

DESCRIPTION OF SOME NEW GENERA AND SPECIES OF ECHINODERMATA FROM THE COAL MEAS- URES AND SUBCARBONIFEROUS ROCKS OF INDIANA, MISSOURI AND IOWA.

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(That part of this article describing the fossils on the first four plates was published in the April number of Vol. XIII of the Journal of the Cincinnati Society of Natural History for the year 1890. The whole article, with the ten plates, was published by the authors and distributed in a brochure on the 14th of June, 1890. The edition was limited and it has had a very limited circulation in Indiana. Nearly all of the crinoids are from this State, and on account of the excellence of the work the State Geologist made application to S. A. Miller for leave to reproduce it and for a loan of the plates from which to take electrotypes, and we are happy to state both authors cheerfully united in granting the request. We have been thus enabled to produce a great palæontological work describing and illustrating more than fifty new fossil species of Echinoderms, the types of more than thirty of which were collected in this State, and all of which may be found in our rocks, practically without cost to the survey.—S. S. GORBY.)

Last summer Sidney J. Hare, E. Butts and D. H. Todd collected a lot of very fine crinoids in the Upper Coal Measures, at Kansas City, Missouri, many of which have fallen into the hands of one of the authors of this paper, Mr. Gurley. They are the finest specimens ever found in the Coal Measures, and it is therefore a pleasure to describe them. The stone quarries in the Waverly or Kinderhook group, at Legrand, on the Chicago & Northwestern railroad, in Marshall County, Iowa, contains some layers of yellowish, soft, sandy limestone, bearing the remains of crinoids and other Echinoderms in a remarkably fine state of preservation, and Mr. Gurley visited the locality soon after its discovery and succeeded in obtaining a large collection. He has been an active collector in the rocks of Indiana, Illinois, Iowa and Missouri for many years.

EUPACHYCRINIDÆ, N. FAM.

The genera for which we propose the family name of Eupachyrcrinidæ, with the genus Eupachyrcrinus as a type, all belong to the Subcarboniferous system and Coal Measures. The calyx is more or less globular or bowl-shaped, and consists of five basals, five subradials, five primary first radials, concave internally with a broad upper face, from one to three azygous interradians and no regular interradians. There are one or more brachials, and the arms are composed of a double series of interlocking plates, which bear short pinnules. The column is small and round. We include in the family Eupachyrcrinus, Delocrinus and Ulocrinus.

EUPACHYCRINUS MAGISTER, N. SP.

Plate I, fig. 1, basal view; fig. 2, azygous side view.

This species is very large; calyx low and broad, somewhat saucer-shaped, bulged a little upon the azygous side, height about half the width, sutures deep, excavation extending about half the thickness of the plates, plates very strongly tuberculated, tubercles conical, elongated and irregular in form and distribution.

The five basal plates are sunk in a cavity on the under side, projecting only half their length beyond the column; even this projection is tubercular; they form in the interior of the calyx a pyramid, which is pierced at the summit by a five-rayed opening connecting with the canal in the center of the column; the points of the rays are rounded. The basal plates are made pentagonal by the truncation made at the points of the rays for the central canal. The diagrammatic views which have been made of the basal plates in this genus are incorrect, in so far as they indicate a pentagonal opening with the angles directed toward the sutures, instead of truncating the plates with the concave depression for the five-rayed opening to the columnar canal. The two basals on the azygous side of the species before us are larger than the others, being nearly as large as the other three.

The subradials are very large, extending into the basal cavity, and curve very gently upward; three are hexagonal, the two longer sides unite with the subradials, the two upper sloping sides, uniting with the first radials, are a little shorter, and the two under sides, uniting with the basals, are very short; two are heptagonal, the one upon the right of the first azygous plate being much larger, and, except the two short sides uniting with the basals, the other sides are of subequal length; the one upon the left has, in addition to the two short sides uniting with the basals, a short side adjoining the second azygous plate. Four of the first radials are pentagonal, twice as wide as high; the upper face is the full width of the plates, and projects over the interior of the calyx, so as to give the

appearance of having great thickness when viewed from above. The other first radial, upon the right of the azygous plates, is quadrilateral, except a very slight truncation by the second azygous plate below the depth of the suture. The first radial is separated from the second or brachial piece, on the outer face, by a wide suture, but within a crenated ridge extends from one angle of the plates to another, forming a pentagon, except as separated by the second azygous plate; the ridge has a furrow upon the outer side in the central part of each plate, and within this there is a wide expansion which supports the brachial and arm pieces. The first azygous plate has four sides, rests between the upper sloping sides of two subradials and the long under side of the first radial on the right, with the shorter side abutting upon the second azygous plate. The second azygous plate is hexagonal, curves inward and supports upon its two short inner faces the third and fourth azygous plates side by side. The vault and other parts unknown.

This species would seem to have its nearest affinity with *E. tuberculatus*, which is described in the *Geo. Sur. Ill.*, vol. II, p. 319. In that species, however, the plates are covered with regularly disposed, narrow, prominent tubercles, the tubercles being arranged in rows, while in this species there is no such arrangement. *E. tuberculatus* is figured in *Geo. Sur. Ill.*, vol V, plate XXIV, figs. 9a and 9b, and the basal plates are proportionally larger, and the under sides of the subradials longer, than they are in the species under consideration, beside all the plates have a different shape, and the sutures are not excavated so deep as in the species before us.

Found in the Upper Coal Measures of Kansas City, Missouri, and now in the collection of William F. E. Gurley.

EUPACHYCRINUS SPHERALIS, N. SP.

Plate I, fig. 3, basal view; fig. 4, azygous side view.

This species is large and constricted at the top of the first radials; calyx somewhat like a widened or inflated sphere, width two-thirds greater than height, sutures distinct but not so deeply excavated as in *E. magister*; plates irregularly tuberculated, but tubercles not half as large as in *E. magister*.

Basal plates are sunk in a cavity on the under side, and project less than half their width beyond the column; subradials, large, extend into the basal cavity and curve upward half the height of the calyx; three are hexagonal and two heptagonal; first radials pentagonal, though the one on the right of the azygous area has a very short truncated side abutting upon the azygous plate; second primary radial, or first brachial piece, smaller than the first and of similar form, except inverted, and

bears upon its upper sloping sides the free arms; the one opposite the azygous side bears two arms, each of which has a single plate followed by a double series of interlocking ones; the others support four arms each; the upper sloping sides bear pentagonal plates, similar in form to the second radials, which are followed with a single plate that, in its turn, bears a double series of interlocking ones.

There are fourteen large, long arms, composed of a double series of interlocking pieces, rounded externally, and flattened upon the sides so that, in an accumbent position, they close somewhat like the arms of an *Ichthyocrinus*; the arms in our specimens are spread out and the extremities are not preserved; pinnules numerous, but not very long; column round, and rather small for such a large crinoid.

This species has its nearest affinity with *E. verrucosus*, described in the *Trans. Chi. Acad. Sci.*, Vol. 1, p. 117, and re-described and figured in the *Report on the Palæontology of Eastern Nebraska*, page 150.

Found in the Upper Coal Measures, at Kansas City, Mo., and now in the collection of Wm. F. E. Gurley.

ULOCRINUS, N. GEN.

(*Ety., oulos, solid, substantial; krinon, lily.*)

This genus has a more or less globular or pyramidal calyx, and is related to *Eupachyocrinus* and *Delocrinus*. There are five basals, forming a slightly convex pentagonal disc, or a low cup; they are of the same size and usually anchylosed; on the exterior of the cup the columnar extension is round, depressed below the surface of the plates and radiately furrowed like the articulating faces of the plates of many crinoid columns; on the interior, a star-like, columnar opening truncates the basal plates with the points of the five rays, between which there are radiating furrows for the attachment of the ligaments. By this arrangement the points of the basal plates are disconnected only by the star-like perforation.

There are five subradials, each one of which may be as large or larger than the five united basals, all regularly alternate with the basals and have the same form, except that one may be truncated by an azygous plate.

The first primary radials are pentagonal and regularly alternate with the subradials, except as interrupted by an azygous plate, they are much wider than high, the upper face is the full width of the plate and projects over the interior of the calyx so as to make a broad articulating face for the first brachial piece; the internal side of the first radial is concave, on the upper face of the plates a furrow extends from one angle of the plates to another, on the inner side of which there is a crenulated ridge for the articulating brachial piece, and an interior central depression and slight concavity at the central internal margin.

There are no regular interradians. A single large quadrangular azygous interradian rests obliquely between two subradials and two primary radials, and form part of the wall of the calyx; upon an angle of this, at the top of the calyx, a small plate intervenes and projects slightly above the first radials. The column is round. Other parts unknown, though very thick, heavy plates, bearing a spine like the first brachial plate of a *Delocrinus* are found associated, and believed to belong to this genus.

The cup formed by the basal plates distinguishes this genus from *Eupachyrinus* and *Delocrinus*, both of which have a concave base and an interior pyramid formed by the basals; the second azygous plate does not truncate a subradial, and forms no part of the wall of the calyx in this genus as it does in *Eupachyrinus*. It is probably as nearly related to *Delocrinus* as it is to *Eupachyrinus*, though at first view it would seem to be more nearly related to the latter. Type *U. buttsi*.

ULOCRINUS BUTTSI, N. SP.

Plate I., fig. 5, azygous side view; fig. 6, basal view.

The calyx of this species is pyramidal or has the form of half an ellipse, elongated. The plates are moderately thick and convex externally so as throw the sutures into wave-like depressions; the sutures are distinct, but the plates are not deeply beveled as is common in many species of *Eupachyrinus*; the surface was, probably, strongly granulous, as the better preserved plates are rough, though evidently slightly worn.

The basal plates are large and form a cup about half as high as wide; the perforation for the columnar canal is pentagonal and star-like; the subradials are very large and longer than wide, which produces the great length or pyramidal form of the calyx; four of the plates are hexagonal and one heptagonal; four of the first radials are pentagonal, wider than long and truncated above the full width of the plates; the one on the right of the azygous side is possibly hexagonal, as one side may be slightly truncated by the second azygous plate; the upper face of the first radials bears a furrow extending from one angle of the plates to another, behind which there is a narrow, crenulated ridge, on which the second radials or brachial pieces articulated. The first azygous plate is irregularly quadrangular and rests obliquely in a notch on the top of a subradial and below the under sloping side of the first radial on the right, but it does not reach the second subradial. The second azygous plate is injured in our specimen, but it appears to have slightly truncated one angle of the first azygous plate, and the two abutting first radials at the top of the calyx.

Found in the Upper Coal Measures, at Kansas City, Mo., and now in the collection of Wm. F. E. Gurley. The specific name is in honor of Mr. E. Butts, of Kansas City, who has done a great deal to make known the natural history of that vicinity.

ULOCRINUS KANSASSENSIS, N. SP.

(Plate I, Fig. 7, azygous side view; Fig. 8, outline view regular side; Fig. 9, top view of calyx to show the prolongation of the first radials and contracted opening of the calyx; Fig. 10, basal view).

The calyx of this species is somewhat half-globular in form, though the height is more than two-thirds the width at the top; the plates are moderately thick and quite convex externally, so as to place the sutures in wave-like depressions quite as deep as they are in *U. buttsi*; sutures distinct, but the plates are not beveled; surface granulous.

The basals form an equal-sided convex pentagon, with a central depression for the star-shaped columnal canal; the subradials are each about the size of the united basals, a little wider than high, all pentagonal and nearly equal-sided, except the hexagonal plate supporting the lower face of the azygous plate. The first radials are pentagonal, except the one on the left of the azygous plates, which becomes hexagonal by the very slight truncation made by the second azygous plate; they are twice as wide as high; the upper face is the full width of the plate, and extends internally nearly one-third the diameter of the calyx; in the specimen described, the width of the calyx is $1\frac{2}{10}$ inches, and the projection of these plates $\frac{1}{10}$ inch, leaving the opening at the top of the calyx only one-half an inch, while the great concavity on the inner side of these plates will give an internal diameter of the calyx immediately below the top of the first radial of nearly an inch; the upper surface is broader than it is in *E. buttsi*, but the markings for the articulating brachials seem to be about the same.

The azygous plate forms part of the calyx, is quadrangular, nearly as large as a first radial, rests obliquely between two subradials and the under sloping side of the right first radial and a second under sloping side of the left first radial; the upper angle extends about as high as the upper face of the radials, and is very slightly, if at all, truncated by an angle of the small second azygous plate.

This species is remarkable for the great over-lapping or interior projection of the first radials, and in this respect exceeds all known species of *Delocrinus* and *Eupachycrinus*. No part above the first radials is known, but some equally remarkably thick brachial plates each bearing a very large spine, occurring at Rock Creek, in Jefferson County, Kansas, appear to belong to this species.

Found in the Upper Coal Measures at Kansas City, Mo., and now in the collection of Wm. F. E. Gurley.

DELOCRINUS, N. GEN.

Ety., delos. manifest, clear; krinon, lily.

The species belonging to this genus are usually robust, calyx basin-shaped, arms broad, composed of a double series of interlocking pieces joining neatly with each other, column round, plates thick, and surface smooth or finely granulous, not sculptured; basals five, occupying a concavity on the under side, and more or less hidden by the column, but forming a little cone in the interior of the calyx; subradials pentagonal and hexagonal, larger than the basals, the lower part inflexed by the depression of the base to meet the basal plates, the middle regularly arched, and the upper part forming a more or less acute angle between the under sloping sides of the first radials; first radials wider than high, pentagonal, upper face truncated the entire width of the plates and separated from the second radial or brachial plate on the outer face by a strong suture, but immediately within a straight crenated ridge extends from one outer angle of the plates to the other, on the upper face of the plates, which is furrowed upon each side so as to form a toothed hinge upon which the second radial or first brachial articulates; behind this hinge, in the middle part of each plate, there is a depression or socket for the reception of a tooth-like projection. On the other side of the second radial or brachial, a dart-shaped furrow also extends on the upper side along the line of union of plates, commencing just within the angle arising from the union of the crenulated ridges and extending to the interior of the cup which receives a corresponding projection from the second radials; second radials or brachials pentagonal, produced externally in a more or less strongly developed spine, and bearing upon the upper or inner sloping sides the free arms, the first one or two plates of which are single, but above these composed of a double series of interlocking plates; when the arms are closed the pinnules are within, and the body is compact something like an Encrinus; there are no regular inter-radials; a single azygous interrarial rests upon the truncated upper end of a subradial, between two first radials, and extends upward between the second radials or brachial plates. It is truncated at the upper end and followed by a single piece, beyond which the connection with the vault or proboscis is unknown. Type D. hemisphericus.

The species upon which this genus is founded was first defined by Shumard, under the name of *Poteriocrinus hemisphericus*, in 1858, in the Transactions of the St. Louis Academy of Science, vol. I, p. 221; Meek, in 1872, under the name of *Scaphiocrinus* (?) *hemisphericus*, Shumard, in the Report on the Palæontology of Eastern Nebraska, p. 147, pl. V, fig. 1a, 1b, and pl. VII, fig. 1a, b, c, redefined and illustrated *Cyathocrinus inflexus* of Geinitz, which is a distinct species as pointed out by Geinitz,

though congeneric. In 1873, under the name of *Scaphiocrinus* (?) *hemisphericus*, Shumard; in Geo. Sur. Ill., vol. V, p. 561, pl. XXIV, fig. 5, Meek, probably, correctly identified and illustrated this species.

In 1880, in the Proceedings U. S. National Museum, vol. II, p. 257, White described a species under the name of *Erisocrinus planus*, which was redescribed and figured in Hayden's Twelfth Ann. Rep. Geo. Sur. Terr., p. 127, pl. XXXV, figs. 5a and 5b, under the name of *Erisocrinus* (*Ceriocrinus*) *planus*. *Ceriocrinus* being proposed and described as a subgenus of *Erisocrinus* and a comparison made with the *Poteriocrinus hemisphericus* of Shumard and *Cyathocrinus inflexus* of Geinitz. *Ceriocrinus* was preoccupied in the Echinodermata, by Koenig, and hence the use of the word by White is not allowable. The genus here under consideration and founded upon the *Poteriocrinus hemisphericus* of Shumard is not a subgenus of *Erisocrinus*, nor does it have any near affinity with it, probably not even family affinity, as will be apparent on the inspection of the species of *Erisocrinus* which have been illustrated. Its nearest generic relations are with *Eupachytrinus* or *Ulocrinus*. The *Erisocrinus planus* of White may not be congeneric with this species, because the small azygous plate does not rest on a subradial, but stands upon two radials and projects upward between two second radials. Only the calyx is known, and it may be that other parts, when found, will distinguish it from this genus, or possibly unite it with *Erisocrinus*. We are inclined to believe that Wachsmuth & Springer were not very careful in their examination of these forms, for when referring to the two species, *hemisphericus* and *planus*, near the top of the page 254, pt. 3, Palæocrinoidea, they are made to say, "We, therefore, can not agree with White in considering the two forms generically identical, and much less specifically," and yet, near the bottom of the same page they refer both *hemisphericus* and *planus* to White's proposed genus *Ceriocrinus*, and under the name of *Ceriocrinus hemisphericus* they refer with approval to Meek's identification in the Report on the Palæontology of Eastern Nebraska, p. 147, which is simply a reproduction of the *inflexus* of Geinitz, which is a distinct species that they recognize on the same page.

In the North American Geology and Palæontology S. A. Miller condemned *Ceriocrinus* of White on the ground that the name was preoccupied, and referred the *hemisphericus* to *Eupachytrinus*, the nearest allied genus then described.

This genus, so far as known, is confined to the Coal Measures of the Western States and Territories. We refer the following species to it:

Delocrinus craigi (*Eupachytrinus craigi*), Meek and Worthen, Geo. Sur. Ill., Vol. VI, p. 527, pl. XXXII, fig. 1, and 1a.

Delocrinus fayettensis (*Eupachytrinus fayettensis*), Worthen, Geo. Sur. Ill., Vol. V, p. 565, pl. XXIV, figs. 10, 10a.

Delocrinus hemisphericus (*Poteriocrinus hemisphericus*), Shumard, Trans. St. Louis Acad. Sci., Vol. I, p. 221. Type of the genus.

Delocrinus inflexus (*Cyathocrinus inflexus*), Geinitz, Carb. und Dyas in Nebraska, p. 62, pl. IV, figs. 20a, b, c, and doubtless the spines and some of the plates and fragments of columns figured on the same page under the name of *Actinocrinus* sp. The spines figured by Meek in the Report on the Palæontology of Eastern Nebraska, pl. V, figs. 2a, 2b and 2c, under the name of *Zeacrinus mucrospinus* probably belong to this species, while the form fig. 1 called *Scaphiocrinus* (?) *hemisphericus* may be distinct. *Delocrinus missouriensis* n. sp. And very doubtfully the *Erisocrinus planus* of White above referred to.

DELOCRINUS HEMISPHERICUS, SHUMARD.

Plate II, Fig. 8, side view, showing azygous plate and first brachial, with spine; Fig. 9, basal view of same; Fig. 10, inner side of brachial spine magnified two diameters.

Shumard defined this species as follows:

"The *body* of this species is subhemispherical, concave below, and the surface finely granulose.

"The *base* is very deeply concave, pentagonal and completely concealed from view when the column remains attached to the cup. The five pieces of which it is composed are of a rhombic shape, longer than wide, and the interior edges nearly double the length of the exterior ones.

"The *columnar facet* is circular, crenulated on the border; the central perforation rather large and pentalobate. In the interior of the calyx the base forms an elevated conical protuberance.

"The *subradial* pieces are thick and longitudinally recurved; four of them are pentagonal, a little longer than wide, their superior edges gently arched and slightly longer than the infero-lateral edges; the basal edges are very short. The fifth subradial is hexagonal, its superior angle being truncated to support an anal piece.

"The *first radial pieces* are pentagonal, very massive, and as wide again as long. The inferior edges are slightly concave and of equal length in three of the pieces, but on the anal side they are unequal. The superior edge is nearly straight and rounded. The articular facet is very broad, nearly horizontal, and furnished with a prominent transverse ridge, which is situated nearest the external margin. Exterior to this is a small ridge which coalesces with the main one before reaching the extremity of the pieces. Both ridges are strongly crenulated.

"*Anal pieces.* Of these pieces only one remains in the specimen before us. It is rather small, elongated hexagonal, and is wedged in between two of the first radials, above which it projects about half its length.

"The secondary radials, vault, arms and column are unknown.

"*Dimensions.* Height of calyx, .30; width, .90; height of first radial pieces, .26; width of same, .42."

His specimens were from Hinkston Creek, Boone County, and on the Missouri River, near Lexington, while our specimens are from Kansas City in the same vicinity. His definition is complete, as far as it goes, and we may add only that which our specimens disclose in addition.

The column is round and composed of alternately thicker and thinner plates radiately furrowed near the outer circumference of the articulating faces; the second radial or brachial articulates upon the crenated ridge on the top of the first radial, bears a tooth-like process that enters the socket in the middle of the posterior part of the first radial, and lateral processes that fill the furrows at the united joints of the first radials, and bears a strong spine, externally, that is directed upward at an angle of about forty-five degrees; the plates bear upon their upper inner sides the free arms; arms, ten; the first plate articulates upon the serrated edge of the second radial; the next plate is wide and thin, and above this the arm consists of a double series of thick interlocking plates that make coarse, wide arms, depressed convex externally, and flattened upon the sides almost as if cut by a knife, so as to close up tight like an *Encrinus*; the first azygous plate is truncated and subquadrate upon the upper face, which is serrated near the outer margin for the articulation of the second plate; beyond this the vault is unknown.

DELOCINUS MISSOURIENSIS, N. SP.

Plate II, fig. 11, side view showing column; fig. 12, basal view; fig. 13, azygous side view.

This species may be distinguished at first view from *D. hemisphericus* by the lower calyx and more angular outline, and the top of the calyx, when viewed from below, presents a pentangular outline; the basals extend slightly beyond the column, the subradials in the median part are sharply convex, as distinguished from the gently arching plates in *D. hemisphericus* and do not extend as high proportionally as they do in the latter species, which reduces the height of the calyx. First radials regularly convex in the middle part, but depressed medially toward the upper face of the plates, which produces the pentangular outline when viewed from below. The second radials or brachials, while exposing a very wide suture, are not quite as thick and do not stand as upright as they do in *D. hemisphericus* and have a more slender spine. The azygous plate is the same as in *D. hemisphericus*. The column is not as regular in the alternate arrangement of the thicker and thinner plates as in *D. hemisphericus*, the larger plates project far beyond the thinner ones and sometimes there are two or more thinner plates between the thicker ones.

Found in the Upper Coal Measures in Kansas City, Missouri, and now in the collection of Wm. F. E. Gurley.

ÆSIOCRINUS, N. GEN.

Ety., aïsios, auspicious, coming at good time; krinon, lily.

Column pentagonal, calyx bowl-shaped, plates smooth or finely granulous, basals five, forming a pentagonal flattened or slightly concave disc, subradials rather large, four hexagonal and one heptagonal, and curving upward so as to reach half the height of the calyx. First radials, five, pentagonal, wider than high and truncated the entire width for the brachials, one or more brachials in each ray supporting strong arms composed of a single series of plates. Arms, ten, bearing pinnules. No regular interradians. A single azygous interradian rests upon the truncated upper end of a subradial, between two first radials, and is followed by two plates that connect with the base of the proboscis. Proboscis, long, composed of four series of gradually tapering plates bearing numerous transverse respiratory fissures or slits on the sides of the plates.

The calyx of this genus bears some resemblance to that of an *Erisocrinus*, but the pentagonal column and azygous plate distinguish it. The azygous plate truncates a subradial as in *Delocrinus*, but otherwise there is no resemblance between the two genera. The long, flowing arms composed of single plates and the remarkably large and peculiarly constructed proboscis characterize this genus and distinguish it from all others. Its family affinities would seem to be with the *Poteriocrinidæ*, but probably a new family should be defined for its reception.

ÆSIOCRINUS MAGNIFICUS, N. SP.

Plate II, Fig. 1, natural size of a specimen as it lies on a slab; Fig. 2, a free proboscis nearly entire and only slightly twisted; Fig. 3, portion of same magnified 2½ diameters to show more distinctly the respiratory openings; Fig. 4, an abnormal branching proboscis; Fig. 5, sectional end view of proboscis.

Calyx deep, bowl-shaped, surface of plates finely granulous; sutures distinct but not beveled; basals forming a pentagonal flattened disc having an outline about twice the diameter of the column; subradials rather large, four hexagonal, one heptagonal, bending abruptly upward from the union with the basals, the upper angle extending high between the first radials so as to make the upper sloping sides of the hexagonal plates much the longer; first radials larger than the subradials, about one-half wider than high, all pentagonal with lateral and inferior sides of equal length and upper truncated sides extending to the fullest width of the plates; first brachial plates wide, short, rounded, separated exteriorly from the first radials by a beveled suture; second brachials wide, short, with long upper sloping sides for the articulation of the large arm plates; arms ten, long, round exteriorly and composed of short cuneiform plates;

pinnules short and rather thick. Proboscis remarkably large, long and composed of four series of gradually tapering convex, tuberculated plates, somewhat similar in appearance to four round tapering columns placed together, giving transversely a subquadrate outline; there is no azygous or anal opening in the proboscis, but there are numerous transverse, respiratory fissures or slits in the longitudinal depressions; these slits exist on both sides of every plate of the proboscis from the second brachials to the very top; some specimens of the proboscis have one or more intercalated plates near the lower end, and all are more or less twisted. There is a bifurcated proboscis in the collection which has five series of plates below the bifurcation, and three intercalated series at the bifurcation, so that each branch has four series, which we have illustrated. It is an abnormal specimen that may have resulted from an injury. The column is small, pentagonal, tuberculated and bore cirrhi to a greater or less extent.

This species was collected in the Upper Coal Measures, at Kansas City, and the specimens are in the collection of Wm. F. E. Gurley, of Danville, Illinois.

ÆSIOCRINUS HAREI, N. SP.

Plate III, fig. 1, natural size as it lies upon a slab.

This species is distinguished from *A. magnificus* by having proportionally a much smaller and a smooth proboscis. The calyx is bowl-shaped; column pentagonal; basals of moderate size; subradials convex and extending half the height of the calyx; first radials wider than high; first and second brachials and arms as in *A. magnificus*, but proportionally smaller. The proboscis is much smaller in proportion to the size of the calyx than it is in *A. magnificus*, and the exterior of the plates is smooth, though the respiratory fissures in the two species are alike. This species is thus founded upon the surface character of the proboscis, and the proportionally larger calyx when compared with other parts of the body and arms.

These Kansas City fossils were collected in blue clay, where they were remarkably well preserved; but some specimens were injured by the collectors, who undertook to wash them when no water should have been applied. Many of the specimens were found with the heads downward and the arms spread out, leaving the base of the calyx upward, with the strong proboscis pressed to one side, as shown in the illustration of this species.

From the Upper Coal Measures of Kansas City, and now in the collection of William F. E. Gurley. The specific name is in honor of Sidney J. Hare.

HYDREIONOCRINUS PENTAGONUS, N. SP.

Plate II, fig. 6, view of azygous side, showing height of calyx and upper truncated face for second radials; fig. 7, basal view.

Calyx large pentagonal and exceedingly depressed to the top of the first radials; plates very thick and sutures well defined; basals rather large and forming an octagonal ring around the end of the column, against the faces of which the subradials and three of the radials rest; subradials small, three triangular, one quadrangular and the other pentagonal, by reason of supporting the first azygous plate; they are slightly convex, and lie in furrows made by the angular convexity made by the first radials; first radials about twice as wide as high, the height not much exceeding the thickness of the plates; the plates are hexagonal, highly convex, depressed toward the sutures, and truncated upon the outer faces, so as to give the calyx a pentagonal outline; the depressions at the sutures appear as furrows in the pentagonal outline of the calyx; first azygous plate quadrangular, narrow, resting upon the upper sloping side of a subradial and forming the bottom of the furrow between two first radials; second azygous plate heptagonal, slightly truncating two first radials; column round.

Second radials and succeeding parts above unknown, and it is therefore possible that this species is a *Zeacrinus*, but from the characters given the inference is, it possessed the ventral sac of an *Hydreionocrinus*, beside the latter genus had, so far as known, its greater development in the Upper Coal Measures, while the former is more characteristic of the upper part of the Subcarboniferous or *Kaskaskia* Group. It is unnecessary to compare this with any species heretofore defined, because it is easily recognized by its strongly marked characters.

Collected in the Upper Coal Measures at Kansas City, and now in the cabinet of Wm. F. E. Gurley, of Danville, Illinois.

ONYCHOCRINUS ULRICH, N. SP.

Plate III, fig. 2, azygous side; fig. 3, symmetrical side, natural size.

Calyx depressed, saucer-shaped; plates finely granulous, sutures distinct; basals three, extending slightly beyond the column; four of the subradials pentagonal, the one opposite the azygous side being the larger one and all sharply pointed at the upper angle; the other one is hexagonal with an upper concave articulating facet for the first azygous plate; primary radials five in each ray, very gradually decreasing in size upward and becoming more and more sharply rounded; each one is wider than high and the sutures are transverse, with the exception of a slight concave central, exterior depression; the fifth plate is angular in the central

part of the upper face and supports the two series of brachials; the brachials and arms are very short and thick, and the sutures between the plates become more and more sinuous toward the extremities; the first arm is given off at about the fourth brachial, and above this there are twelve or more short, branching, curving arms that form a cluster at the end of each ray.

The first regular interrarial is large and octagonal; it is followed by three plates and these by five, and above they are smaller and more numerous; four interbrachial pieces are visible in our specimen, and there are probably more; the azygous plates are small, short, and sutures sinuous.

Found in Keokuk Group, at Crawfordsville, Ind., and now in the collection of Wm. F. E. Gurley. The specific name is in honor of Prof. E. O. Ulrich, of Newport, Ky.

AGARICOCRINUS SPLENDENS, N. SP.

Plate IV, fig. 1, side view with arms; fig. 2, basal view of same.

This species is of medium or rather under medium size; base concave; surface granulous; basals small; first radials small; second radials quadrangular, wider than long; third radials pentagonal, wider than high, and supporting upon each of the upper sloping sides a thin brachial plate, which is followed by another thin plate, having two upper slightly sloping sides which support the regular interlocking series of the arm plates; arms twelve, three in each ray adjoining the azygous side, and two in each of the other three rays; they are a little longer than the greatest diameter of the calyx, rather small and taper to a point; pinules fine; regular interrarial areas narrow, the first plate resting between the second radials, which is followed by two smaller ones situate between the third radials and the first brachials; azygous area having one plate followed by three of nearly the same size, which give breadth to the area between the third radials and the brachial plates; the column is round and composed of alternately thicker and thinner plates. Our specimens do not show the vault.

This is a beautiful little species, quite different from any heretofore described, and occurs in the Keokuk Group, at Crawfordsville, Ind. It is in the collection of Wm. F. E. Gurley.

BATOCRINUS MARINUS, N. SP.

Plate IV, fig. 3, side and basal view; fig. 4, outline view of plates on azygous side.

Species about the average size; calyx expanded at the arm bases so as to be wider than high, and to make the openings through the vault from the arm furrows at right angles to the calyx, surface of the plates flattened and finely granulous; basals three, upright and forming a circle

which appears as if it were the enlarged end of the column; first radials wider and larger than the second and third together, three heptagonal and two hexagonal; the upper face is truncated for the second radial, and the upper sloping sides support the first interradians; second radials quadrangular, a little wider than high; third radials wider than the second but not longer, pentagonal or hexagonal, the lower lateral sides spreading so as to give the greatest width at the angles made with the upper sloping sides; the upper sloping sides support the secondary radials; secondary radials 2×10 , wider than long, somewhat variable in size and shape, the second one bearing upon its upper sloping sides a single tertiary radial; the tertiary radials are succeeded by a double series of interlocking arm plates; arms twenty, rather small, slender, gradually tapering and composed of a double series of plates, alternately interlocking; in our specimens they are coiled together on the vault around the base of the proboscis; pinnules very numerous. Regular interradians five, the first one polygonal, about as large as a first radial and nearly as large as the other four; the first one is followed by two plates and these by two which are between the second secondary radials and the upper sloping sides of the tertiary radials; there is one intersecondary radial in each area; azygous interradians nine, the first one in line with the first radials and of the same size; this is followed by three smaller ones, and these again by three, and these by two which fit between the under sloping sides of the tertiary radials; the proboscis is broken off in our specimen at the top of the folded arms.

Found in the Keokuk Group at Crawfordsville, Ind., and now in the collection of Wm. F. E. Gurley.

BATOCRINUS JUCUNDUS, N. SP.

Plate IV, fig. 5, azygous side with arms; fig. 6, symmetrical view with arms removed, showing proboscis.

Species rather small; calyx globose, nearly as wide as high, height of calyx a little more than height of dome to the base of the proboscis; arm bases very slightly projecting, and arm openings projected upward; surface of the plates smooth or finely granulous, more or less convex or tumid; basals three, short, upright, and forming a pentagonal ring around the column; first primary radials much wider and larger than the second and third together; on some specimens there is an elongated, transverse tubercle on each one, the upper face is broadly truncated for the interior face of the succeeding radial, and the upper sloping sides support the first interradians; second primary radials quadrangular, one-half wider than long; third primary radials wider and larger than the second, pentagonal or hexagonal, the lower lateral sides spreading so as to give the greatest width at the middle part of the plate or at the angles made with the upper

sloping sides; the upper sloping sides support the secondary radials; secondary radials 2×10 , wider than long, the upper the larger, but both of them variable in size and shape; six of them have upper sloping sides for tertiary radials, while four of them bear only a single tertiary radial. Each second secondary radial in the ray opposite the azygous side bears a single arm, and one of the lateral secondary radials on each side bears a single arm; there are, therefore, only sixteen arms; a single plate follows each tertiary radial, and above this the arm is constructed of two series of small plates alternately arranged; the arms are rounded on the outer side, gradually tapering, and bear numerous long pinnules, composed of comparatively long pieces; regular interradians, in some areas two and in others three, the first one polygonal and larger than any other plate above the first primary radials; when it is followed by two interradians they are together no larger than a single secondary interradian; azygous interradians eight or nine, the first rests between the upper sloping sides of two basal plates and is in line with the first radials; it is followed by three plates in the second series, and in one specimen three plates in the third series and in another four; these are followed by a single plate projecting an angle up between the under sloping sides of tertiary radials; the vault and proboscis are constructed of highly tumid polygonal plates; the proboscis extends as far as or beyond the arms; column round.

This is a handsome little species, distinguished by its sixteen arms and the structure of the calyx from all others.

Found in the Keokuk Group at Crawfordsville, Indiana, and now in the collection of William F. E. Gurley.

DICHOCRINUS CINCTUS, N. SP.

Plate IV, fig. 10, symmetrical side view; fig. 11, azygous side, showing vault and valvular opening; fig. 12, summit view.

Calyx obconoidal, nearly twice as high as wide, somewhat truncated at the arm bases, except upon the azygous side, surface of the plates bearing a collection of fine longitudinal lines from the rim at the base, over the central part of the first radials, to the first rim plates, with fine transverse lines between, especially near the top of the calyx; sutures not impressed, and the transverse and longitudinal lines cross without interruption; the band or rim at the base suggests the specific name. The two basals form a little cup, the height of which is equal to the greatest diameter; they are contracted above the base so as to leave a small, smooth, half-cylindrical rim or band at the bottom of the cup; the first radials are about twice as long as wide, very gradually increase in width to the upper truncated end, which bears a concave facet, a little more than one-third the width of the plate, for the attachment of the second radial or first brachial piece; second radial thin, rounded; the third radial a little

thicker, rounded, and bearing upon its upper sloping sides the free arms; arms ten, long, rounded externally, composed of a single series of thin plates, bearing long, strong pinnules closely packed together.

Regular interradians forming part of the vault, and standing but very little above the upper truncated edge of the first radials; first azygous interradial as large as the first radials, inflected toward the vault, and bearing fine longitudinal lines in the middle and lower central part, and transverse lines on each side of these on the upper part; the succeeding plates cover a moderately convex ridge, expanded a little above the other part of the vault, which extends to the side of a central nipple occupying the summit of the vault, and at the junction there is a valvular opening, but it is not connected with the central elevation; this nipple-like elevation is covered with very small polygonal plates, and from the lower part of it five ambulacral ridges radiate to the second and third radials, which ridges are covered with minute polygonal plates. The column is round and composed of thin plates with sharp projecting edges.

Found in the Kinderhook or Waverly Group, at LeGrand, Iowa, and now in the collection of Wm. F. E. Gurley.

POTERIOCRINUS GRANILINEUS, N. SP.

Plate IV, fig. 7, natural size.

Calyx low, basin-shaped; sutures well defined; basals small and hidden by the column; subradials small, hexagonal, except one on the azygous side, which is truncated at the top and heptagonal; first radials wide, short, pentagonal, and truncated on top, where they have their greatest width; second radials quadrangular, short, wider than the first, and having the greatest width at the upper truncated surface; third radials wider than the second, pentagonal, very short, with steep upper sloping sides, which are slightly curved to receive the free arms; arms short, composed of short cuneiform plates, so strongly arched in the middle as to form a subangular ridge down the back of all the rays, on which the granules are so united as to form a keel; all the arms preserved in our specimen (six in number) bifurcate on the sixth plate, and above this the bifurcations are irregular, one of them bifurcating on the fourth plate, and others do not seem to bifurcate at all; the arms are flattened so as to fit closely together as in *Zeacrinus*; pinnules not observed; the first azygous plate is inserted obliquely between a subradial and the upper sloping side of a first radial, with the truncated lower end resting against another subradial; this plate is pentagonal; the second azygous plate rests upon the first above-mentioned subradial, and between the radials on the left and upper sloping side of the first azygous plate on the right; the higher azygous plates are not shown in our specimen; the column is rather small and obscurely pentagonal near the head.

The surface of the plates of body and arms is strongly granulated, and this, with the angularity of the arms and the union of the granules forming a sharp ridge or keel down all the rays, strongly characterize this species, and suggests the specific name. It probably belongs to that branch of the genus *Poteriocrinus* for which Wachsmuth suggested the name *Pachylocrinus*.

Found in the Keokuk Group at Crawfordsville, Ind., and now in the collection of Wm. F. E. Gurley.

POTERIOCRINUS CRAWFORDSVILLENSIS, N. SP.

Plate IV, fig. 8, natural size.

Species large, robust; calyx obconoidal, expanding very gradually from the large column, longer than wide, and composed of smooth, rounded plates with well-defined sutures; basals large, widening but little upward, pentagonal, about as wide as high; subradials longer than wide, expanding but little upward; those shown in our specimen hexagonal, the two on the azygous side probably heptagonal; radials pentagonal, very little wider than high, the articulating surface occupying the entire width of the plates; the second radial or brachial plate in the ray opposite the azygous side is pentagonal, about as high as wide, rounded, and supports upon its two upper sloping sides free arms, one of which bifurcates on the third plate above, and the other does not divide; the arms are robust, long, very slowly tapering, rounded, and composed of thick cuneiform plates; column large, round, composed of thicker and thinner plates, the articulating faces of which are marked by radiating furrows, which show the serrated edges. Proboscis and other parts unknown.

This species belongs to that branch of *Poteriocrinus* for which Wachsmuth proposed the subgeneric name of *Scytalocrinus*. Its characters are very strongly marked, and it resembles *P. missouriensis*, from the St. Louis Group, about as much as it does any other species in the genus.

It was found in the Keokuk Group, at Crawfordsville, Indiana, and belongs to the collection of Wm. F. E. Gurley.

POTERIOCRINUS VERUS, N. SP.

Plate IV., fig. 9, natural size.

Specimens medium size; calyx obconoidal, expanding very gradually, as long as wide, and composed of smooth rounded plates; sutures distinct; basals pentagonal, standing upright, nearly as high as wide; subradials hexagonal on the symmetrical side, about one-half larger than the basals and a little longer than wide; radials pentagonal, wider than high, a little smaller than the subradials, convex, truncated the entire width of the

plates with suture gaping; there are five brachials in two rays and seven in the other, in our specimen before a bifurcation is reached. These plates are nearly as long as wide, round externally, and very slightly constricted, and the sutures are gaping; the last one has very steep, upper-sloping sides for the arms; arms ten, long, composed of very long constricted plates with slanting, gaping sutures; proboscis long. Our specimen shows five subquadrate plates where the arms are broken away, indicating that the proboscis extended nearly or quite to the ends of the arms. Column round, and articulating faces of the plates radiately furrowed.

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

SCAPHIOCRINUS MANUS, N. SP.

Plate IV., fig. 13, azygous side, natural size.

General form of calyx and arms having a fancied resemblance to a hand; calyx cup-shaped, height about the half the diameter at the top, plates convex and sunken at the angles of the sutures; basals hidden within a shallow depression surrounding the end of the column; subradials hexagonal, except one on the azygous side which is truncated at the top and heptagonal; they are larger than the basals, and about half as large as the first radials; first radials pentagonal, one-half wider than high, convex at the upper part, truncated the entire width, and separated from the brachials externally by a wider suture. There is only a single brachial in each ray, and it is rather larger than a first radial, pentagonal, constricted, angular and supports on its upper sloping sides the free arms; the two arms on the left of the azygous plate and the one on the right bifurcate on the eighth plate, and the second arm to the right of the azygous plates bifurcates on the tenth plate; the plates are very slightly wedge-shaped, and have their thickest margins produced into nodes, the alternate arrangement of which gives the arms a rough aspect; pinnules coarse, making the head appear full and dense. The first azygous plate rests between the first two radials, the under side of the first radial on the right, and the second and third azygous plates; the second azygous plate is of the same size as the first, rests on the truncated end of a subradial, and abuts upon a first radial and brachial on the left, the first and third azygous plates on the right and another azygous plate at the top; the third azygous plate is a little smaller, and abuts a brachial on the right. Column and vault unknown.

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

ACTINOCRINUS GRANDIS, N. SP.

Plate V, fig. 1, symmetrical side; plate VI, fig. 1, azygous side.

This is a very large species and proportionally very long; the plates are thick, angular, and deeply sculptured; our specimen has a length of $2\frac{3}{4}$ inches, diameter at the top of the third primary radial $1\frac{9}{16}$ inches, at the top of the basals $\frac{9}{16}$ inch, height of basals $\frac{1}{2}$ inch; the sutures are depressed, and while the ornamentation resembles that on *Strotocrinus regalis*, the ridges are stronger and sculpturing deeper; the radial ridges are high, so that a transverse section above the middle of the first radials is pentagonal; there are deep depressions between the arms, giving a pentagonal outline when seen from above, and this is strongly marked because the vault rises but very little above the radial ridges extending to the bases of the arms.

Basals three, pentagonal, standing nearly upright, and forming a deep bowl-shaped cup having a length more than half its diameter; first primary radials very large, longer than wide, three hexagonal and two heptagonal; second primary radials about as wide as long, hexagonal; third primary radials heptagonal, wider than long, and supporting upon the two upper sloping sides the secondary radials; secondary radials forming the basal support of the arm-like projections, hexagonal, and supporting upon their upper sloping sides tertiary radials; first regular interradsial hexagonal, about the size of second primary radials, supported between the upper sloping sides of the first primary radials and the under sloping sides of the second primary radials. This is followed by two hexagonal plates nearly as large as the third primary radials, and these by three plates, and above the plates graduate through a depressed and sunken area into the plates of the vault; first azygous plate about as large as a primary radial, hexagonal, and resting upon two basal plates; it is followed by two hexagonal plates about as large as the second primary radials, and these by three plates nearly as large as the third primary radials, and these by four plates, and above the plates graduate through a depressed and sunken area to the vault; the vault is covered with small, tumid, polygonal plates; the arm openings are directed upward almost at right angles to the radial ridges from the central area of the vault.

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

TAXOCRINUS SUBOVATUS, N. SP.

Plate V, fig. 3, symmetrical side.

General form of body and arms subovate; basals very small and extending but slightly beyond the column; subradials so small as to allow the middle of the first radials to come in contact with the basals, and yet they project up sharply between the radials; primary radials four to each ray, which increase in width but not in length, the first one being rather longer than the second, and the second a little longer than the third, and the latter as long as the fourth; there are three secondary radials in some of the rays, and four in others; the next bifurcation of the rays takes place on the third, fourth or fifth plate, as shown in our example; the sutures between the plates are moderately sinuous; regular interradians two, the first one long and situate between the first, second and third primary radials on one side, and the second, third and fourth on the other, the second being a little smaller, extending to the second secondary radial, but not truncating it; column round, tapering a little below the calyx, and showing minute crenulations, caused by the furrows on the articulating faces of the plates. Other parts unknown.

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

FORBESOCRINUS SPECIOSUS, N. SP.

Plate V, fig. 8, symmetrical side view; fig. 9, basal view.

Species of medium size; plates highly convex or tumid, and depressed at the sutures; sutures between the radials sinuous; calyx constituting more than half the length of the body, though wider than high; basals small; subradials small but extending one angle high between the radials, reaching nearly to the first azygous plate; primary radials four in each series, plates more than twice as wide as high, the first one heptagonal, the second and third hexagonal by reason of joining two interradians at each end, and the fourth pentagonal and supporting upon its two upper sinuous, sloping sides the secondary radials; secondary radials three in each series, twice as wide as high, the first two hexagonal, the third heptagonal, the two upper sinuous edges sloping very little; tertiary radials from four to eight in the different rays, and the next division more unequal and irregular, the bifurcation not taking place in some rays until the tenth or twelfth plate is reached. Throughout the rays the sutures are sinuous, the upper face being concave; the sutures are all well defined; the ends of the arms are infolded; regular interradians about twenty in each area, the first one the larger and resting upon the upper sloping faces of the first two primary radials; this is followed by two

plates, and these by three, and above these the plates are polygonal of unequal size and extend as high as the commencement of the tertiary radials; intersecondary radials from four to six; intertertiary radials two, one following the other in direct line; azygous area like the regular inter-radial areas, except it may be slightly wider in the middle part.

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

CYATHOCRINUS OPIMUS, N. SP.

Plate V, fig. 5, symmetrical side, natural size.

Species short and plump; calyx one-half wider than high, plates smooth, sutures in depressions; basals forming a flattened pentagon about twice as wide as the thickness of the column; subradials more than three times as large as the basals, larger than the first radials, standing upright, highly convex, and protuberant; first radials one-half wider than high, rounded, pentagonal, truncated nearly the entire width above, and having a deeply concave outward sloping facet for the reception of the brachial pieces. There are two brachials in each of the two rays preserved in our specimen; the first is wide and thin, and is separated from the first radial by a gaping suture; the second is equally as wide but a little higher, and supports upon its upper sloping sides free arms. The arms are robust, round, and each one bifurcates again on the second plate; two of these bifurcate again on the second plate, and one is observed to bifurcate on the third and another on the fourth, and the other arms are so injured that the bifurcations can not be determined. The arms after each bifurcation are of unequal size and bifurcate irregularly. The plates of the arms are slightly constricted in the middle, making the arms angular externally, and the sutures are slightly gaping, or one plate projects slightly beyond the other. The arm on the left of the two described does not divide on the second brachial, but it is not exposed so as to allow proper definition. The column is round, a small part of the ventral sac is exposed on the right side of our specimen; the azygous side and other parts of this species are unknown.

This species will be readily distinguished by its short, plump form, nipple-like subradials and the frequent bifurcations of the arms. It is not without some hesitation that it is referred to the genus *Cyathocrinus*.

Found in the Keokuk Group at Crawfordsville, Ind., and now in the collection of Wm. F. E. Gurley.

POTERIOCRINUS ARCANUS, N. SP.

Plate V, fig. 4, symmetrical view.

This species has a rather long, subcylindrical head, when the arms are closed. Calyx obconoidal, plates rounded, sutures depressed, basals bent

upward from the column and forming a small cup; subradials larger than the basals or first radials, as long as wide and rounded so as to leave the sutures in depressions; first radials wider than high, convex, sutures depressed, upper face horizontally truncated the entire width of the plate, and suture gaping; second radial or brachial longer than wide, rounded, constricted and supporting upon its upper sloping sides the free arms; arms ten, long, rounded externally, and slightly flattened on the sides so as to permit them to close tightly together; plates long and very slightly cuneiform below, but becoming shorter and more cuneiform above; pinules short and coarse; column round and composed of thicker and thinner plates. Azygous side and proboscis unknown.

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

SCAPHIOCRINUS BONOENSIS, N. SP.

Plate V, fig. 6, symmetrical side; fig. 7, azygous side.

All the plates of the body and arms are angular and present a very rough aspect; calyx low, plates sharply angular in the central part, and sutures in angular depressions; basals small, hidden by the column; subradials about as high as wide, standing nearly upright; hexagonal, except the one on the azygous side, which is truncated at the top and heptagonal, and each one is produced into an angular node at the central part; first radials pentagonal, about one third as high as wide, sharply angular at the upper central part, horizontally truncated the entire width of the plate on top, where the suture is gaping; second radials quadrangular, about one-third as long as wide, sharply angular, longitudinally, in the central part, sutures gaping; third radials pentagonal, about half as high as wide, sharply angular in the central part and supporting arms upon the upper sloping sides.

The arms divide on the sixth plate, except one which appears to be abnormal and bifurcates on the eighth; above this the bifurcations are not uniform, one arm after each bifurcation does not again divide, while the other one continues to divide to the sixth bifurcation; the divisions are all on one side of an arm, which, commencing from the third primary radial, we may call the inner side, for the single or non-bifurcating arms are thrown toward each other in each of the five radial series as in *Zecrinus*; the arms are angular externally, each plate having a sharp node on the upper central part, those on which the bifurcation of the arms takes place being most prominent. The plates are slightly cuneiform, and the nodes do not, therefore, follow each other in direct line, but project slightly on one side and then on the other in zigzag order.

The azygous plates are sculptured, the central part of each being the most prominent; the first one is inserted obliquely between a subradial and

a first and second radial; the second azygous plate is much larger than the first, and truncates a subradial; above this the plates are as usual in this genus. The column is pentagonal and plates nodose.

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

ABROTOCRINUS, N. GEN.

Ety.: abrotos, immortal; krinon, lily.

Calyx low, bowl-shaped; basals five, occupying a shallow concavity; subradials hexagonal, as high as wide; first radials pentagonal, wider than high, truncated horizontally the entire width of the plates, sutures gaping; brachial or second radial constricted in the middle and bearing upon its upper sloping sides the free arms; arms bifurcate frequently and bear pinnules; no regular interradians. First azygous plate of the same form and in line with the first radials, resting between the upper sloping sides of two subradials, horizontally truncated the entire width above and having a gaping suture; second azygous plate constricted in the middle and horizontally truncated on top; above this numerous plates form a single longitudinal series until they graduate into the proboscis. Column obscurely pentagonal at the head and becoming round below.

This genus probably belongs to the family Poterioeriniæ, type *A. cymosus*.

ABROTOCRINUS CYMOSUS, N. SP.

Plate V, fig. 2, azygous side view, natural size.

This is a large species, having a low calyx, in proportion to the great length of the arms, and a peculiar enlargement of the plates at each bifurcation of the arms, giving them a knobby aspect; plates granulous, not sculptured, sunken at the angles, and sutures well defined; calyx low, bowl-shaped, height about half the diameter; basals occupying a concavity at the bottom; subradials bending abruptly upward, having a height equal to the greatest width; first radials pentagonal, pointed below; about twice as wide as high, horizontally truncated at the top the entire width and having a gaping suture; second radials or brachials pentagonal, larger than the first radials, nearly as long as wide, rounded externally, constricted at the sides, very tumid in the upper central part, with steep upper sloping sides for the free arms.

The first arm plates are rapidly contracted from the top of the second radials so as to leave a convex knob-like elevation at the bifurcation; the arms are round externally and bifurcate on the seventh and eighth plates; they increase in size toward the bifurcation, and at the point of

bifurcation become proportionally more tumid than the rays are at the division on the second radials. Both arms bifurcate at regular distances, so that there are more than fifty arms before the divisions cease to take place, and there is a swelling at every bifurcation similar to the last above described. Below the bifurcations the plates are round, externally, and very slightly cuneiform, but above the last bifurcation the plates become quite cuneiform, and more or less nodose in zigzag lines, as is common with the arms of *Scaphiocrinus*. Pinnules long and numerous.

First azygous plate as large as a first radial and of the same form, with a gaping suture at the top; second azygous plate rapidly tapering upward and horizontally truncated at the top. Above this ten plates are visible in a single longitudinal series before the series is covered by the overlapping arm on the right. Column obscurely pentagonal near the calyx, but soon becoming round below; the central canal is pentagonal, and a circle of denticulations exists on the articulating face of each plate just within the periphery.

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

GONIOCRINUS, N. GEN.

Ety.; gonia, an angle; krinon, lily.

Calyx small, basin-shaped, plates convex or angular; basals five, small, extending beyond the column; subradials five, about the same size as the basals; first radials larger, wider than long, and supporting on the slightly concave upper faces, a little shorter than the width of the plates, the brachials; brachials, three in each ray, flanged at the sides; arms resembling *Scaphiocrinus*. No regular interradians; azygous interradians, consisting of a series of plates, the first one like a first radial and resting upon the upper truncated face of a subradial, which is followed by plates very much like the brachials, which form a convex arm-like appendage that curves in toward the proboscis at or above the base of the free arms. A small azygous plate also exists on the right side of the area, resting between the upper sloping sides of the two subradials and the under sloping sides of a first radial and the azygous plate which truncates a subradial. Column pentagonal, bearing cirrhi, composed of thicker and thinner plates; canal pentagonal. Type *G. sculptilis*.

GONIOCRINUS SCULPTILIS, N. SP.

Plate VI, fig. 2, symmetrical side, natural size; fig. 3, same magnified more than two diameters; fig. 4, left side of another specimen magnified a little more than two diameters; fig. 5, azygous side of same.

Calyx small, short, basin-shaped, truncated at the top; plates thick, angular, sutures sunken at the angles; basals five, small, extending beyond the column and forming a rim at the base of the calyx; subradials five, about the same size as the basals, angular, sutures depressed and sunken at the angles; first radials wider than high, convex longitudinally, angular, sutures depressed and sunken at the angles; slightly concave facet above, about two thirds the width of the plates, for the articulation of the brachials; brachials, three in each ray, the second one a little longer than the first, and the third longer than the second, and bearing upon its upper sloping sides the free arms; the central part is convex and the sides flanged, but the different series do not come in contact, and the plates of the proboscis may be seen, in our specimens, between the brachials. Arms ten, angular, plates flanged, and giving off armlets or remarkably long, coarse pinnules, at irregular distances, generally on the second or fourth plate, but never alternately. These armlets are supported on the sloping sides of arm-plates axillary in character, and are composed of short plates. A small, quadrangular azygous plate is inserted between the upper sloping sides of two subradials and the under sides of the right first radial and the second azygous plate; the second azygous plate truncates a subradial and is in line with the first radials and of about the same size; the three following plates are of the same size as the brachials and form a prominent, convex ridge to the third brachials, when the series abruptly curves under the arms. Column pentagonal, and bears numerous cirrhi; columnar canal pentagonal, the angles of the pentagon notching the basal plates and corresponding with a pentagonal opening that separates the subradials.

Found in the Waverly or Kinderhook Group, at Le Grand, Iowa, and now in the collection of Wm. F. E. Gurley.

It is quite likely the species described as *Cyathocrinus harrisi* should be referred to this genus. It is certainly nearer to this genus than it is to *Cyathocrinus*. We refer this genus to the *Poteriocrinidae*.

BATOCRINUS POCULUM. N. SP.

Plate VI, fig. 6, symmetrical side, showing part of the arms; fig. 7, azygous side view, showing the broken end of the proboscis; two broken arms are crowded out of place to the right.

Calyx urn or bowl-shaped, medium size, vault moderately convex, proboscis small, subcentral; plates granular, sutures so indistinct as to

be traced with difficulty; basals thick, depressed for the column below, and forming a smooth rim at the base, without indented sutures; first radials very large, nearly as high as wide, two hexagonal and three heptagonal, smooth, sutures indistinct, upper face very slightly arcuate; second radials quadrangular, short; third radials a little larger than the second, but both together not as large as a first radial; secondary and tertiary radials small.

Arms twenty, large, composed of a double series of interlocking plates, above the second tertiary radials; pinnules long, numerous; arm openings to the vault directed outward at right angles to the calyx.

Regular interradials four, the first one very large, irregular, having eight unequal sides; this is followed by two rather small elongated plates, and these by a minute plate. Azygous area very large, bulging out, the first plate in line with the first radials and of the same size and form; this is followed by three plates, larger than second primary radials, and these by four, the central two being small and nearly on a line with the third primary radials, and these are followed by three small plates. Possibly there may be one or two minute plates above these, but if so the sutures in our specimen are too indistinct for their determination.

The vault is moderately convex, but slightly depressed toward the proboscis, and composed of unequal polygonal, convex plates. Proboscis small, cylindrical, and near the lower end composed of smooth, elongated plates. Column round and radiately furrowed toward the circumference, as shown by the plate within the basal depression of our specimen.

Found in the Waverly or Kinderhook Group, at Le Grand, Iowa, and now in the collection of Wm. F. E. Gurley.

BATOCRINUS FACETUS, N. SP.

Plate VI, fig. 8, view of the right side of a specimen, showing there are only three arms in the first radial series on the right of the azygous side.

Calyx medium size, half globular below the arms and conical above, with a subcentral proboscis, plates convex and more or less angular, sutures depressed; basals forming a pentagonal disc nearly covered by the column; first radials about one-half wider than long, upper face concave; second radials quadrangular, nearly as long as the first radials; third radials about as large as the first radials, and supporting on the upper slightly sloping sides the secondary radials; second secondary radials wider than the first secondary radials and of about the same length; two tertiary radials in each of the three series, the second one having the characters of a brachial. There are no tertiary radials in the series opposite the azygous side, and consequently there are only two

arms in that series, and there are tertiary radials in only one branch on the right of the azygous area, and hence there are only three arms in that series. Arms seventeen, long, composed of a double series of interlocking plates bearing long pinnules.

Regular interradials four, the first one large and having nine sides; this is followed by two plates, each of which is longer than wide, and these by a single plate. Azygous area wide and having eleven plates; the first one is as large as a first regular interradial; it is truncated on top by a small quadrangular plate and bears upon each of its upper sloping sides a plate fully as large as itself; these are followed by three smaller plates, the central one being the larger, and these again by three smaller ones, which are followed by a single plate resting between the upper sloping sides of the two plates on the right of the area. There are two small intersecondary plates in the right radial series, seeming to fill the space that would have been occupied by the regular plates if there had been four arms in the series instead of three. The vault is covered with unequal, tumid, polygonal plates. Column round, composed of thicker and thinner plates; columnar canal pentagonal. Height of proboscis unknown.

Found in the Keokuk Group, near Canton, Indiana, and now in the collection of William F. E. Gurley.

BATOCRINUS CANTONENSIS, N. SP.

Plate VI, fig. 9, azygous side, showing proboscis.

Calyx medium size, obconical below the arms and conical above, with a large, long, subcentral proboscis, plates conical or having angular nodes in the form of transverse ridges, base truncated; basals large, thick, forming a wide rim at the bottom, indented at the sutures, first radials a little wider than high; hexagonal, convexity in the form of a transverse ridge; second radials small, quadrangular, half as wide as the first radials; third radials small, pentagonal, very short, a little wider than the second radials and bearing upon the upper sloping sides the secondary radials; two secondary radials in each ray, wider than high, having transverse angular nodes, the upper plates each bearing upon the upper sloping sides a single tertiary radial; the tertiary radials have a concave upper face supporting the free arms.

Arms twenty, openings to the vault directed upward. Above the first two plates the arms consist of a double series of interlocking plates, flattened on the external face of the arms, and toward the upper part more or less depressed and the interlocking ends of the plates bearing small nodes. Pinnules long, numerous.

Regular interradials three, one following the other; first one as large as a first radial, very protuberant and having nine sides; the second one

about half as large, and hexagonal or pentagonal; the third one small, pentagonal and situate between the second secondary radials and abutting the under sloping sides of the tertiary radials. Azygous area wide, interradials seven; the first one heptagonal, resting between the upper sloping sides of two basals and between the first radials, and supporting three azygous plates, the one on the right being the larger. These are followed by three plates, the one on the right being also the larger one, and extending its upper angle between the under sloping sides of the tertiary radials.

The vault and proboscis are composed of very nodose, almost spiniform plates. The proboscis extends beyond the end of the arms. Column round, composed of thicker and thinner plates, the former projecting beyond the latter; columnar canal pentagonal.

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

POTERIOCRINUS SPARTARIUS, N. SP.

Plate VII., fig. 1, view of the right side, showing part of the azygous area and part of the column.

Calyx low, somewhat obconoidal, one-half wider than high, sutures distinct, plates smooth; basals low, forming a pentagon about one-half wider than the thickness of the column with the angles sharply elevated between the under sloping sides of the subradials; subradials a little wider than high, one on the azygous side heptagonal, the others probably hexagonal; first radials one-half wider than high, rounded, pentagonal, articulating surfaces occupying the entire width of the plates, and sutures gaping; each ray has two brachials; the first one is the larger, a little wider than long and rounded externally; the second is shorter than the first, rounded and supports upon its two steep sloping sides the free arms; the arms are rounded externally, bifurcate twice, making forty arms, and are composed of slightly cuneiform plates; the first bifurcation takes place on the eighth plate in some rays, and on the tenth plate in others; above this the bifurcations are irregular, and occur from the fourteenth to the twenty-eighth plates; pinnules numerous, but rather small for the size of the arms.

The azygous area is rather wide, the first plate is pentagonal, a little smaller than a subradial, rests upon the upper sloping sides of two subradials and between the first radial on the right and the azygous plate on the left, and is truncated at the top for the third azygous plate; the second azygous plate is pentagonal, about as large as the first, rests upon the truncated upper end of a subradial and between a first radial on the left and the first and third azygous plate on the right, and is truncated at the upper end for the fourth plate; the third azygous plate is

hexagonal, rests upon the first azygous plate with the first radial and first brachial on the right and the second and fourth azygous plate on the left, and above this the plates graduate into the proboscis.

Column round and bearing long cirrhi at irregular distances from each other.

The specimen illustrated is on a slab and looks much like a little broom, which suggested the specific name.

Found in the Kinderhook or Waverly Group, at Le Grand, Iowa, and now in the collection of Wm. F. E. Gurley.

POTERIOCRINUS SCOPÆ, N. SP.

Plate VII., fig. 2, azygous side.

Calyx low, somewhat obconoidal, about twice as wide as high, sutures distinct, plates smooth, basals low, upright; subradials about as wide as high, one on the azygous side heptagonal, the others probably hexagonal; first radials one-half wider than high, rounded, pentagonal articulating surfaces occupying the entire width of the plates, and sutures gaping, a single brachial in each ray, longer than wide, rounded externally and contracted on both sides, bears upon its upper sloping sides the free arms; the arms are rounded externally, bifurcate twice, making forty arms, and are composed of slightly cuneiform plates; the first bifurcation occurs on the eighth plate; the second bifurcation takes place in each arm from the tenth to the eighteenth plate; pinnules numerous but not large.

The azygous area is very wide and displays a wide proboscis; the first plate is pentagonal, a little smaller than a subradial, rests upon the upper sloping sides of two subradials and between the first radial on the right and the second azygous plate on the left, and is truncated at the top for the third azygous plate; the second plate is pentagonal, about as large as the first, rests upon the truncated upper end of a subradial, and between a first radial on the left and the first and third azygous plate on the right, and is truncated at the upper end for the fourth plate.

Column round, and bears long cirrhi at irregular distances from each other. The resemblance to a little broom suggested the specific name.

This species is distinguished from *P. spartarius* by having only one brachial plate in each ray, a lower calyx, and wider proboscis and azygous area.

Found in the Kinderhook or Waverly Group, at Le Grand, Iowa, and now in the collection of Wm. F. E. Gurley.

POTERIOCRINUS GENISTA, N. SP.

Plate VII, fig. 3, azygous side.

Calyx low, somewhat obconoidal, more than twice as wide as high, sutures distinct, plates smooth, basals low, slightly spreading; subradials about twice as wide as high, one on the azygous side heptagonal, the others probably hexagonal; first radials one-half wider than high, rounded, pentagonal, articulating surfaces occupying the entire width of the plates, and sutures gaping; there is a single brachial in the ray on the right of the azygous area, rounded externally, contracted in the middle and bearing upon its upper sloping sides free arms; the ray on the left of the azygous area has two brachials, the first one is the larger, a little wider than long, rounded externally and slightly contracted in the middle, the second is shorter than the first, rounded, and supports upon its upper sloping sides free arms; the arms are rounded externally, bifurcate twice, making forty arms, and are composed of slightly cuneiform plates; the first division takes place in some arms on the sixth plate, and in others on the eighth plate; the second division takes place in each arm from the tenth to the twentieth plate; pinnules rather small.

The azygous area is very wide and the plates are arranged as in *P. scopæ*; column round and bears long cirrhi at irregular distances. The resemblance to a little broom suggested the specific name.

This species is much like *P. scopæ*, and possibly should not be separated from it, but it is distinguished from it by having two brachials in the ray on the left of the azygous area instead of one, and differs in some of the details of the arm structure, especially in having the first division in some of the arms take place on the sixth plate instead of the eighth. The specimens of *P. spartarius*, *P. scopæ* and *P. genista*, which we have illustrated, are on the same slab, which also bears two other specimens of *P. spartarius* and one of *P. scopæ*. They are all light-colored. The slab is from Le Grand, Iowa, and is in the collection of Wm. F. E. Gurley.

POTERIOCRINUS LEGRANDENSIS, N. SP.

Plate VII, fig. 4, symmetrical side, natural size; fig. 5, symmetrical side, magnified; fig. 6, azygous side, magnified.

Species small, calyx obconoidal, height about two-thirds the greatest diameter, plates smooth, basals small, forming a low pentagonal cup; subradials comparatively large, height and width sub-equal; first radials nearly as high as wide, very convex and much depressed at the separating sutures, so as to give them the appearance of brachials, truncated the entire width above, and separated from the brachials by a ping

suture; a single much-elongated brachial, rounded, and contracted in the middle, supports upon its upper sloping sides, in each radial series, the free arms.

The arms divide on the sixth plate, making twenty arms. The arms are rounded, plates comparatively long, cuneiform, and project alternately for the attachment of coarse pinnules, which gives the arms a rough aspect. Azygous area wide, and plates arranged as in other species of this genus. Column, round.

Found in the Waverly or Kinderhook Group, at Le Grand, Iowa, and now in the collection of Wm. F. E. Gurley.

POTERIOCRINUS CANTONENSIS, N. SP.

Plate VIII, fig. 3, symmetrical side; fig. 4, azygous side, but the figure is slightly incorrect, as the first plate rests between the upper sloping sides of the subradials, and the artist mistook a blemish for the suture.

This species is very slender, and, including the arms, when not compressed, nearly cylindrical; calyx forms a little cup having thick, somewhat angular plates, depressed toward the sutures; basals small, forming a flattened pentagonal disc about twice the diameter of the column; subradials larger, standing nearly upright, and depressed at the sutures; first radials much larger than the subradials, convex, and projecting externally near the upper face, where they are truncated the full width, and have gaping sutures separating them from the single brachial plates; brachial plates long, contracted in the middle, and having very steep upper sides for the articulation of the free arms; arms ten, no division, and composed of a single series of plates, which are long in proportion to the size of the arms, the first one being very long; azygous plates rather small, the first one having an unusually long side abutting upon the second plate, but as usual in this genus, it rests between the upper sloping sides of the subradials and the under sloping side of the right first radial; the second azygous plate is very long and narrow, being so nearly pointed below that it slightly truncates the subradial. By reason of an injury to our specimen at this place, the artist mistook the lines made by the blemish for the sutures, and overlooked the true suture lines, so there is a slight error in the illustration in this regard. Column, round.

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

ONYCHOCRINUS CANTONENSIS, N. SP.

Plate VII., fig. 9, azygous side, natural size.

Calyx low, basin-shaped, plates smooth, sutures distinct; basals three, extending beyond the column, forming a pentagon one-third wider than the diameter of the column; subradials five, comparatively small; not more than half the size of the first radials, two of them pentagonal, two hexagonal and one on the azygous side heptagonal, with sides unequal, the upper one being sinuous in the middle for the reception of a small azygous plate; radials five in each series, well rounded, wider than high, very gradually tapering to the bifurcation on the fifth plate, sutures transverse between the first, second and third plates, but sinuous in the middle part of the fourth; arms or secondary rays very short, the bifurcations taking place on every third plate until the extremities are clustered together like a little, clinched fist at the end of each radial series; the sutures between each of the arm plates are slightly sinuous in the middle part; first regular interradial about the size of a subradial; others not determinable from our specimen; azygous interradials very small, our specimen showing seven plates in a row; column round, composed of thin plates in the upper part, tapering in size downward for a short distance, when the plates become proportionally thicker and finally having a thickness equal to half the diameter of the column, articulating faces of the plates connected near the surface of the column by fine radiating lines which give the sutures a crenulated aspect.

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

RHODOCRINUS SCULPTUS, N. SP.

Plate VII., fig. 11, view of the azygous area, right radial series and one interradial area.

Calyx deep, bowl-shaped, sides swelling but little, plates thickened, convex, and pointed in the center with more or less well defined ridges connecting the subradials and radials, sutures depressed; basals small, extending but little beyond the column; subradials comparatively large, thick, upright, giving the base of the calyx a truncated aspect, pointed or highly convex at the central part of each, with a ridge extending to the adjoining first radials; first radials about two-thirds as large as the subradials, pointed in the center, and bearing a ridge connecting them with the second radials; second radials smaller, quadrangular, a little longer than wide and bearing a central longitudinal ridge; third radials pentagonal, about the same size as the second radials, convex in the central part and bearing a single secondary radial upon each of the upper sloping sides; secondary radials pentagonal, about as large as the third primary radials, and supporting free arms, which, at first, are

directed almost at right angles to the top of the calyx; the arms bifurcate on the fifth plate, and the adjoining arms in each radial series again bifurcate on the third plate, giving to the species thirty arms; arms small, short, rounded externally, and composed of a single series of short plates in the lower part, but above the second axillary plate, composed of a double series of interlocking plates. Pinnules strong and numerous.

Regular interradians, seven, the first one pentagonal, a little smaller than a first radial, and pointed in the center; this is followed by two smaller plates, and these by two that fill the space between the third radials, and these by two smaller ones that connect with the plates of the vault. Azygous interradians, seven, the first one hexagonal, larger than a first radial, pointed in the center, with ridges connecting it with adjoining plates; this is followed by three plates, the middle one extending higher than the others, and these by three smaller plates. A ridge extends from the subradial over the plates in the central part of the azygous area, as distinctly marked as that which crosses the three primary radials.

The calyx of this species resembles that of *R. kirbyi*, but our specimen is light colored, while all of the *kirbyi* from the same locality are dark colored. It is distinguished by having no second secondary radial or brachials and by the smaller and differently constructed arms.

Found in the Kinderhook or Waverly Group, at Le Grand, Iowa, and now in the collection of Wm. F. E. Gurley.

RHODOCRINUS CÆLATUS, N. SP.

Plate VII, fig. 10, view of azygous area, right radial series and an interradian area.

Calyx deep, bowl-shaped, plates sculptured, and bearing prominent radial ridges that give it a somewhat pentagonal outline; sutures depressed; basals small, extending but little, if any, beyond the column; subradials comparatively large; first radials larger than the subradials, heptagonal, and bearing ridges that radiate to each adjoining plate; second radials hexagonal, less than half the size of the first radials, a little smaller than the second, pentagonal, and supporting upon each of the upper sloping sides a single secondary radial; secondary radials about the same size as the third primary radials, pentagonal, protuberant, and support free arms; the arms are round externally, and bifurcate on the fifth plate; the first four plates are cuneiform and have gaping sutures; there are twenty arms, and above the bifurcation they are composed of a double series of interlocking plates; pinnules numerous and strong.

Regular interradians, seven; the first one pentagonal, much smaller than a first radial; it is followed by two smaller plates, and these by two,

and the latter by two smaller ones that unite with the plates of the vault. Azygous area wider between the secondary radials, and plates larger than in the regular interradian areas.

Column large, round, and composed of thicker and thinner plates, the former of which projects beyond the latter.

The calyx of this species resembles that of *R. nanus*, though the plates are more deeply sculptured, and differ some in their relative proportions, while the arms are much like those of *R. watersianus*. Our specimen is light colored. Certain species from Le Grand are invariably dark colored, while others are invariably light colored. This is a peculiarity not known to us as prevailing at any other locality.

Found in the Waverly or Kinderhook Group, at Le Grand, Iowa, and now in the collection of Wm. F. E. Gurley.

ZAECRINUS DUBIUS, N. SP.

Plate VII, fig. 7, symmetrical side; fig. 8, azygous side.

Calyx very small in proportion to the other parts of the body, forming a low cup, not half as high as wide, plates smooth, convex, sutures distinct, and generally beveled; basals forming a small disc scarcely extending beyond the column; subradials small, first radials larger than subradials, one-half wider than high, convex, and much depressed at the side suture, giving them the appearance of brachials, truncated the entire width above, the suture gaping; two brachials in each ray of about the same size as a first radial, the upper one being axillary for the support of the free arms.

The arms divide twice, making thirty arms, the divisions take place from the outer arm in each radial series, while the inner arms or branches remain single. The arms are round externally, and composed of cuneiform plates having a height equal to about half the diameter of the arm. Pinnules small. Azygous area rather wide and convex, with plates arranged as in *Poteriocrinus* and *Scaphiocrinus*. The proboscis, or ventral sac, extends to the top of the arms, where it is crowned with large convex plates, and, in this respect, resembles *Zeacrinus*, as it does also in the manner of the bifurcation of the arms.

If we were to look only at the azygous area, and disregard the fact that the basal plates are sunken at the bottom of the calyx, and probably form a low conical elevation in the interior, we would refer this species to *Poteriocrinus*. But we regard the position of the basal plates as of great importance, and think no species having the basal plates sunken so as to be hidden from a side view of the calyx, should be referred to *Poteriocrinus*. In other words, the genus *Poteriocrinus* should be held to include only species having an obconoidal calyx. The

calyx of this species agrees with *Scaphiocrinus*, but the arms and proboscis agree with *Zeacrinus*. Probably it should not be classed with either genus, but we are not prepared, in the present state of mixed learning respecting the *Poteriocrinidæ*, to propose a new generic name. What we have said here applies with equal force to *Poteriocrinus granilineus*, described on page 343 of this article. We there suggested the species might belong to the branch for which Wachsmuth had suggested the name *Pachylocrinus*, overlooking the fact that on page 241 of Part III, of his *Palæocrinoidea*, he had stated that his *Pachylocrinus* is a synonym for *Woodocrinus*. (*Parisocrinus*, on page 239, is doubtless a typographical error for *Pachylocrinus*, or an accidental oversight.) We have not, at present, access to the work of DeKoninck on *Woodocrinus*, and have little confidence in the amended diagnosis by Wachsmuth.

Found in the Keokuk Group, at Bono, Ind., and now in the collection of Wm. F. E. Gurley.

SCAPHIOCRINUS REPERTUS, N. SP.

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

Calyx basin-shaped, plates convex, smooth, sutures distinct; basals forming a slightly depressed pentagonal disc, extending a little beyond the column; subradials comparatively large, convex, smooth, and forming a little cup; first radials a little larger than the subradials, one-fourth wider than high, highly convex, with a transverse, central, concave depression, truncated the entire width above, and having a projecting rim, and gaping suture above; single brachials wider than high, constricted in the middle, bear upon their upper, sloping sides the free arms.

Arms, ten; small when compared with the brachials and proboscis, and composed of long, constricted cuneiform plates, alternately projecting for the support of the coarse pinnules. The arms are so small as to be incapable of covering the proboscis, which may be seen between them wherever the coarse pinnules are removed. Azygous area has rather large plates arranged as in other species of this genus. The third, fourth and fifth azygous plates in our specimen are perforated with a round opening immediately adjoining the first arm plate on the right, and the proboscis, where visible, is indented at the angles of the plates. Column small, round, and plates radiately furrowed at the outer circumference. Most nearly allied to *S. depressus*.

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

SCAPHIOCRINUS BELLUS, N. SP.

Plate VIII, fig. 5, azygous side; fig. 6, symmetrical side; fig. 7, basal view.

This species is remarkable for its deeply sculptured and highly angular plates of calyx and arms.

Calyx low, basin-shaped, nearly three times as wide as high, plates convex and deeply sculptured; basals forming a flattened pentagonal disc nearly one-half wider than the diameter of the column; subradials larger than the basals, highly convex, deeply sculptured, extending below the basal disc and reaching up half the height of the calyx; an angular ridge extends from the center of each plate to meet another on the adjacent radials, and one is also directed toward each of the abutting basal plates; first radials twice as wide as high, deeply sculptured, having a central elevation from which a ridge extends to the abutting subradials, truncated above the entire width, suture widely gaping, showing great thickness in the upper part of the plate, with ligamental furrows or denticulations on the upper face and on the under side of the brachials.

A single brachial in each ray, wide below, where it articulates with the radials, height and width subequal, constricted on the sides, so as to form a sharp longitudinal ridge in the middle, supports upon the steep upper sloping sides the free arms. Arms ten, long, coarse, separated from each other, plates slightly cuneiform and bearing alternately long, strong pinnules; the first plate is long, constricted on the sides, so as to form a sharp longitudinal ridge in the center, that does not unite with the longitudinal ridge on the brachial below, nor the one on the succeeding arm plate; a wide, gaping suture separates the first arm plate from the brachial, and exposes the same kind of ligamental furrows or denticulations that exist between the brachials and first radials. All the plates of the arms are constricted at the sides and bear a longitudinal ridge in the middle, but the ridges do not connect so as to make a continuous longitudinal keel on the arms, but are arranged in a zigzag line.

Azygous area wide, depressed, plates deeply sculptured and arranged as in other species of this genus. A small part of the flattened proboscis is exposed at and near the top of our specimen. Column pentagonal, sides concave, central canal obscurely pentagonal.

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

SCAPHIOCRINUS LACUNOSUS, N. SP.

Plate VIII, fig. 8, symmetrical side; fig. 9, azygous side; fig. 10, basal view.

Calyx low, basin-shaped, plates thick, sculptured, protuberant, sutures depressed, sunken at the angles; basal plates forming a pentagonal,

depressed disc, extending but little beyond the column; subradials rather large, extending below the basals, and upward half the height of the calyx, sharply sunken at the angles; radials pentagonal, more than twice as wide as high, sculptured, deeply sunken at the angles, concave on the upper face, which extends the full length of the plates, upper margin projecting in a rim, which is separated from the first brachial by a gaping suture. Two brachials in each ray, the first quadrangular and twice as wide as high; the second short, pentagonal, and supporting on its upper sloping sides the free arms.

The arms on some of the rays divide five times, the division taking place from the outer arm, while the inner ones continue single; in other rays, especially in the one upon the right of the azygous area, some of the inner arms bifurcate, hence there are more than fifty arms. The arm plates are cuneiform, rounded externally, contracted on the sides and project at the upper side of the thicker end for the support of the pinnules. Pinnules coarse.

Azygous area wide, plates arranged as in other species of this genus, sculptured and depressed at the angles. Column large, pentagonal, composed of projecting thicker and thinner plates, with a small round central canal.

It most resembles *S. briareus*, from the upper geodiferous shales of the Keokuk Group, at Keokuk, Iowa.

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

SCAPHIOCRINUS PRÆMORSUS, N. SP.

Plate VIII., fig. 11, symmetrical side view.

Calyx low, basin-shaped, plates highly convex, angles sunken, sutures depressed; basals small, forming a depressed pentagonal disc extending but little beyond the column; subradials small, thick, extending below the basals and forming a low cup with upper angles projecting half the height of the first radials; first radials twice as wide as high, sunken at the angles, truncated the entire width above with a projecting rim and very wide, gaping suture. A single brachial in each ray, sharply angular, longitudinally, and contracted at the sides, supports on steep upper sloping sides the free arms, except in the radial series, opposite the azygous side, where the brachial is truncated above and supports a single arm. The arms are angular externally, sutures very marked, plates cuneiform and bear short, very coarse pinnules. The ray opposite the azygous side bifurcates on the fourth plate, and again on the sixth plate, making four arms to the ray; the other rays bifurcate on the sixth plate, making six arms to each of the four radial series, which gives to the species twenty-eight arms.

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

DICHOCRINUS ULRICHI, N. SP.

Plate VIII., fig. 12, side view; fig. 13, azygous side.

Calyx obconoidal, very slightly inflated above the middle of the first radials, a little higher than wide, sutures slightly depressed so as to give the plates a little convexity, surface apparently smooth; basals form a little cup, not quite as wide as high, the notch at the union of the basals on the azygous side being a little deeper than it is on the opposite side; first radials a little longer than wide, and increasing in width very slightly toward the upper end where each has a concave facet full two-thirds of the width of the plate for the articulation of the brachial plates. There is only one brachial, in our specimen, in the ray opposite the azygous side, but, possibly, two plates have been anchylosed, though no evidence of a suture can be detected. The first brachials are quite as thick as the second, which bear the arms upon the upper sloping sides. Arms ten, long, robust, rounded externally and composed of a single series of thin plates very slightly cuneiform. Pinnules very coarse and closely packed together.

Regular interradians or interbrachials form part of the vault. First azygous plate hexagonal, a little narrower above than below, and slightly arched toward the vault; it is followed by two smaller plates, and these by others covering a convex elevation higher than the surrounding part of the vault. Column round.

Attention should probably be called to the fact that Wachsmuth & Springer say, in the generic diagnosis of *Dichocrinus*, that "the arm plates from the base up are composed of a double series of pieces;" but in *Dichocrinus cinctus*, described in this paper, the arm plates consist of a single series of small pieces, and in the species here described they consist of a single series of wide cuneiform pieces. Again they say the azygous plate is "quadrangular," but in *Dichocrinus ulrichi* it has two sides below and two above and is hexagonal, and in *Dichocrinus cinctus* there are two sides below and more than two abutting plates above, and hence it is polygonal. Their generic diagnosis will stand reformation.

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

POTERIOCRINUS SUBRAMOSUS, N. SP.

Plate X, fig. 1, azygous side view; where the illustration shows only three plates before there is a bifurcation in an arm, the arms are injured, and probably there should be four plates.

Species robust, calyx obconoidal, expanding gradually from a rather large column, longer than wide, and composed of smooth, rounded plates with well-defined sutures; basals large, standing upright, pentagonal,

higher than wide; subradials as long as wide, the one on the azygous side heptagonal, the others probably hexagonal; first radials wider than high, rounded, pentagonal, articulating surface occupying a little less than the entire width of the plates and concave on the upper side for the reception of the brachials; there are three brachials in the rays on the azygous side, rounded, much wider than long, the third one supporting the free arms upon its upper sloping sides; these arms bifurcate again on the fourth plate (those having only three plates in the illustration are injured and restored, and it is doubtful whether there are three or four plates), and these again on the fourth plate, except one arm on the right, which bifurcates on the sixth plate; all the plates are highly rounded, and the sutures are distinct. The arms bifurcate so frequently in the part of our specimen which is preserved that there are evidently thirty or more arms. The first azygous plate is large, hexagonal, rests upon the upper sloping sides of two subradials and between the right first radial and the second azygous plate: the second azygous plate is hexagonal, and about as large as the first azygous plate, and rests upon a subradial and between the first radial on the left and the first azygous plate; these two azygous plates are followed above by three small ones, and above these the proboscis is unknown; column composed of alternately thicker and thinner plates, which are radiately furrowed upon their articulating surfaces, and show the zigzag lines upon the surface of the column. The other side of this species is unknown.

Found in the Keokuk Group, at Crawfordsville, Ind., and now in the collection of Wm. F. E. Gurley.

SCAPHIOCRINUS GRAPHICUS, N. SP.

Plate X, fig. 4, azygous side view.

Species medium size; calyx bowl-shaped, plates rounded, finely sculptured, sutures distinct; basals extending beyond the column, forming a pentagon one-half wider than the column; subradials longer than wide, expanding and widening a little and constituting nearly the whole body of the calyx; first radials on the azygous side pentagonal, rounded, wider than high, projecting outward toward the upper face, where they are truncated less than the entire width for the reception of the brachials; upper face concave, sutures gaping; first brachial rounded, wider than high, sutures gaping; second brachial longer than wide, rounded constricted, and supporting upon its upper sloping sides the free arms. Arms ten, keeled, finely lined or granulous, plates somewhat constricted, some longer than wide, others wider than long, obliquely truncated at the ends, the upper ends projecting alternately on opposite sides for the support of strong, angular pinnules. Azygous area wide,

elongated; first azygous plate pentagonal, resting between the upper sloping sides of two subradials and between the first radial on the right and the second azygous plate; second azygous plate hexagonal, resting upon a subradial and between the first radial on the left and the first and third azygous plates on the right; the third azygous plate rests upon the first azygous plate and between the first radial on the right and the second and fourth azygous plates on the left; the azygous plates are truncated at the top and become gradually smaller above, eight being shown in the specimen described. Column obscurely pentagonal and composed of thicker and thinner plates. Symmetrical side unknown.

Found in the Keokuk Group, at Crawfordsville, Ind., and now in the collection of Wm. F. E. Gurley.

SCAPHIOCRINUS GRANULIFERUS, N. SP.

Plate X, fig. 3, symmetrical side view.

Calyx shallow, bowl-shaped, about twice as wide as high to the top of the first radials, base concave, plates convex, sutures depressed, surface granulous; basals small contained within the concave base; subradials as wide or wider than high, highly convex or protuberant and deeply depressed at the sutures, they rise nearly vertically; first radials wider than high, pentagonal, projecting outward at the upper margin, rounded, depressed toward the sutures, truncated the entire width above, and separated on the outside from the brachials by wide, gaping sutures; brachials constricted in the middle, longer than wide, with steep upper sloping sides for the articulation of the arms above. Arms ten, no bifurcations, plates long, some of them more than twice as long as wide, rounded and angulated on the outside, constricted in the middle, obliquely truncated at the ends, with the upper ends projecting alternately on opposite sides for the support of pinnules, composed of very long joints; sutures in the arms gaping; azygous side unknown. Column round, composed of alternately thicker and thinner plates, some of which bear short, round cirrhi.

It is found in the Keokuk Group, at Crawfordsville, Ind., and is now in the collection of Wm. F. E. Gurley.

SCAPHIOCRINUS DISPARILIS, N. SP.

Plate IX, fig. 1, a small specimen; Plate X, fig. 2, a large specimen.

Species medium size, plates smooth or finely granulous, sutures distinct; calyx bowl-shaped, as wide or wider than high; basals extending beyond the column, forming a pentagon nearly twice its diameter; subradials a little larger than the basals, hexagonal, about as wide as high; first radials rounded, heptagonal, nearly one-half wider than high and

truncated the entire width above for the support of the brachials, sutures gaping; brachials longer than wide, rounded and constricted in the middle, and supporting upon the upper sloping sides the free arms. Arms ten, plates long, rounded and smooth on the outside; first plate very long; above this they gradually shorten and become cuneiform, and support alternately on opposite sides rather coarse, strong pinnules. The other side unknown. Column round and composed of alternately thicker and thinner plates which are radiately furrowed upon their articulating surfaces.

Found in the Keokuk Group, at Crawfordsville, Ind., and now in the collection of Wm. F. E. Gurley.

BARYCRINUS PRINCEPS, N. SP.

Plate IX, fig. 2, azygous side; fig. 3, opposite side view.

Species very robust, plates smooth, calyx depressed between the radials, sutures distinct, angles of the plates sunken as is usual in this genus; basals moderate size, forming a pentagonal disc half hidden by the column, the portion of each plate exposed, when the column is attached, being but little more than a triangular piece which extends up between the under sloping sides of the subradials; subradials about as wide as high, much larger than the basals, four of them hexagonal and one on the azygous side heptagonal; first radials twice as wide as high, rounded, pentagonal, truncated nearly the entire width above, so as to present a broad, concave or almost half circular outward sloping facet, for the reception of the brachial pieces; the brachials are wide, rounded and thin; there are two in each ray on the azygous side and in the ray opposite thereto, and six in each of the lateral rays; the lateral rays bifurcate on the sixth plate, from the first radial, and the ray opposite the azygous side bifurcates on the second plate above the first radial, and no other bifurcation takes place in these three rays, but it is quite different with the rays on the azygous side. The ray on the right of the azygous side first bifurcates on the second plate from the first radial, and the left arm does not again divide, but the right one bifurcates again on the fourth plate, while the ray on the left of the azygous side first bifurcates on the second plate from the first radial and the right arm does not again divide, but the left one bifurcates again on the fourth plate; when the bifurcation takes place in any of the rays the arms are of equal size, but above these bifurcations moderately strong branches or armlets are given off at intervals of about four plates along their sides, bearing some resemblance to those on *Onychocrinus*. There are therefore twelve arms, no pinnules. The first azygous plate is quadrangular and rests between the upper sides of two subradials and the under side of the right first radial; the second plate

rests between the first radials and truncates a subradial and the first azygous plate. Above this the azygous plates and vault are unknown. It is not without some hesitation that this species is referred to *Barycrinus*.

Found in the Keokuk Group, at Crawfordsville, Ind., and now in the collection Wm. F. E. Gurley.

ÆSIOCRINUS BASILICUS, N. SP.

Plate IX, fig. 4, symmetrical view; fig. 5, azygous side view, with part of proboscis; fig. 6, basal view.

Calyx half globular or, depressed, bowl-shaped, plates slightly convex, sutures distinct but not beveled except between the radials and brachials and at the axillaries; surface of all the plates of calyx and arms granulous. Basals forming a pentagonal, flattened disc having an outline a little more than twice the diameter of the column. Subradials large, four hexagonal, one heptagonal, curving upward from the basals more than half the height of the calyx, making the upper sloping sides much the longer. First radials pentagonal, twice as wide as high, the under sloping sides about twice as long as the lateral faces, and the upper truncated sides extending to the greatest width of the plates, with a beveled or slightly gaping suture. First brachials short, more than three times as wide as long. Second brachials more than three times as wide as high, with long upper sloping sides for the articulation of the free arms.

The right arms in two of the radial series opposite the azygous side bifurcate on the second plate, the other arms are not preserved in our specimen. There is a small interaxillary plate in one of these arms and a peculiar slit in another arm above the angle of the axillary plate, both of which may be abnormal freaks or the result of some injury. The arm plates preserved in our specimen are not cuneiform, though they may become so nearer the end of the rays.

The proboscis in this species seems to be exactly like the proboscis in *Æsiocrinus magnificus*. The column is small, pentagonal, the plates articulated on a row of denticulations near the margin, and it is probable that otherwise it agrees with the column in the type species.

It is readily distinguished from the other known species by the lower calyx and increased number of arms.

Found in the Upper Coal Measures at Kansas City, Missouri, and now in the collection of Wm. F. E. Gurley.

DELOCRINUS HEMISPHERICUS, SHUMARD.

Plate X, fig. 5, view of head with nearly complete arms.

We have illustrated this specimen to show the arms and spines, because heretofore this part of the species has not been figured. It is from Kansas City, and is in the collection of Wm. F. E. Gurley.

ULOCRINUS, SP.

Plate X, fig. 9, shows the circular cavity on the lower side of the anchylosed basals for the insertion and attachment of the end of the column; figs. 10 and 11 show the pentagonal opening through the anchylosed plates and radiating muscular impressions. Fig. 11 is magnified $6\frac{1}{2}$ diameters; fig. 12 shows the convexity on the inner side of the basal plates; figs. 12 and 13 show the peculiar denticulations upon the edges of the plates. Fig. 13 is a magnified view, $6\frac{1}{2}$ diameters.

The plates here described and illustrated belong to an undefined species of Ulocrinus, which we have not seen fit to name for want of more perfect specimens. Part of the characters represented by the illustrations we believe to be not only of generic but of family importance, and also to throw some light upon the structure of palæozoic crinoids at a point which has been substantially overlooked. It will be observed that the plates are of the same size and are anchylosed, which we believe to be the case in all species of this genus.

The external side of the basal plates of this species is almost flat, while the internal side has a convexity greater than the thickness of the plates. The base of the crinoid is thus strengthened by the thickening of the plates around the part to which the column attached and by the anchylosis of the basal plates. There is an external circular depression into which the end of the column was inserted, and this depression is surrounded by a rim to afford further strength to the point of union between the column and the body of the crinoid. At least three plates of the column were inserted in this circular depression, one of which had an extended rim beyond the column that filled a circular furrow on the interior of this depression which locked the column in the basal plates. The first plate of the column at the base of this circular depression is thin and radiately ridged to interlock with the second plate.

The rays of the opening on the internal side of these plates are flanged so as to enlarge the end of the columnar canal, as it passes through the basal plates, or to put a head on it, as it were; this enlargement is also surrounded by a rim for some kind of muscular attachment and to give strength to this part of the body. On the outside of this rim there are radiating, ligamental furrows or vascular markings for the attachment of the animal sarcode, while all other parts of the interior of the calyx are smooth and free from any such scars.

The plates of the calyx of *Ulocrinus* are large and thin compared with those of *Eupachyrinus* and without any such beveled external sutures which may have been filled with tissues to strengthen the body as exists in the latter genus. But we find peculiar denticulations upon the edges of all the plates of the calyx, which must have served to hold the plates in their places and give strength to the body. These are shown by fig. 13, magnified $6\frac{1}{2}$ diameters.

EUPACHYCRINUS MAGISTER, MILLER AND GURLEY.

Plate X, fig. 7, basal plates as seen from below; fig. 6, as seen in the interior of the calyx, and fig. 8, side view showing interior conical form of basals.

It will be observed that the plates are of about the same size, and form a conical elevation in the interior of the calyx, pierced at the summit by a pentagonal opening for the columnal canal, with the rounded angles truncating the ends of the plates. The plates are anchylosed. The pentagonal opening is surrounded with ligamental scars or radiating ligamental lines, while the other parts of the internal sides of the plates are smooth. The internal sides of subradials and radials are smooth, and show no indications of muscular scars. We believe the basal plates of mature specimens of this genus are always anchylosed, which gave greater strength to this part of the body than it would have had without the anchylosis. The last plates of the column, in all our specimens, are connected with the basals, showing that they were firmly attached during the life of the animal. The only ligamental attachment of the animal to the test of the calyx was probably this one to the basal plates immediately surrounding the entrance from the columnar canal. The other plates of the calyx surrounded the sarcode and kept it in place.

SCHOENASTER LEGRANDENSIS, N. SP.

Plate IX, fig. 7, ventral view; fig. 8, dorsal view; fig. 9, part of ventral side magnified $6\frac{1}{2}$ diameters.

Body thin, regularly pentagonal, sides concave, with long, narrow, gradually tapering convex arms. Plates on the dorsal side of the disc in our specimen apparently anchylosed, and spines, if any belonged to the margin, broken away. Ventral side depressed and flat between the arm furrows, where it consists of very small plates, and if they imbricate inward the overlap must be very slight. Ambulacral furrows wide, deep; two rows of subquadrangular, ambulacral plates form the bottom of each furrow, on each side of which there is a row of oblong ambulacral plates, having an obliquely inward imbricating arrangement, presenting somewhat the appearance of a twisted cord; these are continued to the ends of the arms with the same obliquely inward, imbricating arrangement. Five pairs of oral plates.

This species is small in comparison with the two heretofore described, has sides less convex, and narrower arms.

Found in the Waverly or Kinderhook Group, at Le Grand, Iowa, and now in the collection of Wm. F. E. Gurley.

AGANASTER, N. GEN.

Ety.: agan, very much; aster, star.

Plate IX, fig. 10, dorsal view of Aganaster gregarius, with points of rays broken off; fig. 11, dorsal side of arm magnified.

In 1869 Meek and Worthen described an Ophiuroidea, in the Proceedings of the Academy of Science of Philadelphia, p. 169, under the name of *Protaster gregarius*, which they redefined and illustrated in the Geological Survey of Illinois, vol. V, p. 509, under the name of *Protaster* (?) *gregarius*. They had numerous specimens "in the condition of casts and molds, in a very fine, somewhat granular matrix, that did not show the details of its structure very clearly," but they said, "It will probably be found to be generically distinct from the Silurian typical forms of *Protaster*, but we prefer to place it provisionally in that genus for the present." In the collection of Mr. Gurley there are several specimens belonging to this species, and they show a few characters not observed by Meek and Worthen, and demonstrate very clearly this species does not belong to the genus *Protaster*; we therefore propose to include this species in a new genus, *Aganaster*, and describe the characters, so far as known, as follows:

General outline, a central circular disc with five long, narrow rays; the circular disc on the dorsal side is covered with small polygonal plates which are not interrupted by the presence of the rays, thus showing the disc had a depth greater than the depth of the rays; rays very narrow and convex or half cylindrical, spine-bearing, gradually tapering and from the dorsal side appear as if composed of plates arranged exactly opposite each other; the ventral side shows a rather deep central disc with marginal plates. There are ten oral plates in the central part of the disc. Type, *A. gregarius*.

AGANASTER (?), SP.

Plate IX., fig. 12, ventral side; fig. 13, part of same magnified.

We have figured this fragment to show the ankylosis of the oral plates, and the pores passing through the ambulacral plates, and also those passing between them. It will be observed that one pore passes through each plate near the marginal end, while a double row of pores passes between the plates in the central part of the arm furrow. We believe this is an *Aganaster*, from the depth of the central part of the disc, and the arrangement of the plates in the arm furrows; but the specimen is larger than any *Aganaster gregarius* we have seen and the rays are wider, and as we do not know the position of the pores in the rays of *Aganaster*, it may be our specimen does not belong to this genus.

TROOSTOCRINUS NITIDULUS, N. SP.

Plate IX., fig. 14, a small specimen; fig. 15, a large specimen with lower end broken off,
Plate X., fig. 14, summit view.

Calyx very slender, subfusiform, five-sided, pyramidal above, very slightly tapering, sides flat, triangular below, very small and triangular at the base with a central circular depression, surface apparently smooth.

Basals forming a triangular cup, one angle of which is on the right of the anal side; the cup is a little more than one-fourth the length of the calyx, notched at the top for the abutting radials. Radials more than two-thirds the length of the calyx, not as sloping as the basals, increase in thickness from below upward, forks a little more than one-third the length and end in sharp points at the extreme upper part of the calyx, with sides standing at right angles above the ambulacra. Oral or deltoïd plates not visible in our specimen. Each radial sinus is deep and extends downward less than half the length of the radials, and contains between thirty and forty pore pieces or side plates in a double alternating row. Summit, narrow; mouth central, circular; spiracles or ovarian openings small; anal aperture large, elongated, and truncates two radial limbs.

Found in the St. Louis Group, at Lanesville, Indiana, and is now in the collection of Wm. F. E. Gurley.

ARCHÆOCIDARIS LEGRANDENSIS, N. SP.

Plate X, fig. 15, natural size.

This species is founded upon the fragment of a body, and our justification for naming and describing it is to be found in the fact that it is the oldest Archæocidaris known in America, and carries this genus back to the lowest Subcarboniferous deposits, whereas, heretofore, it has not been known below the Burlington Group. The fragment has all the characters of the genus so far as the interambulacral plates can show them.

Body evidently small, interambulacral plates small, hexagonal as far as observed; central tubercle occupying about half the diameter of a plate, projecting up twice as high as the ridge at the margin of the plate and perforated in the centre; annular ring at the base obscure, but having a concave depression around it and a distinct elevation toward the margin; marginal nodes obscure, spine very long, round, smooth, contracted a little near the lower end, and slightly swelling just above the contraction, and then very gradually tapering to the end; an expanded base or thickened annulation marks the point of attachment. Ambulacra unknown.

Found in the Kinderhook or Waverly Group, at LeGrand, Iowa, and now in the collection of Wm. F. E. Gurley.

EXPLANATION OF PLATES.

PLATE 1.

EUPACHYCRINUS MAGISTER, N. SP.

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Fig. 1. Basal view.

Fig. 2. Azygous side view.

EUPACHYCRINUS SPHÆRALIS, N. SP.

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Fig. 3. Basal view.

Fig. 4. Azygous side view.

ULOCINUS BUTTSI, N. SP.

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Fig. 5. Azygous side view.

Fig. 6. Basal view.

ULOCINUS KANSASSENSIS, N. SP.

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Fig. 7. Azygous side view.

Fig. 8. Outline view regular side.

Fig. 9. Top view of calyx to show the prolongation of the first radials and contracted opening of the calyx.

Fig. 10. Basal view.

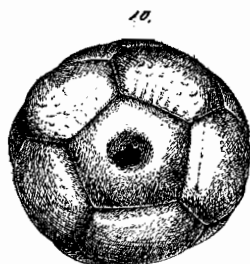
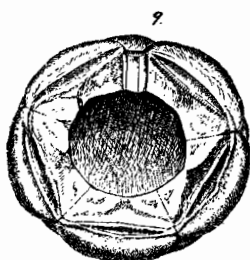
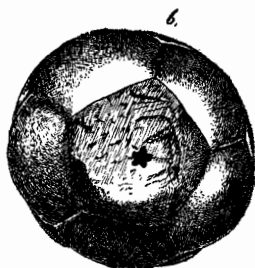
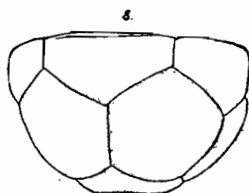
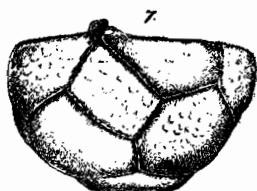
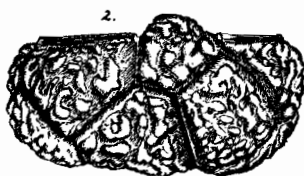
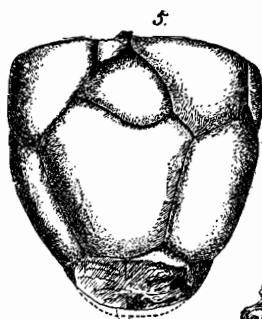
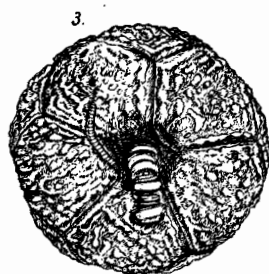
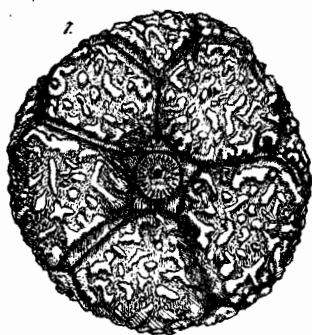


PLATE 2.

ÆSIOCRINUS MAGNIFICUS, N. SP.

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- Fig. 1. Natural size of a specimen as it lies on a slab.
- Fig. 2. A free proboscis nearly entire and only slightly twisted.
- Fig. 3. Portion of same magnified two and one-half diameters to show more distinctly the respiratory openings.
- Fig. 4. An abnormal branching proboscis.
- Fig. 5. Sectional end view of proboscis.

HYDREIONOCRINUS PENTAGONUS, N. SP.

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- Fig. 6. View of azygous side showing height of calyx and upper truncated face for second radials.
- Fig. 7. Basal view.

DELOCRINUS HEMISPHERICUS, *Shumard*.

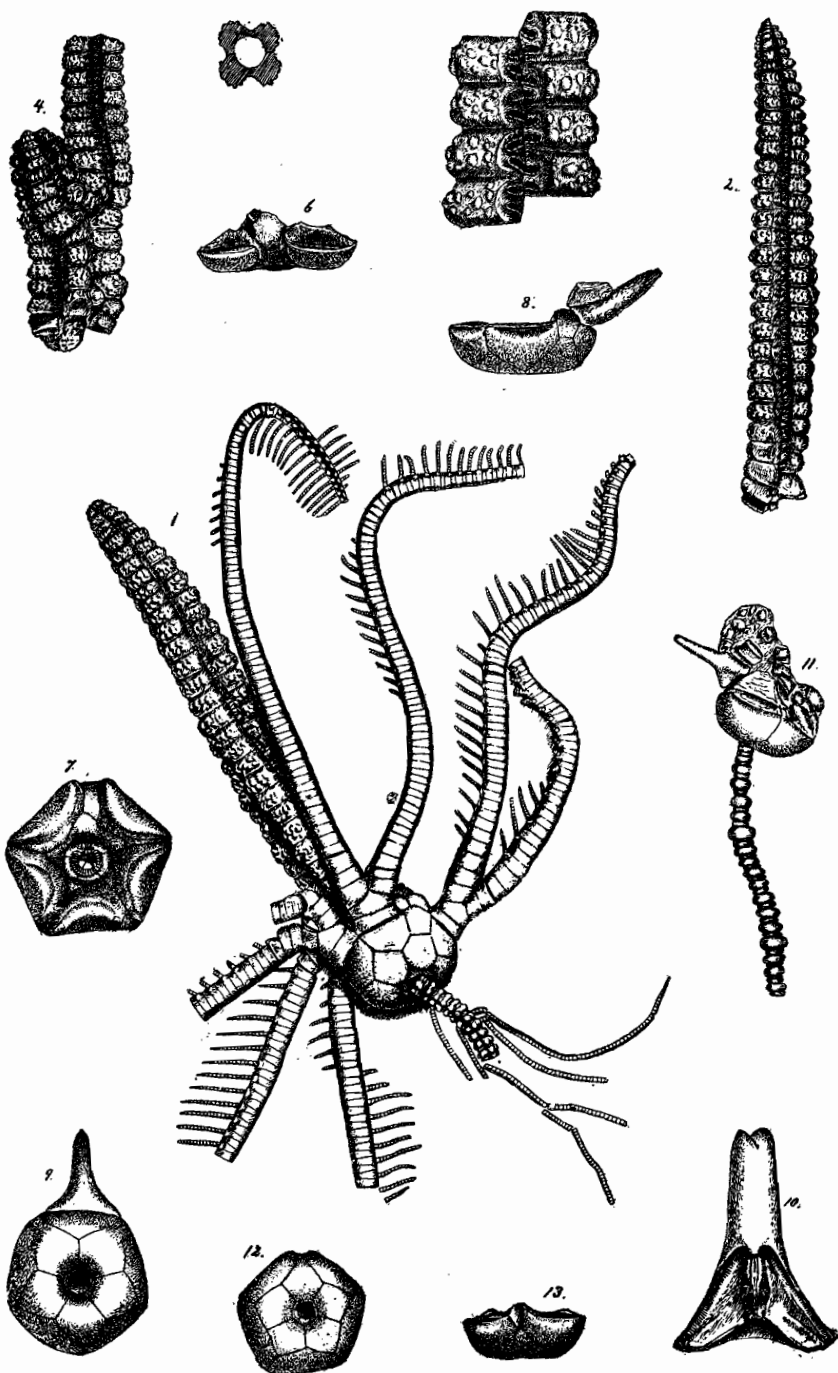
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- Fig. 8. Side view showing azygous plate and first brachial, with spine.
- Fig. 9. Basal view of same.
- Fig. 10. Inner side of brachial spine magnified two diameters.

DELOCRINUS MISSOURIENSIS, N. SP.

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- Fig. 11. Side view showing column.
- Fig. 12. Basal view.
- Fig. 13. Azygous side view.



EXPLANATION OF PLATES.

PLATE 3.

ÆSIOCRINUS HARRI, N. SP.

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Fig. 1. Natural size as it lies upon a slab.

ONYCHOCRINUS ULRICHI, N. SP.

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Fig. 2. Azygous side.

Fig. 3. Symmetrical side, natural size.

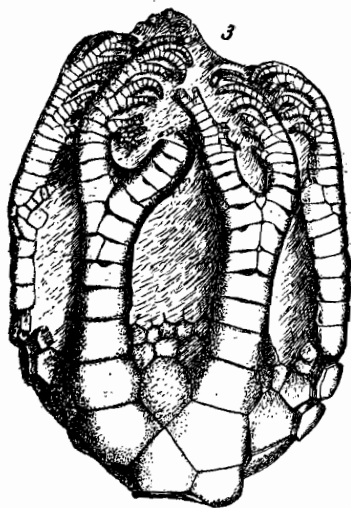
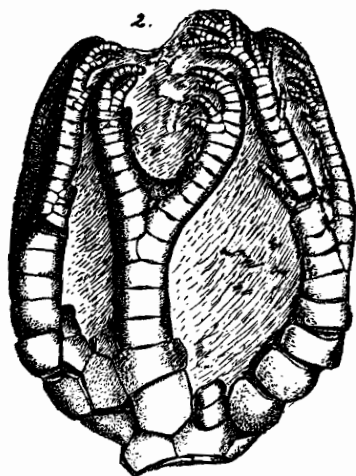
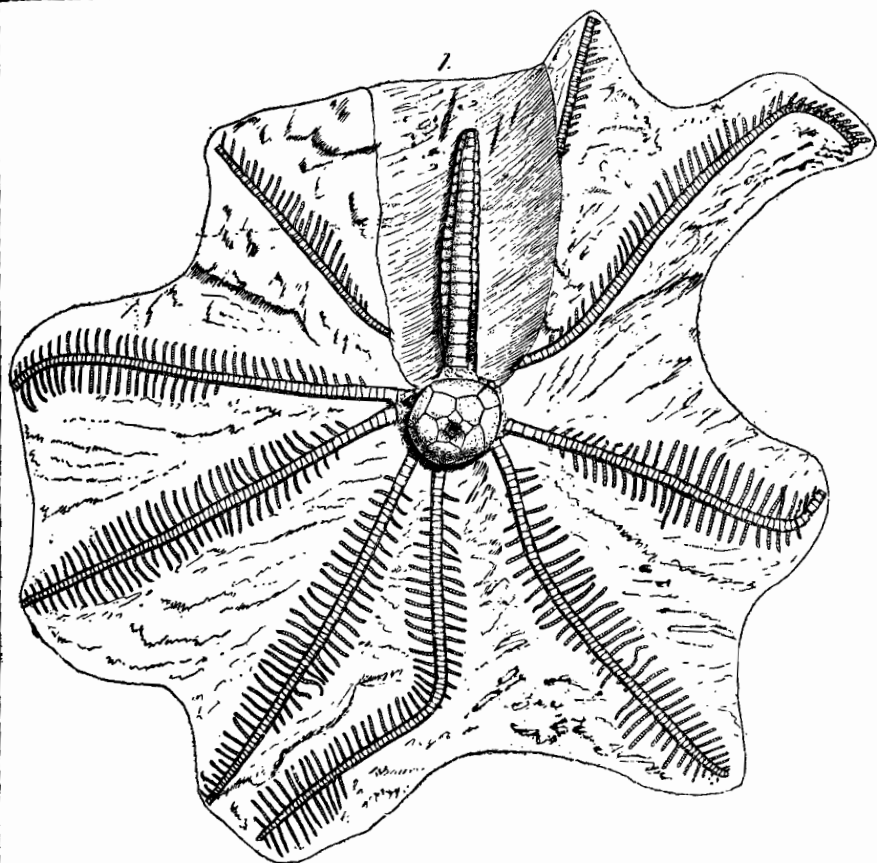


PLATE 4.

AGARICOCRINUS SPLENDENS, N. SP.

Page 340.

- Fig. 1. Side view, with arms.
Fig. 2. Basal view of same.

BATOCRINUS MARINUS, N. SP.

Page 340.

- Fig. 3. Side and basal view.
Fig. 4. Outline view of plates on azygous side.

BATOCRINUS JUCUNDUS, N. SP.

Page 341.

- Fig. 5. Azygous side, with arms.
Fig. 6. Symmetrical view, with arms removed, showing proboscis.

POTERIOCRINUS GRANILINEUS, N. SP.

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- Fig. 7. Natural size.

POTERIOCRINUS CRAWFORDSVILLENSIS, N. SP.

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- Fig. 8. Natural size.

POTERIOCRINUS VERUS, N. SP.

Page 344.

- Fig. 9. Natural size.

DICHOCCRINUS CINCTUS, N. SP.

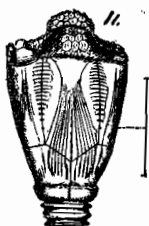
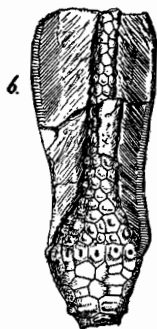
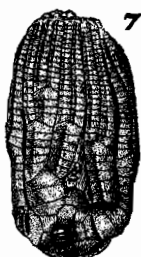
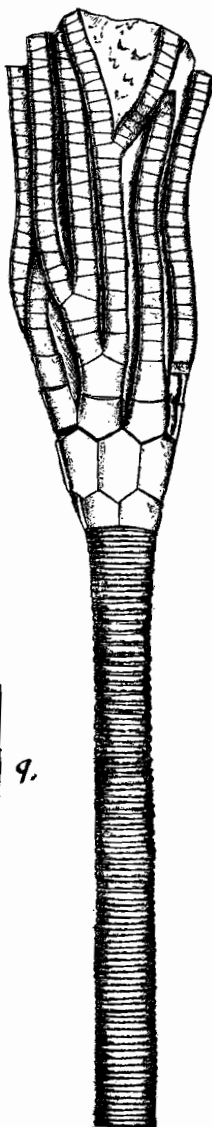
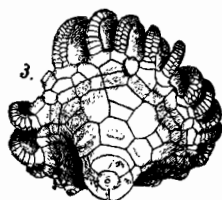
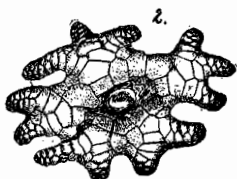
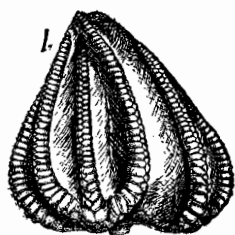
Page 342.

- Fig. 10. Symmetrical side view.
Fig. 11. Azygous side, showing vault and valvular opening.
Fig. 12. Summit view.

SCAPHIOCRINUS MANUS, N. SP.

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- Fig. 13. Azygous side, natural size.



EXPLANATION OF PLATES.

PLATE 5.

ACTINOCRINUS GRANDIS, N. SP.

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Fig. 1. Symmetrical side, reduced a little below natural size.

ABROTOCRINUS CYMOSUS, N. SP.

Page 350.

Fig. 2. Azygous side view, natural size.

TAXOCRINUS SUBOVATUS, N. SP.

Page 347.

Fig. 3. Azygous side view, natural size.

POTERIOCRINUS ARCANUS, N. SP.

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Fig. 4. Symmetrical view.

CYATHOCRINUS OPIMUS, N. SP.

Page 348.

Fig. 5. Symmetrical side, natural size.

SCAPHIOCRINUS BONOENSIS, N. SP.

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Fig. 6. Symmetrical side.

Fig. 7. Azygous side.

FORBESOCRINUS SPECIOSUS, N. SP.

Page 347.

Fig. 8. Symmetrical side view.

Fig. 9. Basal view.

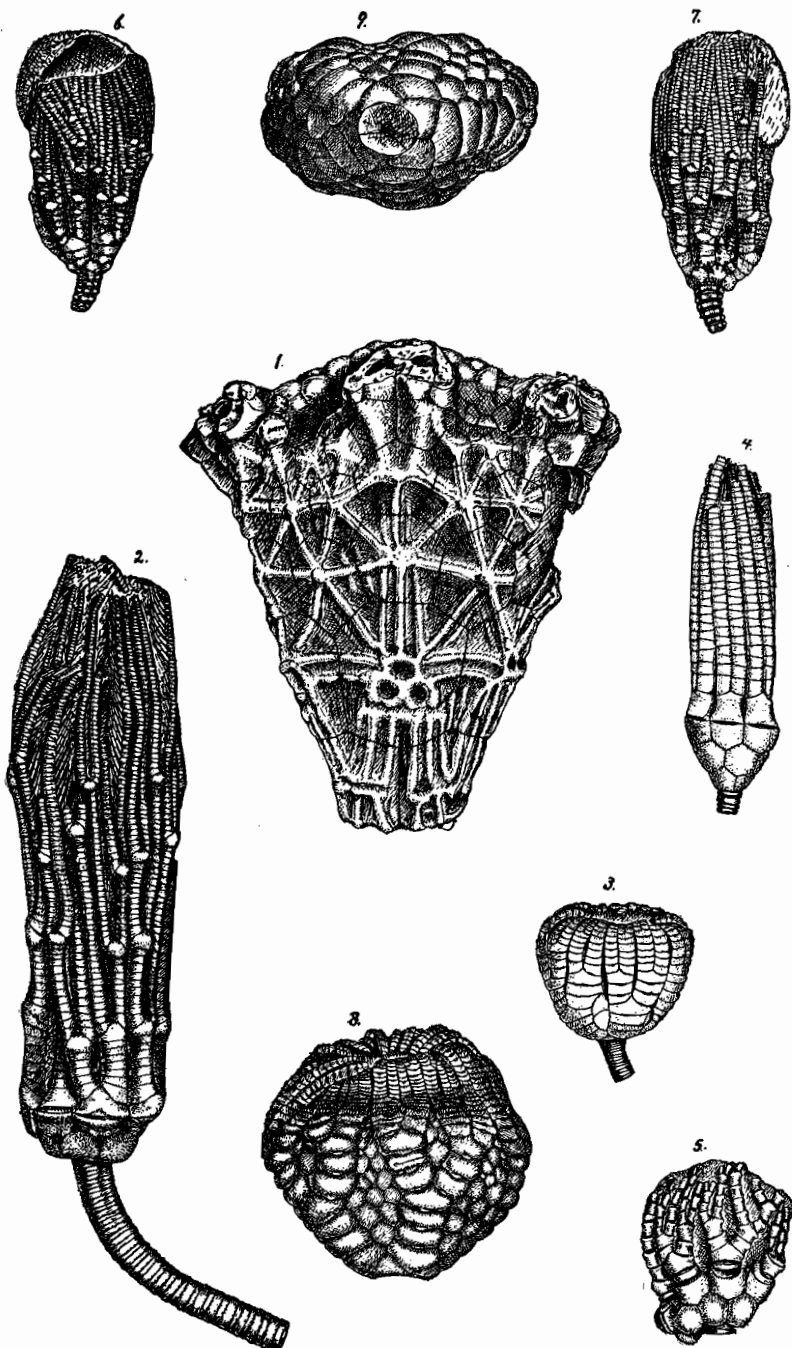


PLATE 6.

ACTINOCRINUS GRANDIS, N. SP.

Page 346.

- Fig. 1. Azygous size reduced a little below natural size.

GONIOCRINUS SCULPTILIS, N. SP.

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- Fig. 2. Symmetrical side, natural size.
Fig. 3. Same, magnified more than two diameters.
Fig. 4. Left side of another specimen magnified a little more than two diameters.
Fig. 5. Azygous side of same.

BATOCRINUS POCULUM, N. SP.

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- Fig. 6. Symmetrical side showing part of the arms.
Fig. 7. Azygous side view, showing the broken end of the proboscis. Two broken arms are crowded out of place to the right.

BATOCRINUS FACETUS, N. SP.

Page 353.

- Fig. 8. View of the right side of a specimen, showing there are only three arms in the first radial series on the right of the azygous side.

BATOCRINUS CANTONENSIS, N. SP.

Page 354.

- Fig. 9. Azygous side, showing proboscis.

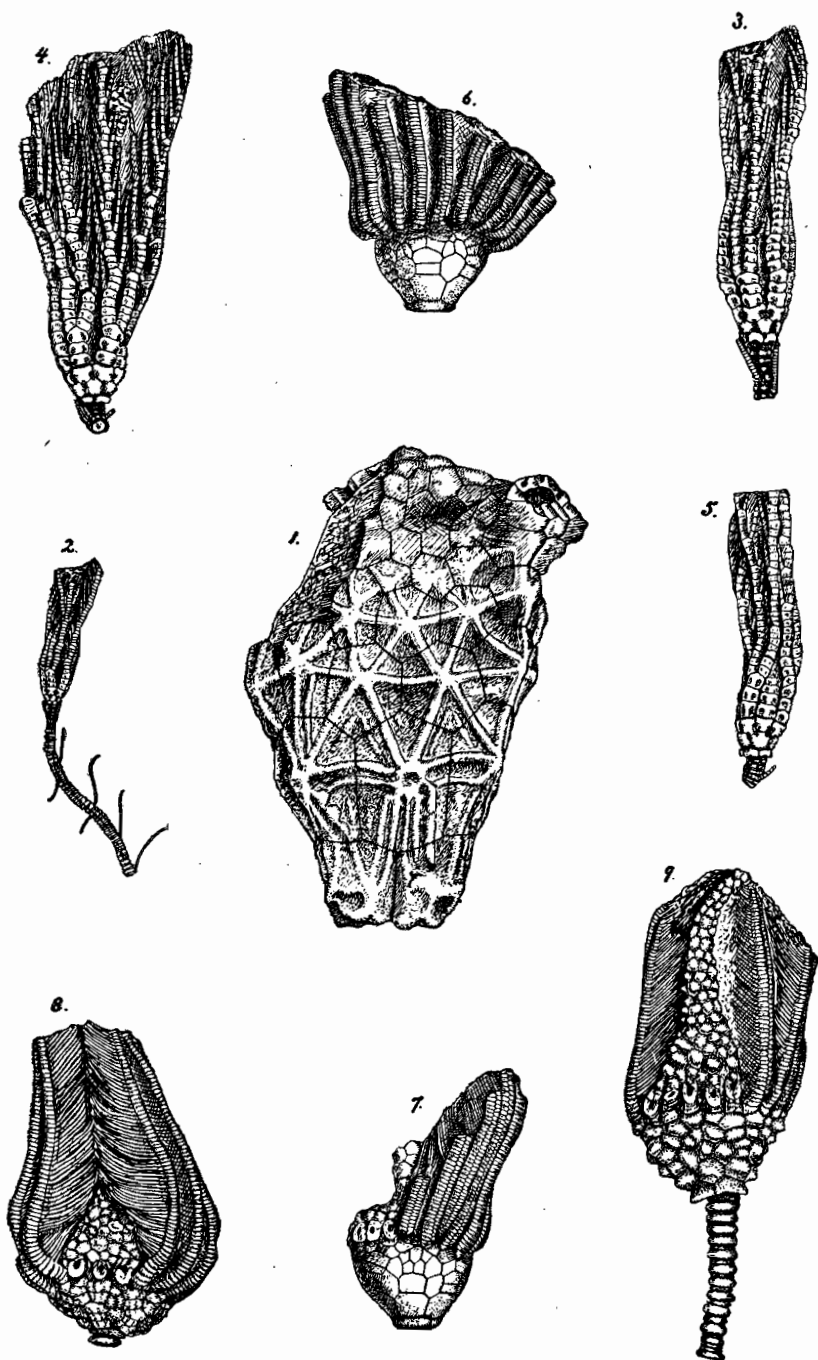


PLATE 7.

POTERIOCRINUS SPARTARIUS, N. SP.

Page 355.

- Fig. 1. View of the right side, showing part of the azygous area and part of the column.

POTERIOCRINUS SCOPÆ, N. SP.

Page 356.

- Fig. 2. Azygous side.

POTERIOCRINUS GENISTA, N. SP.

Page 357.

- Fig. 3. Azygous side.

POTERIOCRINUS LEGRANDENSIS, N. SP.

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- Fig. 4. Symmetrical side, natural size.

- Fig. 5. Symmetrical side, magnified.

- Fig. 6. Azygous side, magnified.

ZEACRINUS DUBIUS, N. SP.

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- Fig. 7. Symmetrical side.

- Fig. 8. Azygous side.

ONYCHOCRINUS CANTONENSIS, N. SP.

Page 359.

- Fig. 9. Azygous side, natural size.

RHODOCRINUS CÆLATUS, N. SP.

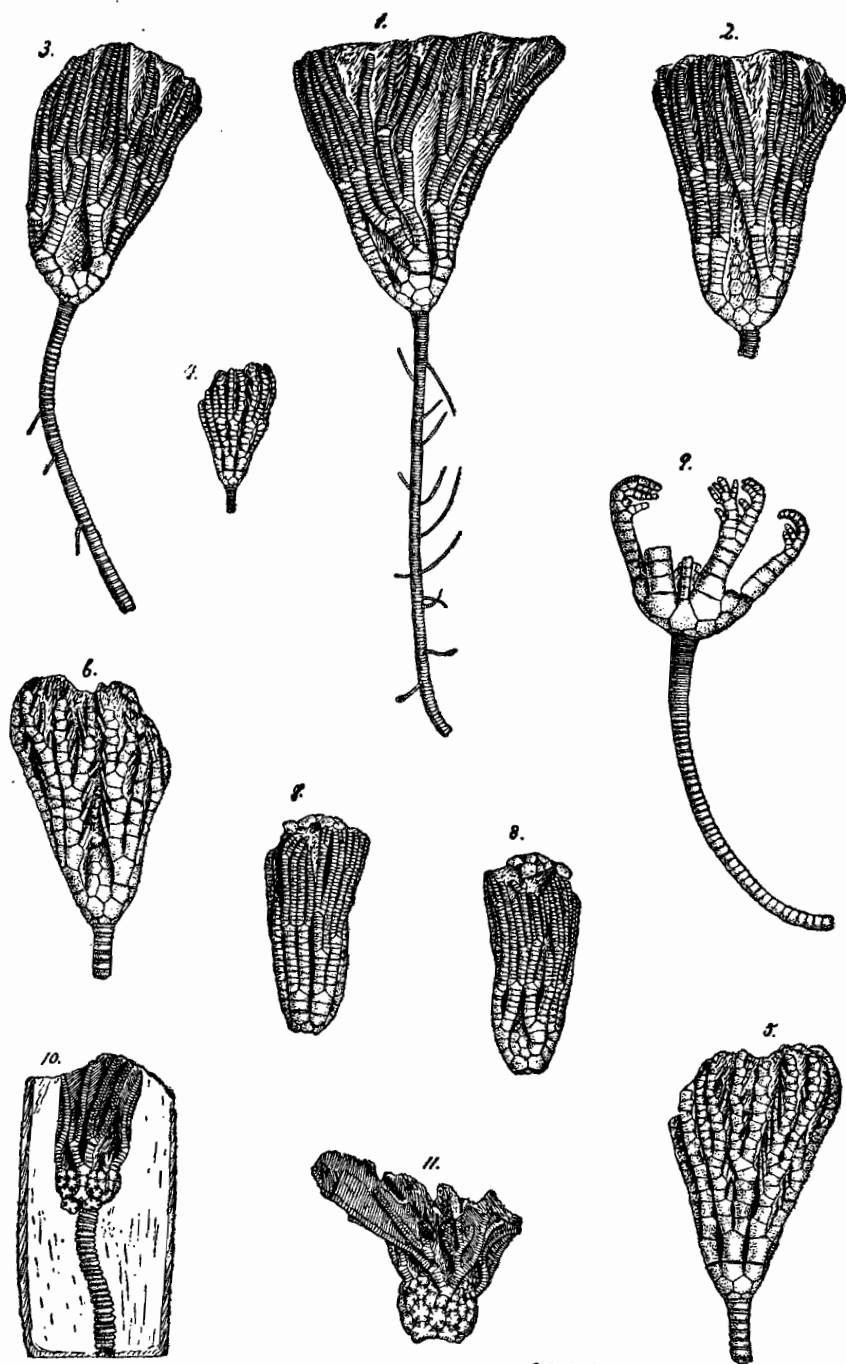
Page 360.

- Fig. 10. View of azygous area, right radial series and an interradiar area.

RHODOCRINUS SCULPTUS, N. SP.

Page 359.

- Fig. 11. View of the azygous area, right radial series and one interradiar area.



EXPLANATION OF PLATES.

PLATE 8.

SCAPHIOCRINUS REPERTUS, N. SP.

Page 362.

Fig. 1. Symmetrical side.

Fig. 2. Azygous side.

POTERIOCRINUS CANTONENSIS, N. SP.

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Fig. 3. Symmetrical side.

Fig. 4. Azygous side, but the figure is slightly incorrect, as the first plate rests between the upper sloping sides of the subradials, and the artist mistook a blemish for the suture.

SCAPHIOCRINUS BELLUS, N. SP.

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Fig. 5. Azygous side.

Fig. 6. Symmetrical side.

Fig. 7. Basal view.

SCAPHIOCRINUS LACUNOSUS, N. SP.

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Fig. 8. Symmetrical side.

Fig. 9. Azygous side.

Fig. 10. Basal view.

SCAPHIOCRINUS PRÆMORSUS, N. SP.

Page 364.

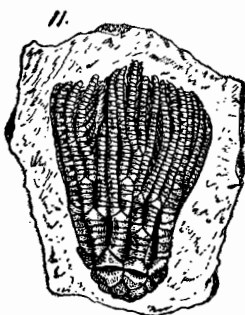
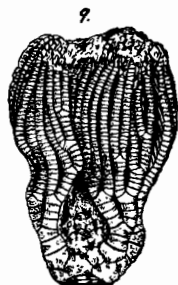
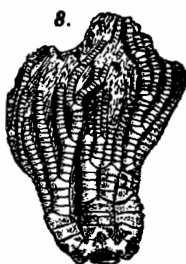
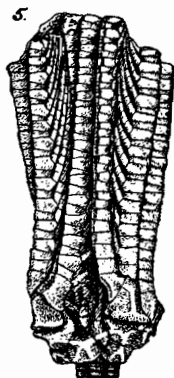
Fig. 11. Symmetrical side view.

DICHOCCRINUS ULRICHI, N. SP.

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Fig. 12. Side view.

Fig. 13. Azygous side.



EXPLANATION OF PLATES.

PLATE 9.

SCAPHIOCRINUS DISPARILIS, N. SP.

Page 367.

Fig. 1. A small specimen.

BARYCRINUS PRINCEPS, N. SP.

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Fig. 2. Azygous side.

Fig. 3. Opposite side view.

ÆSIOCRINUS BASILICUS, N. SP.

Page 369.

Fig. 4. Symmetrical view.

Fig. 5. Azygous side view, with part of proboscis.

Fig. 6. Basal view.

SCHOENASTER LEGRANDENSIS, N. SP.

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Fig. 7. Ventral view.

Fig. 8. Dorsal view.

Fig. 9. Part of ventral side magnified $6\frac{1}{2}$ diameters.

AGANASTER, N. GEN.

Page 372.

Fig. 10. Dorsal view of Aganaster gregarius, with points of rays broken off.

Fig. 11. Dorsal side of arm magnified.

AGANASTER (?) SP.

Page 372.

Fig. 12. Ventral side.

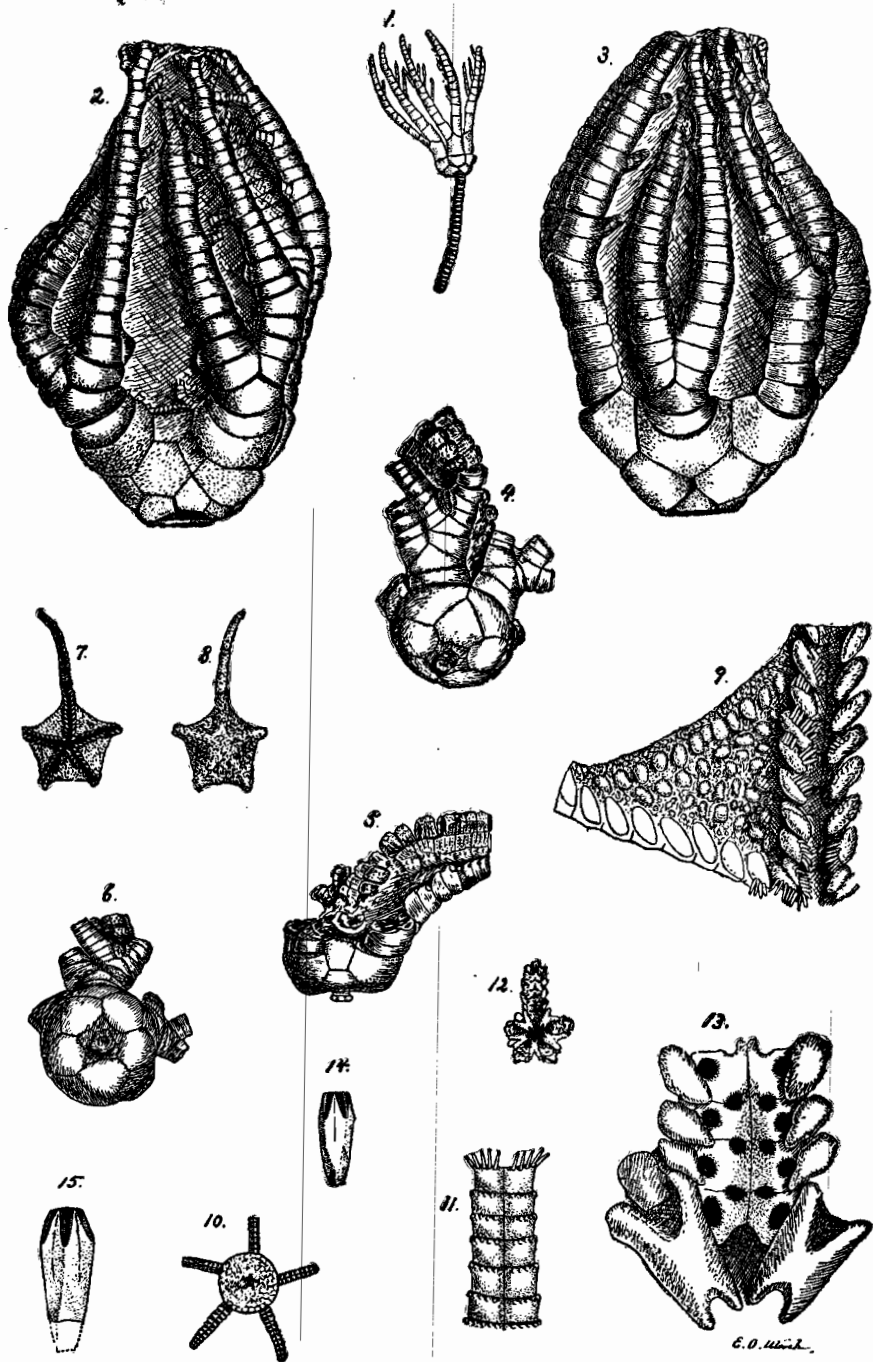
Fig. 13. Part of the same magnified.

TROOSTOCRINUS NITIDULUS, N. SP.

Page 373.

Fig. 14. Is a small specimen.

Fig. 15. A large specimen with lower end broken off.



EXPLANATION OF PLATES.

PLATE 10.

POTERIOCRINUS SUBRAMOSUS, N. SP.

Page 365.

- Fig. 1. Azygous side view. Where the illustration shows only three plates before there is a bifurcation in an arm; the arms are injured, and probably there should be four plates.

SCAPHIOCRINUS DISPARILIS, N. SP.

Page 367.

- Fig. 2. A large specimen.

SCAPHIOCRINUS GRANULIFERUS, N. SP.

Page 367.

- Fig. 3. Symmetrical side view.

SCAPHIOCRINUS GRAPHICUS, N. SP.

Page 366.

- Fig. 4. Azygous side view.

DELOCRINUS HEMISPHERICUS, *Shumard*.

Page 370.

- Fig. 5. View of head with nearly complete arms.

EUPACHYCRINUS MAGISTER, *Miller and Gurley*.

Page 371.

- Fig. 7. Basal plates as seen from below.

- Fig. 6. As seen in the interior of the calyx.

- Fig. 8. Side view showing interior conical form of basals.

ULOCINUS, SP.

Page 370.

- Fig. 9. Shows the circular cavity on the lower side of the anchylosed basals for the insertion and attachment of the end of the column.

- Figs. 10 and 11 show the pentagonal opening through the anchylosed plates and radiating muscular impressions.

- Fig. 11. Is magnified $6\frac{1}{2}$ diameters.

- Fig. 12. Shows the convexity on the inner side of the basal plates.

- Figs. 12 and 13 show the peculiar denticulations upon the edges of the plates.

- Fig. 13. Is a magnified view, $6\frac{1}{2}$ diameters.

TROOSTOCRINUS NITIDULUS, N. SP.

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- Fig. 14. Summit view.

ARCHÆOCIDARIS LEGRANDENSIS, N. SP.

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- Fig. 15. Natural size.

