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TWO NEW CRINOIDS FROM THE MIDDLE DEVONIAN SILICA FORMATION

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VOLUME 22

TWO NEW CRINOIDS FROM THE MIDDLE DEVONIAN SILICA FORMATION

ROBERT V. KESLING

ABSTRACT—New crinoids from the Silica Formation in northwestern Ohio are named *Gennaeocrinus dulukae* and *Poteriocrinites duluki*. The *Gennaeocrinus* is characterized by bowl-shaped cup, low crests and spinelike nodes on RR, $PBrBr_1$, $IBrBr_1$, and $IBrBr_2$, narrow arms, and interbrachials developed as high as IQBrBr; the preserved part of the calyx shows 6 arms per ray with two arms on each inner quarter-ray. The *Poteriocrinites* is characterized by subconical cup, elevated narrow RR facets, broad and slightly rugose radiating ridges on IBB, BB, RR, RA, and X_1 (with double crests on B-B ridges), median shallow grooves on IBB, and strongly pentastellate heteromorphic column.

INTRODUCTION

EVEN AFTER MORE THAN forty years of intensive collecting in the quarries of the Medusa Portland Cement Company near Sylvania, Ohio, new crinoids are still discovered from time to time through long and careful scouring of the outcrop—and considerable good fortune. Mr. and Mrs. Jerome F. Duluk each found a new species. I am pleased to name the species in their honors and to express thanks for their donations of the specimens to the Museum of Paleontology of The University of Michigan.

The crinoid fauna previously known from the Silica Formation includes:

Ameliacrinus benderi Kesling
Arthroacantha carpenteri (Hinde)
Botryocrinus niemani Kesling
Corocrinus nodosus Kier
Decadocrinus hughwingi Kesling
D. stewartae Kier
Euryocrinus ? laddi Stewart
Gennaeocrinus chilmanae Kesling
Gilbertsocrinus alpenensis Ehlers
G. ohioensis Stewart
Hexacrinus ? sp.
Opsiocrinus mariana Kier
Proctothylacocrinus esseri Kesling
P. longus Kier

This list is impressive, but it is somewhat misleading. Although the number of species is large, four are known from the holotype alone; of all crinoids, only *Arthroacantha* and *Gilbertsocrinus* can be said to be common in collections, and good specimens of these are now becoming scarce in the field.

Professors C. A. Arnold and E. C. Stumm critically read the manuscript of this paper, for which I am grateful.

SYSTEMATIC DESCRIPTIONS

Class CRINOIDEA
Subclass CAMERATA Wachsmuth & Springer
Order MONOBATHRIDA Moore & Laudon
Family PERIECHOCRINITIDAE Austin & Austin
Genus GENNAEOCRINUS Wachsmuth & Springer
GENNAEOCRINUS DULUKAE n. sp.
Pl. 1, figs. 1–5

Description.—Cup rather low and bowl-shaped (pl. 1, fig. 2). BB three, nearly flat or slightly indented, the area crushed in and partly hidden by columnals; each B subhexagonal, smaller than adjoining R or X_1, without basal flange. Each B with three ridges: a median ridge to the ventrally adjacent R, and lateral ridges to the ventrolateral RR or R and X_1.

RR + X_1 forming a circlet of nearly equal hexagonal plates (pl. 1, fig. 3). Each R with a narrow but conspicuous median ray ridge to PBr_1 from the central sharp node and faint radial crests to adjacent RR and to $IBrBr_1$ or X_2; RR of A, C, and D rays each with one radial ridge extending through middle of adjoining B; RR of B and E rays each with paired radial ridges extending to lateral margins of the two adjoining BB.

PBr_1 only slightly smaller than R below (pl. 1, figs. 4, 5), regularly hexagonal, traversed by narrow median ray ridge through central sharp node and ornamented with faint radial crests to laterally adjacent plates. PBr_2 axillary, smaller than PBr_1, hexagonal, with Y formed by bifurcated median ray ridge; faint and slightly irregular crests to laterodorsally and ventrally adjacent plates (pl. 1, fig. 2). R, PBr_1, and PBr_2 forming a graduated vertical series.

SBr_1 axillary, hexagonal, bordered by PBr_2, two $TBrBr_1$, $ISBr_1$, and two IBrBr or XX plates. In outer quarter-ray, each arm free and biserial at about TBr_4; in inner quarter-ray, TBr_1 much wider than high, polygonal, with nearly parallel dorsal and ventral sides, and TBr_2 axillary. QBrBr in inner quarter-ray leading to two arms, free and biserial at about $QBrBr_4$.

IBrBr in series of 1–2–3, becoming irregular in upper rows. IBr_1 hexagonal, nearly as large as PBr_1, with central sharp node and faint crests to adjoining plates. $IBrBr_2$ heptagonal, about same size as PBr_2, with sharp central node and faint crests to adjoining plates. $IBrBr_3$ polygonal, much smaller than SBrBr, ornamented with irregular crests. Ventral IBrBr smaller and less regular, ornamented with irregular network of faint crests.

$ISBr_1$ rather large, ornamented with irregular fine crests, set atop PBr_2 and between two $TBrBr_1$, followed by much smaller and irregular ISBrBr (pl. 1, fig. 5). ITBr well developed, dorsally acuminate, bordered on outer side by three TBrBr and on inner side by two TBrBr and one QBr. Small IQBr in each inner quarter-ray (pl. 1, fig. 5).

Posterior interray incomplete. X_1 similar in size and ornamentation to R, but with narrower ventral sides. Middle X_2 much smaller than PBr_1, about the size of IBr_2 plate, bearing central node and radiating crests; median interray ridge very weakly developed (pl. 1, fig. 3). Lateral X_2 hexagonal, intermediate in size between middle X_2 and IBr_1 of other interrays, with central node and radial crests (pl. 1, figs. 3–5). XX_3 plates small, only slightly larger than $IBrBr_3$, the radial crests becoming irregular. Other XX plates unknown.

Tegmen covered with mosaic of tiny polygonal plates, apparently somewhat lobate (pl. 1, fig. 1). Calyx granular, only the free arms becoming smooth. Rays clearly defined by narrow median ray ridges, even on axillary PBr_2 less than one-fourth the width of the plate. Central sharp nodes (or low blunt spines) on RR, $PBrBr_1$, $IBrBr_1$, $IBrBr_2$, X_1, and XX_2, no central elevation on other interray plates. Radial crests very faint, scarcely apparent without coating of sublimate, ventrally becoming irregular and merging into a meshwork.

Columnals circular, with broad flangelike epifacet nearly twice the diameter of the articulum. Crenularium very narrow, circular, consisting of fine crenulae. Lumen apparently circular, less than half the diameter of the areola.

Remarks.—Nearly half of the cup has been broken off above the RR in the only known specimen, the holotype. Even though the posterior (CD) interray is missing, identity of the preserved rays can be deduced from the disposition of plates and ornament.

In *Gennaeocrinus* and its relatives among the monocyclic camerates, certain characters are firmly entrenched and constitute the keys for identification of rays in the new species. (1) Five RR + X_1 form a circlet of six plates around the BB; structurally, X_1 corresponds to one of the RR and the three XX_2 correspond to PBr_1 and the laterally adjacent $IBrBr_1$. (2) Although the posterior interray is conspicuously wider than other interrays, it does not approach the width of two interrays plus the intervening ray; the median X_2 is narrower than the corresponding PBr_1 ray plate and the lateral XX_2 are somewhat narrower than the corresponding $IBrBr_1$ interray plates. (3) The three equal BB invariably have one of their B-B sutures along the midplane of the posterior interray. (4) Sutures around the perimeter of the BB circlet form a hexagon, even if the edges of the BB have broad flanges extended beyond to form a large circle, as in *Gennaeocrinus variabilis* Kesling & Smith. (5) Since the three sutures between BB are normal to alternating sides of the hexagon, three of the surrounding plates each border one B (including RR of the A, C, and D rays) and the other three each border two BB (including X_1 and RR of the B and E rays). (6) Where radial ornamental ridges are developed, a plate of the RR + X_1 circlet which borders one B has a single ridge extending through the midplane of the B; but a plate which borders two BB has a pair of ridges diverging slightly to straddle the B-B suture, one ridge extending onto the left margin

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EXPLANATION OF PLATE 1

Figures × 3, except as noted; specimen coated with sublimated ammonium chloride

FIGS. *1–5*—*Gennaeocrinus dulukae* n. sp. Holotype UMMP 57349. *1,* ventral (tegminal) view, plates somewhat disarranged. *2, 4,* lateral and inclined views centered on B ray. *3,* dorsal (basal) view with B ray uppermost. *5,* inclined lateral view of B and C rays with certain interbrachial plates labeled, × 8.

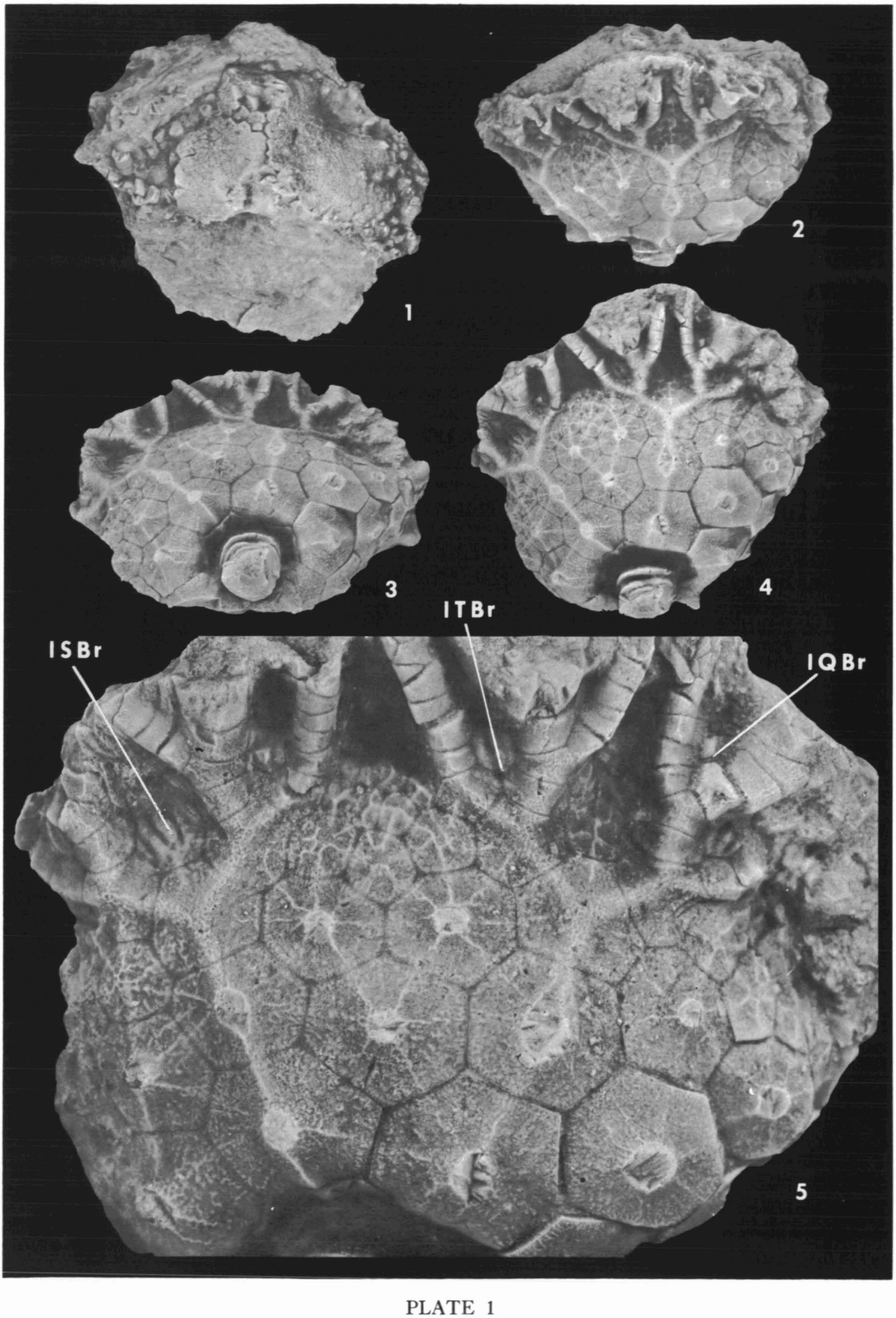

PLATE 1

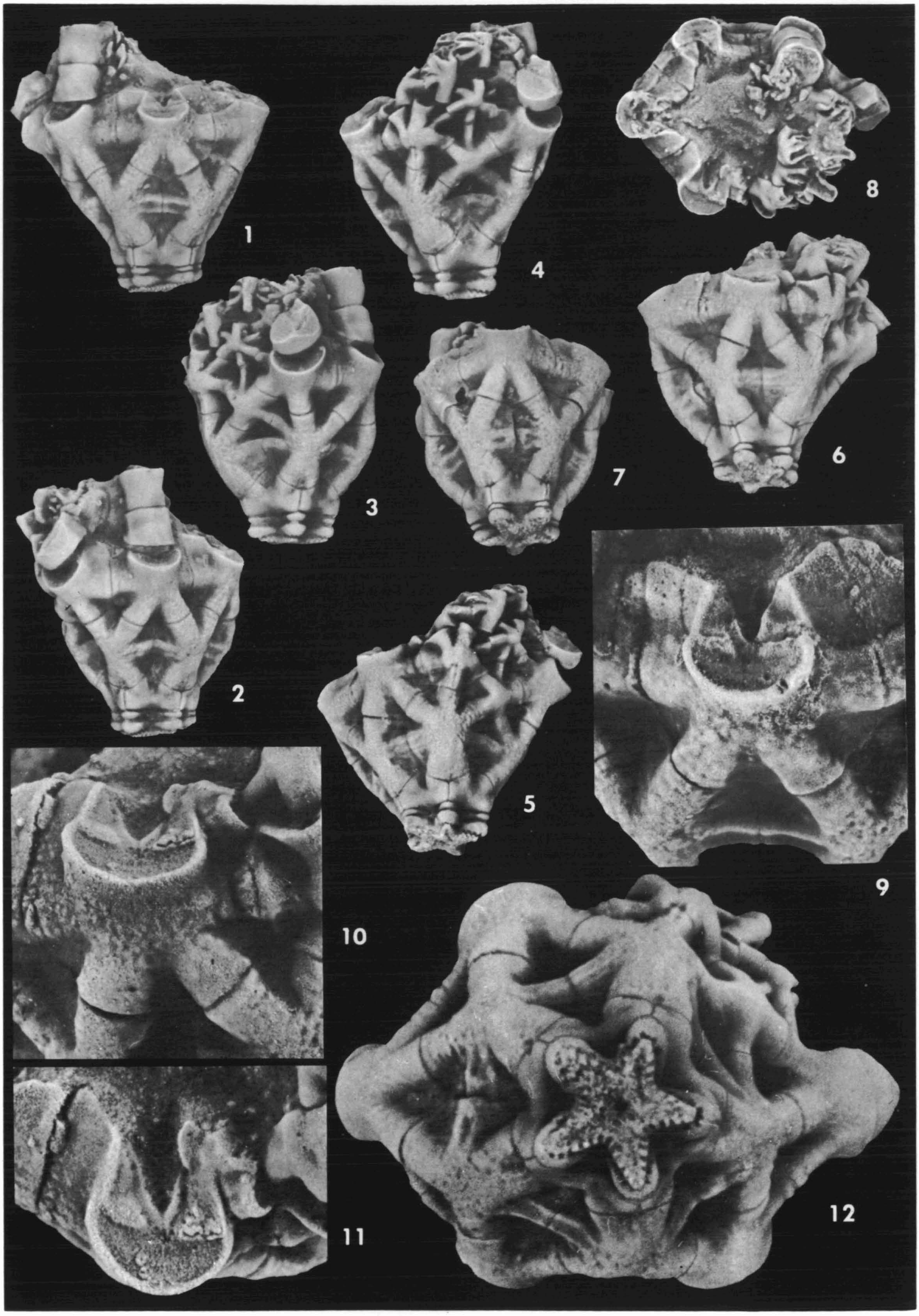

PLATE 2

of one B and one ridge onto the right margin of the other B. Hence, in ornamented *Gennaeocrinus,* single radial ridges mark the RR of the A, C, and D rays, and paired radial ridges mark the RR of the B and E rays and X_1.

As applied to the photographs of the specimen, the dorsal (basal) view (pl. 1, fig. 3) shows the six plates of RR + X_1 circlet, three that bear one radial ridge directed dorsally alternating with three that bear a pair of radial ridges in the corresponding position. It also shows the uppermost plate, bearing paired ridges, extending into a fully developed ray; therefore, this plate cannot be X_1. By elimination, X_1 must be one of the other two plates with paired ridges, either the one at the left or the one at the lower right. Obviously, the plate at the left is succeeded by a plate that is narrower than the $PBrBr_1$ plates of the preserved rays; hence that plate is X_1 and the succeeding plate is the middle X_2. With X_1 and the posterior interray located, the preserved rays are readily identified as A, B, and C.

The genus *Gennaeocrinus* itself is a primitive camerate in having numerous IBrBr plates and hexagonal $PBrBr_1$. *Gennaeocrinus dulukae* is further primitive in having arms incorporated in the cup as high as QBrBr, as shown by the presence of IQBrBr plates (pl. 1, fig. 5).

Although the base of the holotype is crushed in and partly obscured by columnals, it is clear that the BB did not bear flanges. With nearly flat or indented BB, not provided with flanges, the new species shows some resemblance to *Megistocrinus* in its bowl-shaped cup. It is clearly separated from that genus by its clearly defined median ray ridges on the cup and by the branching of rays within the cup. *Gennaeocrinus dulukae* must be regarded as an atypical species of the genus, at least until *Gennaeocrinus* is revised.

The species is named in honor of Cecelia (Mrs. Jerome F.) Duluk, who found the specimen and gave it to the Museum of Paleontology.

Occurrence.—Middle Devonian Silica Formation, unit 9 of Ehlers, Stumm, & Kesling (1951, p. 19, 20), exposed in Medusa Portland Cement Company quarry, about 3 miles WSW of Sylvania, in Lucas County, Ohio.

Type.—Holotype UMMP 57349.

Subclass INADUNATA
Wachsmuth & Springer
Order CLADIDA Moore & Laudon
Family POTERIOCRINITIDAE Bassler
Genus POTERIOCRINITES Miller
POTERIOCRINITES DULUKI n. sp.
Pl. 2, figs. 1–12

Description.—Calyx small in only known specimen. Dorsal cup subconical (pl. 2, figs. 1–7), its sides inclined at about 60° to the base. IBB small but clearly defined. Each IB in lateral view pentagonal, wider than high, with a straight border at the columnal facet; its apex deeply indented in a V as part of a triangular pit, and its mid-dorsal region crossed by a shallow groove between the two marginal ridges, one to each of the adjacent BB; lateral edges protuberant. In dorsal (basal) view, IBB circlet forming a pentagon with radial apices (pl. 2, fig. 12), but lower and prominent part of IBB nearly pentastellate with interradial apices. Protuberant edges of IBB not involved in narrow triangular indentations between closeset dorsal ridges of BB, but instead thrust out abruptly; short angular furrow between protuberant edge and marginal ridge near each ventrolateral corner. Facet for column strongly pentastellate (pl. 2, fig. 12), with interradial apices.

BB nearly equal, those of AB, DE, and AE interrays hexagonal and those of BC and CD interrays heptagonal, as normal for genus. Centers of BB joined to centers of RR by very prominent semicylindrical ridges, and to adjacent BB by somewhat lower but wide ridges bearing a pair of crests each. Each B with two thick closeset dorsal ridges leading to the margins of the two adjacent IBB and outlining a shallow and narrow triangular indentation. In posterior region, BB with lateral ridges to RA and to X_1, narrower than other ridges but with steep declivitous sides (pl. 2, figs. 3–5).

RR nearly equal, that of C ray somewhat

EXPLANATION OF PLATE 2

Figures × 4, except as noted; specimen coated with sublimated ammonium chloride

FIGS. *1–12*—***Poteriocrinites duluki*** n. sp. Holotype UMMP 57350. *1–3,* lateral views centered on A, B, and C rays. *4,* lateral view centered on RA. *5,* inclined lateral view centered on X_1. *6, 7,* inclined lateral views centered on D and E rays. *8,* ventral (tegminal) view. *9,* view of R of A ray, showing facet, × 10. *10, 11,* views of R of D ray, showing facet, × 10. *12,* dorsal (basal) view, showing columnals; C ray at right, E ray at left; × 8.

smaller (pl. 2, fig. 3). Radial facet about half the width of the plate, especially well developed, its outer half set atop a semicylindrical prominence rising rather conspicuously from the center of the R. Each R joined to BB and other RR by very prominent subcylindrical ridges; those of posterior region joined to RA and X_1 by narrower but steep-sided ridges (pl. 2, fig. 4).

PBr_1 and PBr_2 about the same size, each slightly wider than high, outer surface subcylindrical (pl. 2, fig. 2). Other BrBr unknown.

RA pentagonal, its junction with R, two BB, and X_1 wider than its junction with RX_1 above. Ridges from center of plate to B of CD interray and to R of C ray especially prominent, nearly as wide as B-R ridges (pl. 2, fig. 3); ridges to B of BC interray and to X_1 slightly narrower, forming a cross with the prominent ridges (pl. 2, fig. 4); and ridge to RX_1 lower and very narrow (pl. 2, fig. 5). As normal in genus, RA lower than R of C ray, its upper edge about level with lower edge of R facet.

X_1 about same size as RA, hexagonal, its upper edge only a little higher than R of D ray; prominent ridges to RA, B, R, LX_1, and X_2; very narrow ridge to RX_1. As seen on exposed edges (pl. 2, fig. 8), X_1 and other XX very thin, their ridges actually deep convolutions of the plates. LX_1, X_2, RX_1, RX_2, and RRX_1 present but somewhat displaced; each polygonal and wider than high, bearing radial ridges of which the median (vertical) ridge is relatively wide and the others are very narrow (pl. 2, figs. 3–5). Two other XX attached to top of specimen, probably X_3 and RX_3. Plates in each stack of anal series apparently decreasing very gradually in size.

RR facets outlined by narrow rim, each deeply incised by sharp V for ambulacral groove. Outer (dorsal) ligament fossa semicircular (pl. 2, fig. 11). Transverse fulcral ridge of facet divided into two parts, with no central element to separate outer fossa from ambulacral groove (pl. 2, figs. 9–11). Two triangular inner (ventral) muscular fossae, one on each side of ambulacral groove, their apices extended proximally to give the facet a proximodistal dimension greater than its width.

Ornamentation of cup distinctive. In general, ridges slightly narrower than the triangular pits they outline. Strongest ridges passing from IBB through BB to RR, semicylindrical (pl. 2, figs. 1, 2, 6, 7). B-B ridges lower, sloping slightly toward suture, double crested (pl. 2, figs. 7, 12). Triangular pits around all corner junctions of cup except IB-B-IB, especially deep around RA and X_1 (pl. 2, figs. 3–5). Very weak rugosity on ridges, visible only with low-angle lighting and high magnification (pl. 2, figs. 9–11). Except for lower plates of anal chimney, tegminal plates unknown.

Column heteromorphic, at least in preserved proximal section. Nodals and internodals pentastellate (pl. 2, fig. 12), interradial tips of the former round and of the latter acuminate. Nodal with strongly convex epifacet; its crenularium with deep crenellae to accommodate culmina of the internodal in symplexy. Internodal with marginal crenularium bearing about six culminae along each of the ten sides; its areola rather large and pentastellate around very small lumen. Internodals very thin and deeply articulated with nodals, scarcely visible laterally (pl. 2, figs. 1–7).

Remarks.—For several reasons, classification of this crinoid is difficult. (1) It has an RA pentagonal like those of the Poteriocrinitidae, yet the junction with RX_1 is so narrow that the plate is essentially quadrangular like those of the Botryocrinidae, but with a truncated corner; in addition, occasional specimens of the Botryocrinidae have more than four sides on RA. (2) It has narrow RR facets, like those in both Poteriocrinitidae and Botryocrinidae; the transverse fulcral ridge is typical of the Poteriocrinitidae. (3) The pattern and development of ridges on the cup is more typical of the Botryocrinidae than the Poteriocrinitidae. (4) *Poteriocrinites* was once defined (Moore & Laudon, 1944, p. 155) as having "stem round"; however, pentastellate columnals occur in some species of *Poteriocrinites* as well as *Botryocrinus*. (5) Both *Poteriocrinites* and *Botryocrinus* have Devonian species with great range of cup form, ornamental ridges, size of RR facets, and columnal shape; these genera have been interpreted so broadly that together they can accommodate practically any dicyclic inadunate with five IBB visible in lateral view, RA offset to the left below R of the C ray, well-developed facets less than the width of the RR, and an anal sac or chimney of numerous plicate plates.

From these observations, it is clear that the Botryocrinidae and the Poteriocrinitidae are closely related dicyclic inadunates. The common key for identification is a quadrate RA in Botryocrinidae and pentagonal RA in Poteriocrinitidae. Even though this separates most of botryocrinids from the poteriocrinitids, exceptions are known which cast doubt on the significance of this character. Whether RA is quadrate or pentagonal depends on plate development in a small critical posteroventral region of the cup. At that place, four plates lie in close proximity: RA, X_1, RX_1, and R of the C ray. If X_1 is more developed than RA, it is inserted between RA and RX_1, spanning the whole area between RR of the C and D rays, as in typical botryocrinids; but if X_1 is less developed than RA, it is cut off from R of the C ray by the RA-RX_1 junction, as in typical poteriocrinitids. In both families, the plates in the critical region contact the same plates above and below; hence the total number of sutures is the same. Botryocrinidae have heptagonal X_1 (bounded by RA, B, two RR, LX_1, X_2, and RX_1) and quadrate RA (bounded by two BB, X_1, and R), whereas Poteriocrinitidae have hexagonal X_1 (bounded by RA, B, R, LX_1, X_2 and RX_1) and pentagonal RA (bounded by two BB, X_1, RX_1, and R). Therefore, assignment of a specimen to one family or the other depends on small differences in plate development which originate early in the ontogeny.

It is quite possible that the new species is an atypical *Botryocrinus*. If it is, the species to which it shows strongest similarity is *Botryocrinus costatus* Goldring. Dimensions of the new species are compared with those reported by Goldring for the largest cotype of *B. costatus* (table 1). The two species are very much alike in their strongly ridged cups, elevated facets about half as wide as the RR, and pentastellate columnals. Nevertheless, there seem to be some differences. As shown in the illustrations of *B. costatus* by Goldring (1954, pl. 3, figs. 1–7), specimens which approach the size of the holotype of *duluki* have B-R ridges that are as wide or wider than adjacent pits, B-B ridges that are not much lower than B-R ridges and lack double crests, and IBB without prominent protuberant lateral edges. In addition, Goldring stated of the largest cotype of *B. costatus* (1954, p. 24):

> . . . rim-like thickenings border the margins of the plates and are particularly well shown on the ridges. The entire area of some of the basals and radials is covered by a nested series of such thickenings, parallel to the margins of the plates and giving a wrinkled appearance to the surface of the dorsal cup.

In the holotype of the new species, which is about the same size as the specimen described by Goldring, only a weak rugosity can be found on the ridges of the cup, not comparable with that present in large specimens of *Botryocrinus costatus*. Hence, even if the Silica crinoid should later prove to be an atypical *Botryocrinus*, it is nevertheless a new species.

If, as I believe, the RA is normally developed in the new crinoid, then the species is properly assigned to *Poteriocrinites*. The most similar species of that genus to which it can be compared is one described by Goldring (1934, p. 191–193, pl. 2, figs. 6, 7) as *Poteriocrinus(?) arkonensis*." There can be no question that her species belongs in *Poteriocrinites* as the genus is now interpreted. Of the holotype, Goldring said that the columnals were strongly pentangular, alternating in thickness, their angles alternating with the IBB, "deep grooves between extending up onto infrabasals and giving base a decided pentangular aspect." She gave the following dimensions of height and width in the holotype of *P. arkonensis*: dorsal cup, 6.6 mm x 3.2 mm (base) and 8.0 mm (top of RR); IBB, 1.7 x 3.0 mm; B of AB interray, 2.8 x 3.4 mm; R of A ray, 2.5 x 3.7 mm. Gold-

TABLE 1—COMPARISON OF *BOTRYOCRINUS COSTATUS* GOLDRING AND *POTERIOCRINITES DULUKI* N. SP. Measurements in mm.

Character	*Botryocrinus costatus* Goldring, largest cotype*	*Poteriocrinites duluki*, n. sp., holotype**
Dorsal cup height	7.2†	7.4
Dorsal cup base	4.0‡	3.6
Dorsal cup at arm bases	9–10	10±
IB (average)	2.1 × 2.7	1.8 × 2.5
B of CD interray	3.6 × 3.2	3.9 × 3.5
B of AB interray	3.4 × 3.2	3.6 × 3.1
RA	2.7 × 2.7§	3.0 × 2.5
X_1	3.1 × 3.3‖	3.0 × 2.9

* Measurements as given by Goldring (1954, p. 22-23). The illustration (1954, pl. 3, fig. 5) is obviously × 3, not × 4 as stated in the plate explanation (1954, p. 44).
† Probably measured along edge of cup; from the figure, height normal to base about 6.8 mm.
‡ Probably measured at base of BB instead of IBB; from the figure, width at base of IBB about 3.2 mm.
§ From the figure, height × width of RA about 2.2 × 2.2 mm.
‖ From the figure, height × width of X_1 about 2.7 × 4.1 mm.
**Measured with Gaertner Scientific Corporation measuring microscope.

TABLE 2—COMPARISON OF *POTERIOCRINITES ARKONENSIS* GOLDRING AND *P. DULUKI* N. SP. The former based on UMMP 24172.

	P. arkonensis	*P. duluki*
Nodals	No epifacet	Epifacet
IBB	As wide as high, no median groove	Wider than high, median shallow groove
IB-B-IB junction	common pit	Pit only on B
Ridges on cup	Broad, gently convex surface	Narrower, strongly convex surface
Pits on cup	Smaller, shallower	Larger, deeper
B-B ridges	No double crest, only slightly lower than B-R ridges	Double crest, conspicuously below B-R ridges
RR facets	Over 4/5 width of RR	About ½ width of RR
RA-RX_1	Wide suture, broad ridge	Narrow suture, very narrow ridge
X_1	Median ridge much wider than other radial ridges	Median ridge only slightly wider than other radial ridges

ring did not mention ridges on *P. arkonensis* and she compared it with the relatively smooth *P. nassa* Hall, but her figures indicate that ridges are present. Our Museum of Paleontology has a specimen collected by Charles Southworth, UMMP 24172, which has been identified as *P. arkonensis* and comes from the Arkona Shale exposed in bluffs along the Ausable River at Hungry Hollow, 2 miles E and ¾ mile N of Arkona. It matches Goldring's description in most particulars, differing only in width of the RR facets, which do not extend the full width of the RR as stated in the description of the holotype. A comparison of UMMP 24172 with the holotype of *P. duluki* is presented in table 2. *P. arkonensis* and *P. duluki* agree in their pattern of ridges on the cup, arrangement and general size of plates, and pentastellate column. As shown in table 2, they differ in proportions of the IBB, details of nodal plates, and relative widths of the cup ridges.

The species is named in honor of Mr. Jerome F. Duluk, who found the specimen and gave it to the Museum of Paleontology.

Occurrence.—Middle Devonian Silica Formation, unit 13 of Ehlers, Stumm, & Kesling (1951, p. 19), exposed in Medusa Portland Cement Company quarry, about 3 miles WSW of Sylvania, in Lucas County, Ohio.

Type.—Holotype UMMP 57350.

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