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## CRINOIDS FROM THE SILICA SHALE, DEVONIAN, OF OHIO

GRACE A. STEWART,  
Department of Geology,  
Ohio State University

Recently the writer has had the privilege of examining some crinoids from the private collection of V. E. Ladd of Toledo, Ohio. The specimens were all collected from the Silica shale in the Kelley's Island Lime and Cement Company quarry at Silica, Lucas County, Ohio. They represent two new species, and a young specimen of *Arthracantha carpenteri* (Hinde) which has the arms exceptionally well preserved.

One of the new species, *Gilbertsocrinus ohioensis* n. sp., belongs in a genus heretofore unrecognized in the Devonian strata of Ohio. Thus far eight species of this interesting genus have been collected in rocks of Hamilton age. The species and their occurrences are as follows: *G. greenei* Miller and Gurley and *G. indianensis* Miller and Gurley from Clark County, Indiana; *G. spinigerus* (Hall) from the Moscow (Ludlowville) of western New York; *G. alpenensis* Ehlers from the Hamilton near Alpena, Michigan, and the Ludlowville of western New York; *G. intersculptus* Goldring from the Skaneateles formation, Unadilla valley, New York; *G. rarispinus* Goldring from the Moscow formation, Georgetown, New York; *G. spinonodosus* Goldring, Tichenor formation (Ludlowville), Eighteen Mile Creek, New York; and *G. multicalcaratus* Goldring from the Kashong beds of the Moscow formation, East Bethany, New York. Goldring has shown that *G. indianensis* is synonymous with *G. spinigerus*.

This very interesting series of species, although closely related, show distinct and progressive changes in ornamentation and in the development and distribution of spines. The Ohio species is characterized particularly by the development of strong nodes on only the radial plates.

The second new form, *Euryocrinus? laddii* n. sp., has been placed only tentatively in the genus *Euryocrinus*. It doubtless represents an undescribed genus of the Ichthyocrinidae but the incompleteness of the specimen, particularly in the interradial areas, makes it unwise to erect a new genus until additional and better material can be found.

Dr. Winifred Goldring, of the New York State Museum, was kind enough to examine the crinoid specimens discussed in this paper. The writer wishes to acknowledge her helpful suggestions with deep appreciation.

### Order *Camerata* Wachsmuth and Springer

Family *Rhodocrinidae* Roemer

*Gilbertsocrinus ohioensis* n. sp.

(Plate I, figs. 1-4)

*Description.*—This species is represented by two imperfectly preserved specimens, the combined characters of which are sufficient to demonstrate its distinctiveness from any previously described species of the genus.

The measurements of the two dorsal cups which have somewhat different proportions are: height to arm bases 10 mm., greatest width about 14 mm. at the arm bases; height to arm bases 8 mm., greatest width 8 mm. at the first primibrachs. Cup somewhat cylindrical in outline and pentagonal in cross section; the smaller specimen is noticeably restricted between first primibrachs and arm bases.

Basal pit wide, of moderate depth, enclosed by basals and lower half of the radials. Although infrabasals are present their general shape and character cannot be determined definitely. Basal plates large, hexagonal in outline, extending wedge-like between the lower half of the radials and forming the re-entrant angles. Radials are the largest plates in the cup, heptagonal in outline, the surface extended into large conspicuous spines. First primibrachs about as high as the radials, hexagonal in outline; primaxils only slightly lower than the first primibrachs, heptagonal in outline.

Primary interbrachials somewhat larger than first primibrachs, hexagonal in outline, extending for half their length between the radials, and resting on the truncated basals below. In four of the interradial areas the primary interbrachial is apparently followed by four rows of interbrachials composed of the series 3, 3, 2, 2. The succession of plates in the posterior interradial area has not been determined.

Secundibrachs 2 x 10. The second is axillary; on its inner side an arm arises, and on its outer an interradial appendage. Intersecundibrachs not determined. Each arm bifurcates on the fourth or fifth secundibrach, the inner arm again on the third tertibrach, giving three arms to the half ray or six to the ray. These have been determined from two rays only, the others are not sufficiently well preserved to be accurately counted.

Arms ten, short, zigzag biserial, with long pinnules.

The character of the tegmen cannot be definitely determined. However it appears to be low as is characteristic of most other species of the genus, and is composed of numerous small nodose plates. Interradial tubular appendages are formed from single series of cylindrical discs; evidently not recurved.

Column round, 2 to 2.5 mm. in diameter; axial canal large.

The ornamentation is the type distinctive of other species of the genus. Long blunt spines are present on all the radials. A radial ridge extends from the base, forking on the primaxil. On the first primibrach it is modified into a low, rounded node. All of the interradial plates, with the exception of the primary interbrachial, have distinct nodes at the center. These are connected by low ridges which define rhombic outlines on the surface of the plates. Nodes are also present on the tegmen plates but their character and distribution cannot be definitely determined.

*Remarks.*—The two specimens upon which this species is based consist of two dorsal cups, one of which has a portion of the arms preserved. One is larger and more robust than the other, but details of surface sculpture and other features seem to be identical and thus justify inclusion in the same species. The form is of much interest because it adds yet another variant to the interesting assemblage of species of *Gilbertsocrinus* of middle Devonian age.

The lack of strong nodes on all but the radials seems to be the outstanding feature of the species. In this respect it resembles *G. rarispinus* Goldring, but differs in having strongly developed radial ridges, and less prominent ridges connecting the nodes in the interradial series. From *G. spinigerus* (Hall) it differs in the absence of spines on the primary interbrachial, and in having biserial rather than uniserial arms. It may be separated from *G. greenei* by the absence of spines on both primary interbrachials and first primibrach. From *G. alpenensis* Ehlers it differs in the absence of spines on the first primibrach. The arm arrangement is very much like *G. intersculptus* Goldring but there are no spines on the primibrachs.

*Horizon and Locality.*—Silica shale, middle Devonian, probably lower ten feet, quarry Sandusky Lime and Cement Company, Silica, Lucas Co., Ohio.

#### Family *Hexacrinidae* Wachsmuth and Springer

##### *Arthracantha carpenteri* (Hinde)

(Plate I, fig. 5)

A very fine specimen of a young *Arthracantha carpenteri* (Hinde) in Mr. Ladd's collection deserves special mention because to my knowledge only one other specimen has been figured which even approaches it in the completeness and excellence of the arm preservation. The other specimen from the Hamilton shale at Thedford, Ontario, Canada, was originally described and figured by Elvira Wood (7), and later refigured by Winifred Goldring (2). Miss Wood's specimen is evidently a mature

form and is considerably larger than the Silica shale specimen. The arms have been distorted somewhat, and the upper part is missing, so that the true outline of the crown is not evident.

The Silica shale specimen, on the other hand, has the arms complete to the tips, thus showing the manner of infolding at the distal end. Although it is crushed on one side, the original outline of the crown is intact, and apparently has not been impaired in any way.

The larger Ontario specimen has longer arms with more frequent bifurcations. At least three bifurcations occur above the primaxil and probably a fourth, since the upper portion of the crown is incomplete.

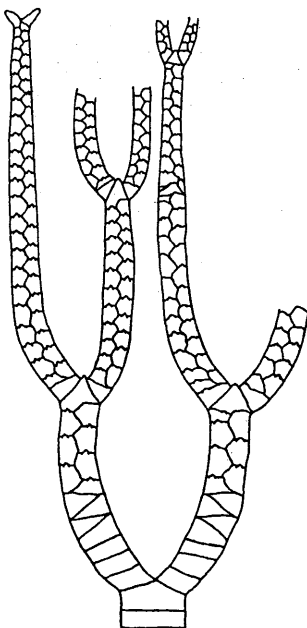


Fig. 1. Analysis of plate arrangement in left anterior arm of *Arthracantha carpenteri* (Hinde).

The Silica shale form, on the other hand, has just two bifurcations above the primaxil on all but one arm, where a third division can be seen very close to the tip.

A noteworthy feature of the Ohio specimen is the strong development of the distally pointing tubercles on the axillaries, which seem to be proportionately stronger than in Wood's specimen. They are extended into short spines, one on the secundaxil, and two on the tertaxil. Here and there, with no definite arrangement, a large, strong tubercle is developed between bifurcations. In all other respects the detail of the arms seems to be identical with the Canadian specimen as also are the details of the dorsal cup.

Fig. 1. *Horizon and Locality*.—Silica shale, Kelley's Island Lime and Cement Company quarry, Silica, Ohio.

Order *Flexibilia* ZittelSuborder *Sagenocrinoidea* SpringerFamily *Ichthyocrinidae* Angelin (em. W. and Sp.)*Euryocrinus* ? *laddii* n. sp.

(Plate I, fig. 6)

*Description.*—A medium sized species, with an elongate, more or less ovoid body, the arms infolding distally. A fairly complete laterally compressed crown measures 37 mm. in height, and 7 mm. in width at the base of the cup, increasing in width to 25 mm. at the tertaxils the region of greatest width.

Base of dorsal cup broadly and shallowly concave, pentagonal in outline. The condition of preservation is such that neither infrabasals nor basals can be clearly defined. Apparently three large infrabasals are present entirely surrounded by the basals. Although the actual outline of the basals cannot be accurately determined they are seen to extend in side view in two interrarial areas as narrow triangular facets between the radials; the posterior basal appears to be longer than the others and rectangular in outline. Radials wider than high, hexagonal in outline, approximately 4 mm. in breadth at the widest portion just above the middle, and 2.5 mm. in height. Upper margin of radials somewhat arcuate, the lower curving into the edge of the basal facet. Surface smooth except for pronounced vertical and transverse angularities. The vertical angularities form the points of the basal pentagon, the basals making the re-entrant angles.

Primibrachs three, wider than high, the middle one somewhat lower than the other two; first primibrach hexagonal in outline, second somewhat quadrangular, while the primaxil is pentagonal. All three are practically the same width. The dimensions of the primaxil are: height 2.75 mm., width 6 mm.

Anal plate angular, the exact outline not determined with certainty; followed by several series of angular plates whose number cannot be determined. In the other interrarial areas at least one row of angular plates is present, extending up to the secundibrachs. In two areas the primary interbrachial has been preserved and is seen to be pentagonal in outline. Unfortunately most of the plates in the interrarial series have been destroyed in the cleaning so that their character is not certainly known.

Arms dichotomous, bifurcating on the third secundibrach; secundibrachs somewhat narrower than primibrachs and higher in relation to the width. One large intersecondibrach may have been formerly present but has not been determined definitely. First secundibrach pentagonal, second somewhat quadrangular, while the secundaxil is pentagonal and slightly higher than the others. The second bifurcation takes place in the seventh tertibrach on the outer branch, and in the fourth on the inner branch; from the first tertibrach the arms abut, just how high cannot be determined with accuracy. Plates are short and wide and

interlock laterally by angular margins with prominent ridges. Succeeding brachials narrow and high. The third bifurcation takes place on the twelfth quartibrach in the outer branch, and on the seventh quartibrach in the inner. The intervals of bifurcation above this cannot be determined.

Column not preserved, but judging from the size of the basal facet it was evidently large.

The only ornamentation consists of the angularities on the radial and lower brachials and the angular ridges at the margins of the interlocking plates.

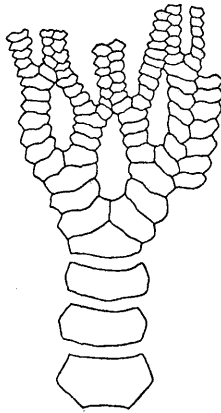


Fig. 2. Analysis of right posterior ray of *Euryocrinus ladii* n. sp.

*Remarks.*—This interesting form is represented by one incomplete crown. Its characters are sufficiently striking to justify separation from all described species. It is placed provisionally in *Euryocrinus* with which genus it seems to agree more closely than any other genus of the Ichthyocrinidae. It differs, however, in the higher incorporation of the brachial plates in the dorsal cup which includes to at least the secundibrachs and probably beyond; and the anal series of plates are much more numerous. Other genera of the Ichthyocrinidae of Devonian age which have resemblances in common with the form under consideration are *Clidochirus*, *Synaptocrinus*, and *Dactylocrinus*. However, all three of them have only two primibrachs, while this form has three. From *Clidochirus* it can further be separated in the presence of interradial plates in all of the interradial areas instead of just the posterior, and in the absence of a radianal plate. *Synaptocrinus* lacks plates in all the interradial areas, and *Dactylocrinus* has a different arm arrangement above the secundibrachs.

Evidently only one other species of the genus *Euryocrinus* has been recognized in Devonian rocks in North America, *E. barrisi* Springer. This species is represented by two calices from the Traverse group of the middle Devonian at Partridge Point near Alpena, Michigan, and a more complete specimen from rocks of Hamilton age at New Buffalo,

Iowa. *Euryocrinus ? laddii* n. sp. may be separated from it not only by the generic differences just discussed but also by the different shape of the crown, the absence of nodose projections at the margin of the brachials, and the less sharply angular rays.

Additional and better preserved material will no doubt necessitate the separation of this form under a new genus.

The species is named in honor of V. E. Ladd, of Toledo, Ohio, who kindly loaned the specimen to the writer for study.

Fig. 2. *Horizon and Locality*.—Silica shale, probably lower ten feet, Kelley's Island Lime and Cement Company quarry, Silica, Ohio.

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## EXPLANATION OF PLATE I

(All figures magnified  $\times 2$ )*Gilbertsocrinus ohioensis* n. sp.

- Fig. 1. Lateral view of specimen showing strong development of radial spines and proximal portion of arms.
- Fig. 2. Basal view of same specimen.
- Fig. 3. Lateral view of larger specimen showing the forking of the radial ridge on the primaxil, and the arm bases.
- Fig. 4. Basal view of same specimen.

*Arthracantha carpenteri* (Hinde)

- Fig. 5. Right posterior view of specimen showing especially well the manner of arm bifurcation and the strong development of blunt spines on the arms.

*Euryocrinus ? laddii* n. sp.

- Fig. 6. Right posterior view of crown showing character of dorsal cup and abutting arms. In the lower right interradial area one plate of the interradial series is visible.



