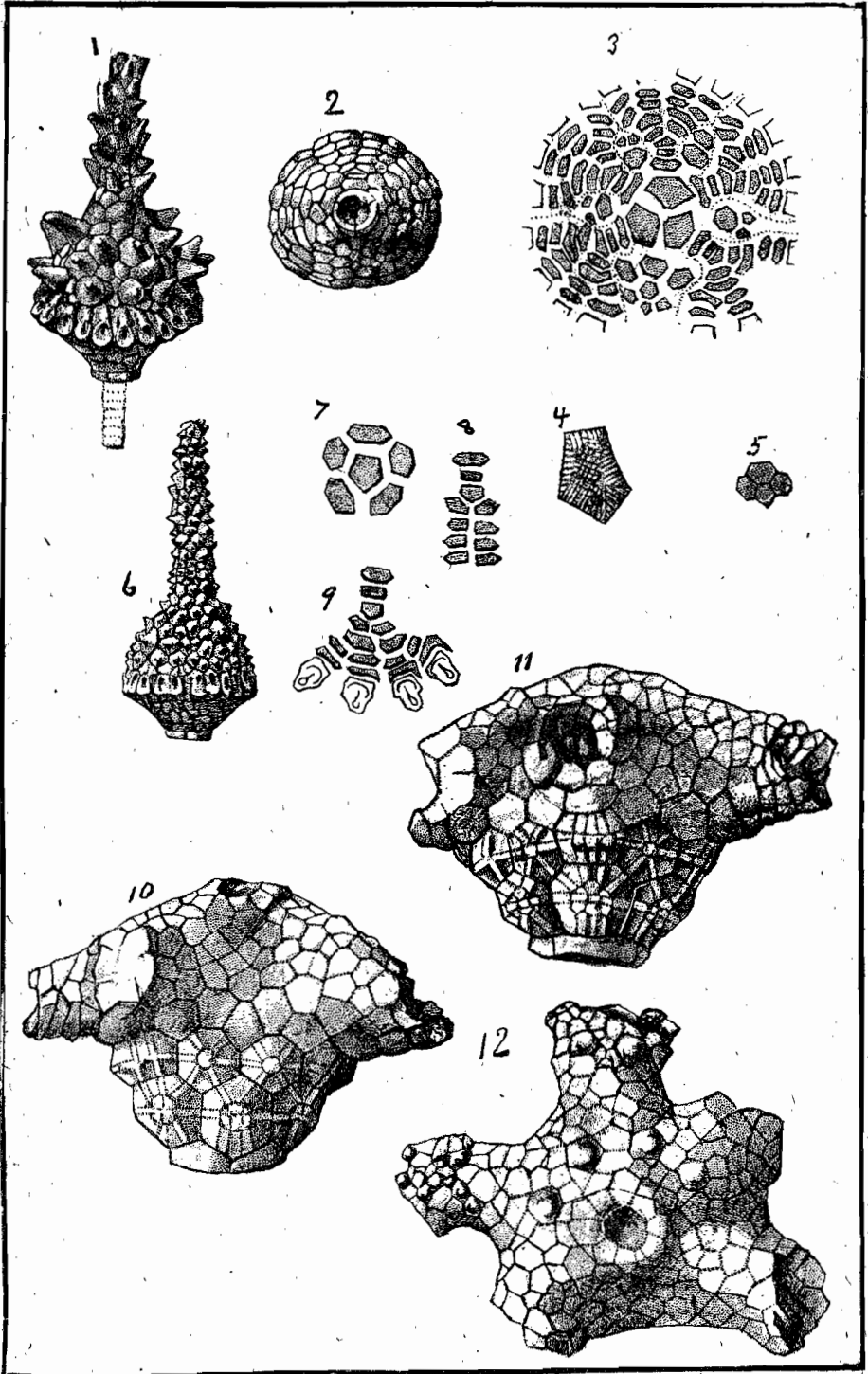
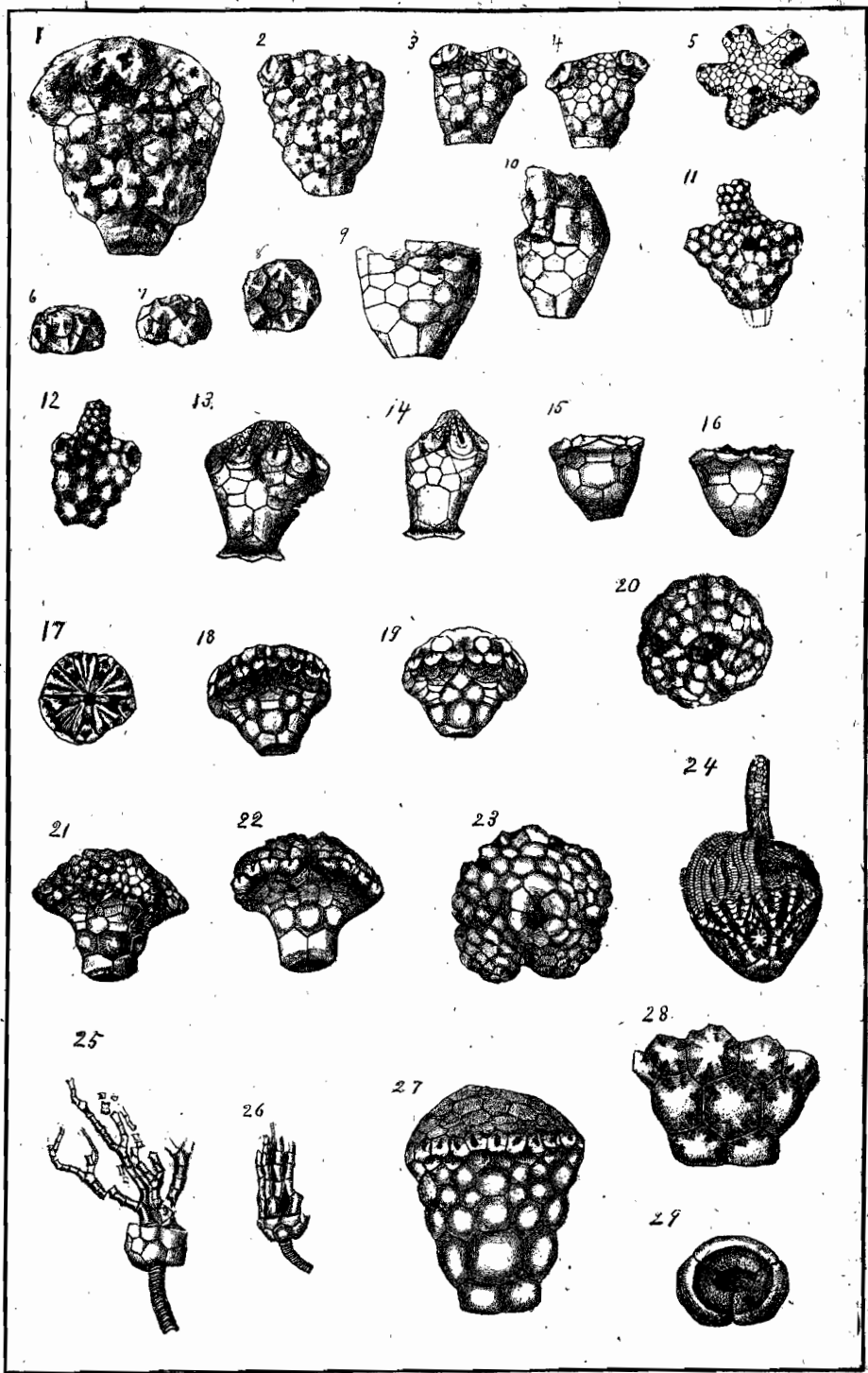


PLATE V.		PAGE.
<i>SACCOCRINUS BENEDICTI</i> , N. SP.		283
Fig. 1, a large specimen; Fig. 2, azygous side of a medium sized specimen.		
<i>SACCOCRINUS HOWARDI</i> , N. SP.		284
Fig. 3, side view; Fig. 4, azygous view; Fig. 5, summit view.		
<i>CYATHOCRINUS GORBYI</i> , N. SP.		298
Fig. 6, azygous view; Fig. 7, side view; Fig. 8, basal view.		
<i>GAZACRINUS INORNATUS</i> , N. SP.		303
Figs. 9, 10, 15 and 16, views of different specimens; Figs. 9 and 10 show some of the arm plates and the second and third radials are anchylosed; Fig. 16 is an azygous view; Fig. 17 shows the internal structure of the vault, the outer plates being removed.		
<i>MELOCRINUS ÆQUALIS</i> , N. SP.		302
Fig. 11, view of two interrarial areas, with the middle arm broken off close to the body, the outline of the basal plates is from another specimen; Fig. 12, another interrarial area on the same specimen.		
<i>CYLIPOCRINUS CANALICULATUS</i> , N. SP.		285
Fig. 13, side view; Fig. 14, azygous view.		
<i>BATOCRINUS COMPARILIS</i> , N. SP.		286
Fig. 18, side view, Fig. 19, azygous view; Fig. 20, summit view with the proboscis broken off.		
<i>BATOCRINUS BRITTSI</i> , N. SP.		287
Fig. 21, side view; Fig. 22, azygous view; Fig. 23, summit view.		
<i>BATOCRINUS DECREPITUS</i> , N. SP.		288
Fig. 24; side view showing the proboscis extending beyond the arms.		
<i>SCAPHIOCRINUS LYONI</i> , N. SP.		299
Fig. 25, azygous plates are shown on the left.		
<i>SCAPHIOCRINUS MANIFORMIS</i> , N. SP.		300
Fig. 26, lateral view.		
<i>ACTINOCRINUS BLAIRI</i> , N. SP.		289
Fig. 27, side view of calyx and part of the vault; Fig. 28, part of the azygous side of another specimen showing slight sculpturing toward the sutures; Fig. 29, basal view of same.		



## PLATE VI.

PAGE.

## ACTINOCRINUS BRITTSI, N. SP.

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Fig. 1, showing plates, but broken off at the lower end; Fig. 2, vault of same specimen; Fig. 3, side view of a cast; Fig. 4, vault of same specimen.

## ERETMOCRINUS PRÆGRAVIS, N. SP.

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Fig. 5, azygous view; Fig. 6, basal view.

## BATOCRINUS BLAIRI, N. SP.

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Fig. 7, summit view; Fig. 8, azygous view; Fig. 9, view opposite the azygous side, one-half the length of the basals is broken off; Fig. 10, basal view of another specimen to show basals not eroded.

## ACTINOCRINUS FOSSATUS, N. SP.

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Fig. 11, azygous view; Fig. 12, side view.

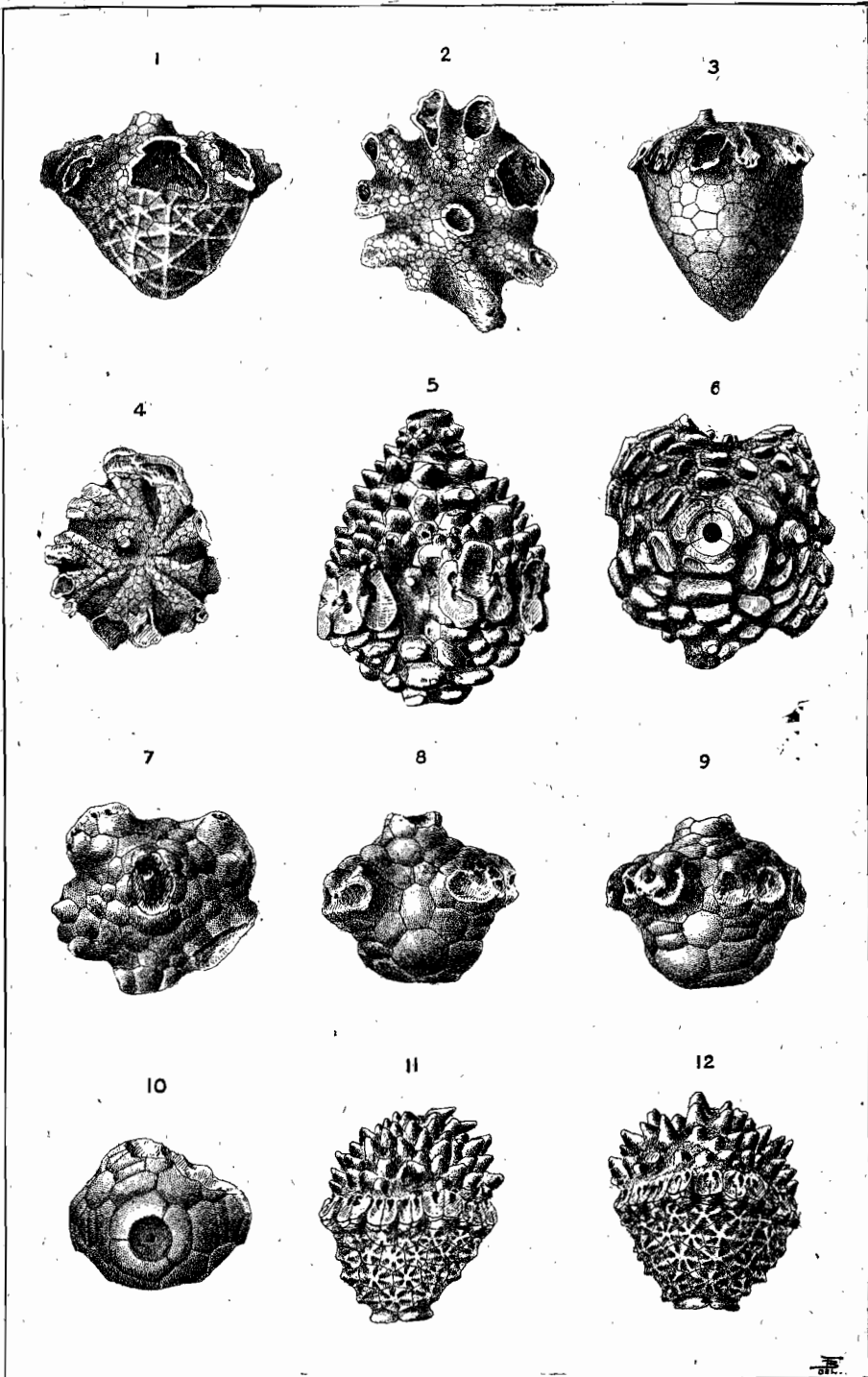


PLATE VII.		PAGE.
BLAIROCRINUS ARROSUS, N. SP.		295
Figs. 1 and 2, basal views of two specimens; Figs. 3 and 4, summit views of the same two specimens; Fig. 5, side view a little inclined to show the plates surrounding the orifice.		
BLAIROCRINUS BULLATUS, N. SP.		295
Fig. 6, side view; Fig. 7, basal view.		
AGARICOCRINUS GERMANUS, N. SP.		296
Fig. 8, view of the vault; Fig. 9, azygous side view; Fig. 10, basal view.		
AGARICOCRINUS CHOUTEAUENSIS, N. SP.		297
Fig. 11, summit view; Fig. 12, lateral view; Fig. 13, basal view with part of the column.		
CYPHOCRINUS GORBYI, N. SP.		305
Fig. 14, showing vault, central spinous plate and anal orifice slightly on one side of a direct line to the center of the azygous area; Fig. 15, side view, part of the central vault spine is broken off; Fig. 16, basal view.		



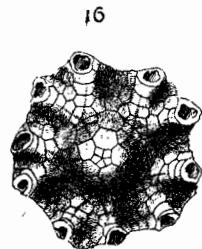
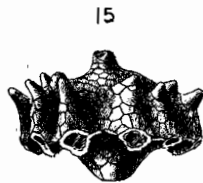
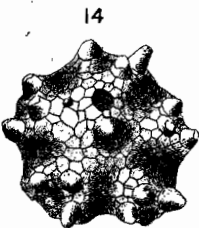
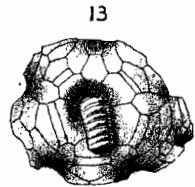
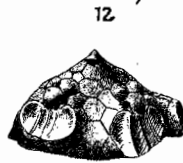
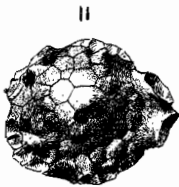
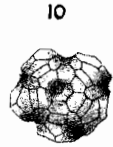
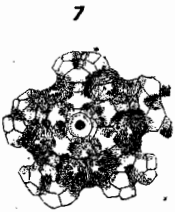
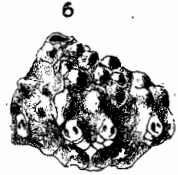
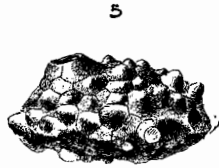
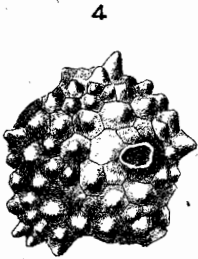
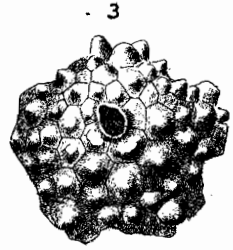
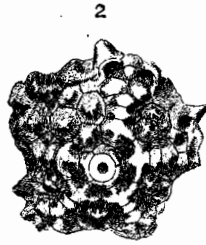
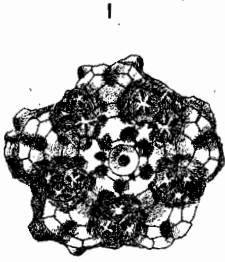
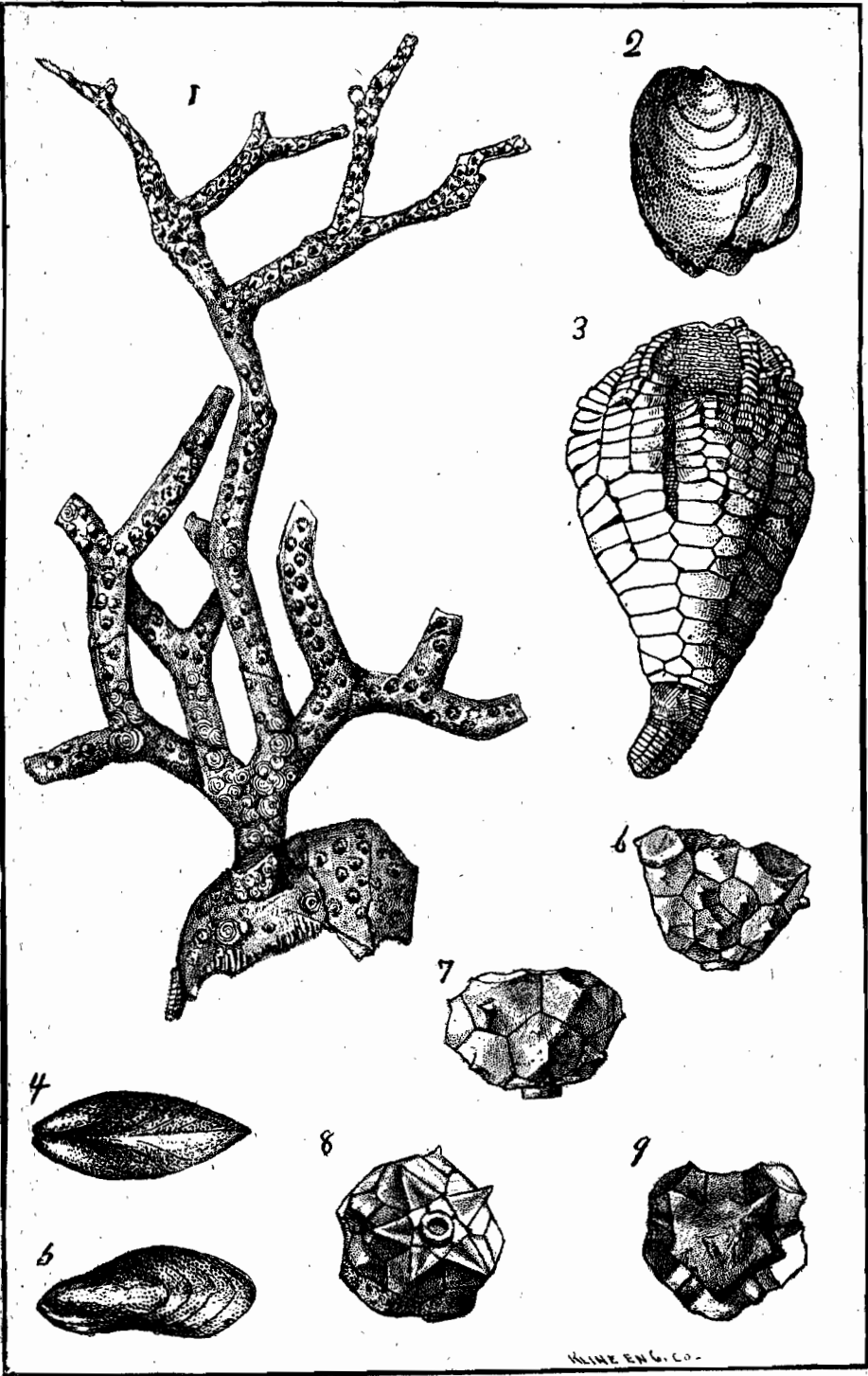


PLATE VIII.		PAGE.
	<i>STRIATOPORA GORBYI</i> , N. SP.	261
Fig. 1, natural size, showing ramose method of growth, distribution of cells and some rosettes of chalcedony on the lower part.		
	<i>LINGULA PARRISHI</i> , N. SP.	307
Fig. 2, cast having the lateral and front margins broken away.		
	<i>ICHTHYOCRINUS GREENII</i> , N. SP.	306
Fig. 3, lateral view, natural size, column and part of the arms eroded.		
	<i>MODIOLOPSIS DYCHII</i> , N. SP.	331
Fig. 4, cardinal view; Fig. 5, left valve, natural size.		
	<i>BARYCRINUS STELLIFER</i> , N. SP.	300
Fig. 6, azygous view; Fig. 7, opposite view; Fig. 8, basal view; Fig. 9, interior of the calyx, all natural size.		



- LINGULA PARRISHI*, N. SP. 307
- Fig. 1, a well-preserved specimen having only a little of the lateral and front margins broken off, and preserving part of the external shell.
- LINGULA SEDALIENSIS*, N. SP. 308
- Fig. 2, dorsal valve, slightly broken at the beak and at the frontal margin, natural size.
- LINGULA GORBYI*, N. SP. 309
- Fig. 3, a large fragmentary specimen; Fig. 4, a smaller, nearly perfect specimen, having only a small piece broken from the left side near the beak; natural size.
- CRANIA BLAIRI*, N. SP. 310
- Figs. 5 and 6, dorsal views of two specimens; the margins of both are imperfect.
- CRANIA GREENII*, N. SP. 310
- Fig. 7, dorsal valve; the outer margin is not all preserved; a, posterior part of the shell.
- RHYNCHONELLA COLLETTI*, N. SP. 311
- Fig. 8, ventral view; Fig. 9, cardinal view, natural size.
- TEREBRATULA OCCIDENTALIS*, N. SP. 313
- Fig. 10, dorsal view; Fig. 11, ventral view; Fig. 12, profile view of a smaller specimen; Fig. 13, cardinal view of same.
- ATHYRIS OTTERVILLENSIS*, N. SP. 314
- Fig. 14, cardinal view; Fig. 15, ventral view.
- ATHYRIS BRITTSI*, N. SP. 314
- Fig. 16, dorsal view; Fig. 17, ventral view; Fig. 18, cardinal view.
- ATRYPA MISSOURIENSIS*, N. SP. 315
- Fig. 19, ventral view; Fig. 20, dorsal view; Fig. 21, profile view.
- RHYNCHONELLA KOKOMOENSIS*, N. SP. 312
- Fig. 22, ventral view; Fig. 23, front view; Fig. 24, dorsal view.
- RETZIA TRIANGULARIS*, N. SP. 315
- Fig. 25, dorsal view; Fig. 26, profile view.
- MICROCYCLUS BLAIRI*, N. SP. 261
- Fig. 27, a large specimen; Fig. 28, a smaller one.
- RETZIA PLICATA*, N. SP. 316
- Fig. 29, ventral view; Fig. 30, cardinal view; Fig. 31, an interior, showing part of the coils, some of them extending to the front margin.
- RETZIA CIRCULARIS*, N. SP. 316
- Fig. 32, ventral view. Fig. 33, dorsal view; Fig. 34, profile view.
- HYOLITHES LANCEOLATUS*, N. SP. 317
- Fig. 35, side view; Fig. 36, transverse section.
- MESOTHYRA GURLEYI*, N. SP. 331
- Fig. 37, post-abdomen, natural size.
- TRYBLIDIUM MADISONENSE*, N. SP. 318
- Fig. 38, side view, natural size.
- HOLOPEA HUBBARDI*, N. SP. 318
- Fig. 39, front view, showing aperture and height of shell; Fig. 40, summit view, showing surface markings.
- MURCHISONIA HAMMELLI*, N. SP. 319
- Fig. 41, front view, showing aperture somewhat injured; Fig. 42, posterior view, natural size.
- MACROCARIS GORBYI*, N. SP. 332
- Fig. 43, interior of carapace valves and four abdominal segments; Fig. 44, four and part of another abdominal segment and the post-abdomen slightly broken at the end; Fig. 45, eight abdominal segments and the post-abdomen; Fig. 46, a tooth found in the same rocks that may possibly belong to the internal masticatory apparatus.

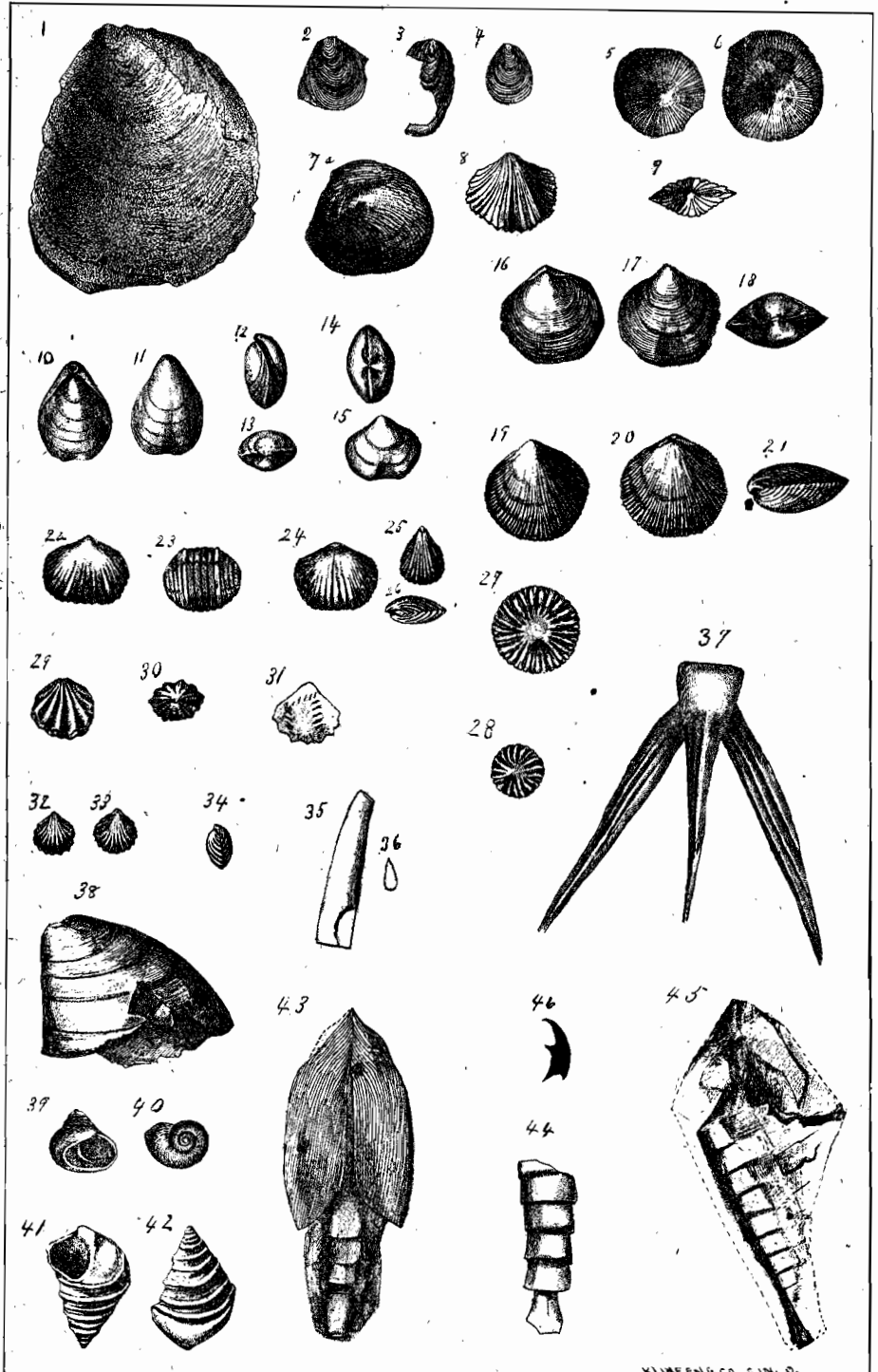
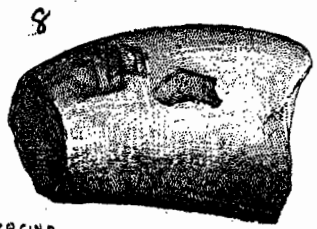
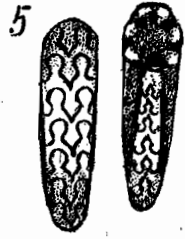
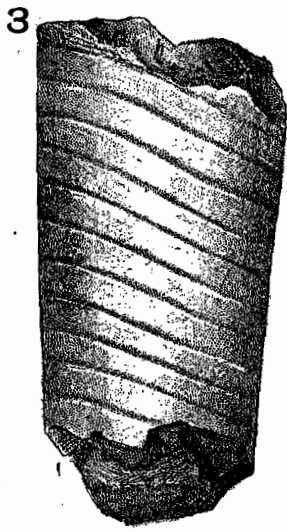
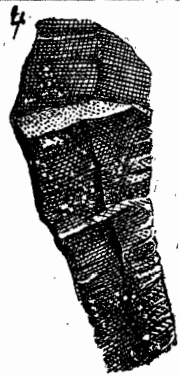
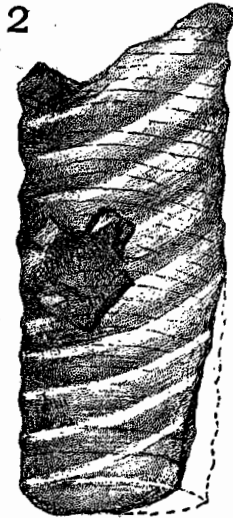
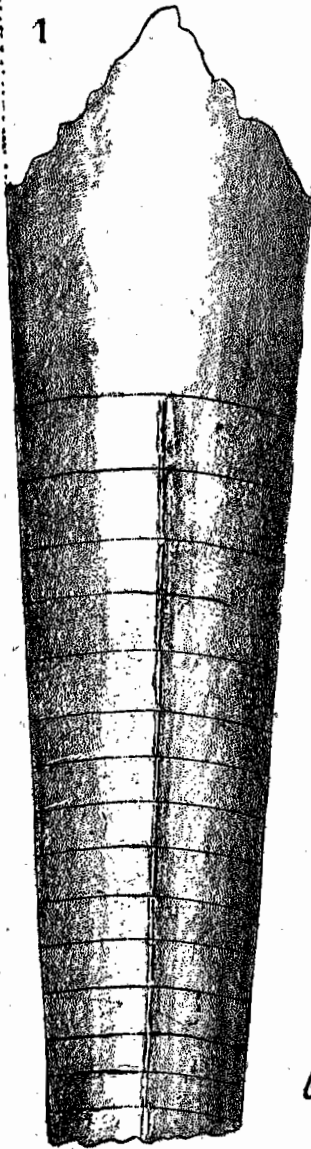
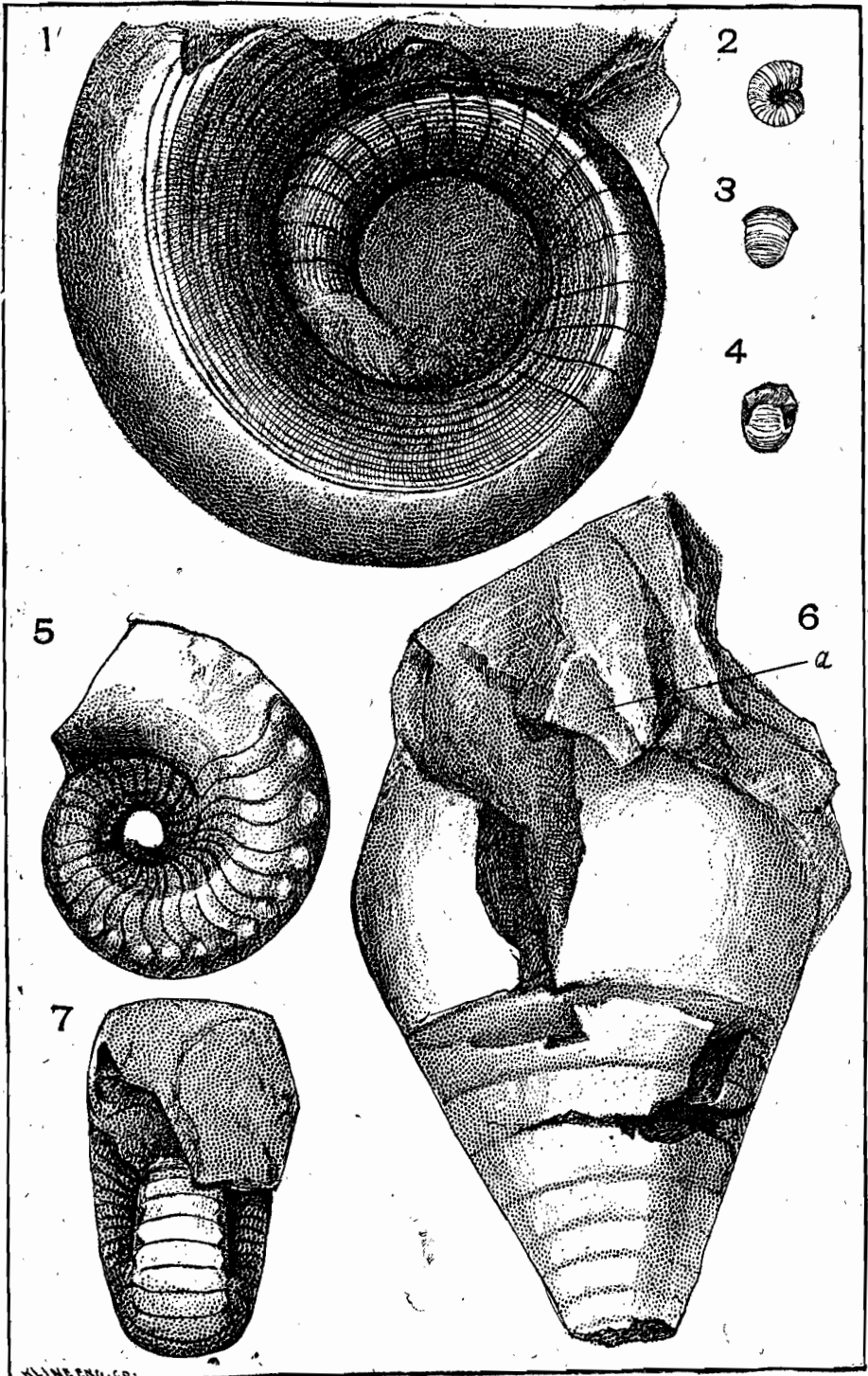


	PLATE X.	PAGE.
	ORTHOCERAS COLLETTI, N. SP.	321
Fig. 1, natural size.		
	ORTHOCERAS GORBYI, N. SP.	322
Fig. 2, dorso-lateral view, natural size.		
	ORTHOCERAS FRANKLINENSE, N. SP.	322
Fig. 3, side view, natural size.		
	CONULARIA INTERTEXTA, N. SP.	317
Fig. 4, specimen broken and fragmentary, magnified about one and a half diameters; the longitudinal lines, in the upper part, should be inclined somewhat diagonally.		
	GONIATITES GREENII, N. SP.	330
Fig. 5, two dorsal views; Fig. 6, lateral view, all magnified three diameters.		
	CYRTOCERAS THOMPSONI, N. SP.	323
Fig. 7, dorsal view; Fig. 8, lateral view.		



	PAGE.
PLATE XI.	
STREPTODISCUS INDIANENSE, N. SP.	325
Fig. 1, lateral view, natural size.	
NAUTILUS TODDI, N. SP.	326
Fig. 2, lateral view, natural size, showing two radiating furrows; Figs. 3 and 4, dorsal views, each showing a radiating furrow.	
METACOCERAS CAVATIFORME, HYATT.	326
Fig. 5, lateral view, natural size; Fig. 7, dorsal view.	
POTERICERAS MISSOURIENSE, N. SP.	324
Fig. 6, dorsal view, natural size; part of the shell at <i>a</i> .	





## PLATE XII.

PAGE.

## CRYTOCERAS HOWARDI, N. SP.

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Fig. 1, lateral view of nine chambers, including the body chamber, natural size.

## SOLENOCHILUS BLAIRI, N. SP.

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Fig. 2, lateral view, natural size, except the body chamber appears contracted toward the aperture, because less than half the circumference is preserved at that place.

