TWO NEW CRINOIDS OF THE FAMILY PERIECHOCRINITIDAE FROM THE MIDDLE DEVONIAN THUNDER BAY LIMESTONE OF MICHIGAN

BY
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11. Two New Crinoids of the Family Periechocrinitidae from the Middle Devonian Thunder Bay Limestone of Michigan, by Robert V. Kesling. Pages 143–155, with 2 plates.
TWO NEW CRINOIDS OF THE FAMILY PERIECHOCRINITIDAE
FROM THE MIDDLE DEVONIAN THUNDER BAY LIMESTONE
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ABSTRACT

Gennaeocrinus romingeri and Corocrinus pettyesi, two distinctive new crinoids from the Thunder Bay Limestone exposed at Partridge Point, near Alpena, Michigan, are named for the men who discovered the holotypes many years ago. Gennaeocrinus romingeri is distinguished by its bowl-shaped dorsal cup, pattern of concentric triangles produced by pronounced costae normal to sutures of the cup plates, few IBrBr₃ in each interray, smooth tegminal plates except for one central tubercle, and six arms in each ray formed on axillary PBr₂, SBrBr₁, and free TBrBr₃ on the inner quarter-rays. Corocrinus pettyesi is characterized by basal flanges on the BB and by very large RR and X₁ (anal x), nearly twice the size of PBrBr₁, provided with double ridges extending onto BB.

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INTRODUCTION

A LTHOUGH CRINOIDS from the Thunder Bay Limestone of Michigan have been studied for nearly a century and have been described by Barris and Wachsmuth (1886), Wachsmuth and Springer (1897), Wood (1904), Thomas (1920), Springer (1920; 1921), and others, two new species have been distinguished. When the holotypes were discovered many years ago, they were not recognized as new nor described. Both crinoids belong to the family Periechocrinitidae.

Gennaeocrinus romingeri is named in honor of Dr. Carl Ludwig Rominger, who found the holotype, probably in 1898, the year in which he
made extensive collections from the exposure at Partridge Point. *Corocrinus pettyesi* is named in honor of Mr. Leon O. Pettyes, of Alpena, Michigan, who discovered the holotype; the specimen may have been part of an extensive collection of invertebrates obtained from him in 1926. One additional specimen of *Gennaeocrinus romingeri* and two of *Corocrinus pettyesi* were collected by Mr. Irving G. Reimann in 1945, at which time he was employed by the Buffalo Society of Natural Sciences and presented the specimens to the Museum of the Society.

All specimens are fairly well preserved, although the distal parts of the arms are missing. As deposited in the Museum of Paleontology and the Buffalo Museum of Natural Sciences, they were partly obscured by weathered matrix. This was removed by careful cleaning with small needles and Airdent abrasion.

Professor Chester A. Arnold and Professor Lewis B. Kellum critically read the manuscript. Mrs. Helen Mysyk typed the final draft, and Mr. Karoly Kutasi assisted in photography. My sincere thanks to each for help in preparing this paper.

Holotypes of both species are deposited and catalogued in the Museum of Paleontology of The University of Michigan.

**LOCALITY**

All specimens described here are from the same locality.

Bluffs on the northeast side of Partridge Point, a peninsula between Lake Huron and Squaw Bay, about 4 miles south of Alpena, Michigan, extending from the center of sec. 11 into its SE 1/4, T. 30N., R. 8E. Type locality of the Thunder Bay Limestone.

**SYSTEMATIC DESCRIPTIONS**

**Subclass CAMERATA** Wachsmuth and Springer 1885
Order **MONOBATHRIDA** Moore and Laudon 1943
Suborder **Tanaocrinina** Moore 1952
Superfamily **Periechocrinitae** Ubaghs 1953
Family **Periechocrinitidae** Austin and Austin 1843
Genus **Gennaeocrinus** Wachsmuth and Springer 1881

*Type species.*—By original designation (1881, p. 161), *Actinocrinus kentuckiensis* Shumard (1866, p. 345).

**Gennaeocrinus romingeri**, sp. nov.
(Pl. I, Figs. 1–8)

*Dorsal cup.*—Cup bowl-shaped rather than cup-shaped, with a rather flat base reminiscent of *Megistocrinus*, composed of 3 BB, 5 RR, 5 PBrBr,
5 \( PBBr_3 \), 10 \( SBrBr_3 \), \( X_1 \) (anal \( x \)), 3 \( XX_2 \), 5 \( XX_3 \), 5 \( XX_4 \), about 5 \( XX_5 \), 4 \( IBrBr_1 \), 8 or 9 \( IBrBr_2 \), 12 or 13 \( IBrBr_3 \), 8 or 9 \( IBrBr_4 \), and several \( ISBrBr \) and \( ITBrBr \) (Fig. 1).

\( BB \) forming large regular hexagon, about two-fifths the diameter of entire cup (Pl. I, Figs. 1, 8). Each of the three \( BB \) pentagonal, bounded distally by three \( RR \) or by two \( RR \) and \( X_1 \) and laterally by two other \( BB \), ornamented with seven or eight regularly spaced sharp costae normal to its distal side and three or four normal to each of its distolateral sides (Fig. 1). Proximal angle of \( PB \) modified by a relatively small facet for articulation with column; margin around facet slightly elevated and unornamented.

**Fig. 1.** *Gennaecrinus romingeri*, sp. nov. Labeled plate diagram, with pattern of ornamentation indicated on some rays and interrays.
RR very large, together with the similar X₁ forming a circlet three-fourths the diameter of the entire cup. Each R hexagonal; those of C and D rays (Pl. I, Figs. 4–6) bounded by B, R, IBr₁, PBr₁, X₂, and X₁; those of B and E rays (Pl. I, Figs. 3–4, 6–7) bounded by a pair of BB, 2 RR, 2 IBrBr₁, and PBr₁; that of A ray (Pl. I, Figs. 3, 7) in contact with 1 B, 2 RR, 2 IBrBr₁, and PBr₁. Each plate ornamented with a thick ridge from its center to PBr₁ along the middle of the ray and with regularly spaced costae normal to each side, about seven or eight extending dorsally onto B or BB, seven or eight laterally onto adjacent RR or R and X₁, five or six lateroventrally onto IBrBr₁ or IBr₁ and X₂, and about four dorsally onto PBr₁; ridge much higher than costae and nearly three times as wide as each costa.

PBrBr₁ nearly half as high and two-thirds as wide as RR. Those of C and D rays (Pl. I, Figs. 4–6) bounded by R, X₂, PBr₁, IBr₂, and IBr₁, hence five-sided; those of other rays bounded by R, 2 IBrBr₁, 2 IBrBr₂, and PBr₁, hence six-sided as normal for the genus. Each PBr₁ ornamented with a thick median ridge extending from R to PBr₂ and with regularly spaced costae normal to the sides, about four extending onto R, five or six onto each IBr₁, four or five onto each IBr₂, and four onto PBr₂.

PBrBr₂ axillary (Fig. 1); those of the two posterior (C and D) rays each bordered by PBr₁, X₂, X₃, 2 SBrBr₁, ISBr₁, and IBr₂, hence seven-sided; those of other rays normally bordered by PBr₁, 2 IBrBr₁, 2 SBrBr₁, and ISBr₁, hence six-sided (subpentagonal except for narrow dorsal contact with small ISBr₁). Each PBr₁ ornamented with strong ridges in form of Y, radiating from center to PBr₁ and SBrBr₁, and with a few costae normal to sides bordering PBr₁ and IBrBr₂ or IBr₂, X₂, and X₃.

SBrBr₁ axillary (Fig. 1); those of half-rays at sides of posterior (CD) interray each bordered by PBr₁, X₃, X₄, 2 TBrBr₁, ITBr₁, and ISBr₁; others bordered by PBr₂, IBr₂, 2 TBrBr₁, ITBr₁, IISBr₁, and (in some) by IBr₃, hence six- or seven-sided. Each SBr₁ ornamented with pronounced ridges in form of Y, outlining the branching of the ray.

TBrBr₁ incorporated in calyx, other TBrBr free. TBrBr₃ on inner quarter-rays axillary, so that each ray bears 6 arms (Pl. I, Fig. 8).

ISBrBr₁ very narrow. ITBrBr₁ small. Other interbrachials small and irregular, their boundaries indistinct.

IBrBr₁ about the same size as PBrBr₁, normally hexagonal, bordered by 2 RR, 2 PBrBr₁, and 2 IBrBr₂. In AB interray of holotype (Pl. I, Fig. 3), IBr₁ larger than other IBrBr₁, bordered ventrally by 3 IBrBr₂ and hence seven-sided. IBr₁ ornamented by five or six costae normal to each side, its center raised in a general protuberance.
Normally two $IBrBr_2$ in each interray (Pl. I, Figs. 4, 6–7), but AB interray of holotype with three $IBrBr_2$ (Pl. I, Fig. 3). Normal $IBr_2$ septagonal, bordered by $IBr_1$, $IBr_3$, 2 $IBrBr_3$, $SBr_3$, $PBr_2$, and $PBr_1$, ornamented with a few costae normal to each side; its central protuberance less pronounced than that of $IBr_1$.

Normally only about three $IBrBr_3$ in each interray, small, each about half the size of $IBr_2$ (Pl. I, Figs. 6–7); four $IBrBr_3$ in AB interray of holotype, displaced upward by enlarged $IBr_1$ and three $IBrBr_3$ (Pl. I, Fig. 3). Only two or three $IBrBr_4$ in each interray. Few $IBrBr$ in the third and fourth ranges, resulting in very steep walls of dorsal cup (Pl. I, Fig. 6).

$X_1$ (anal $x$) very large (Pl. I, Figs. 1, 5, 8), the same size and shape as $RR$, bordered by $B$, 2 $RR$, and 3 $XX_2$. $XX_2$ of about equal size, smaller than $IBrBr_2$ in other interrays; the two lateral $XX_2$ each bordered by $R$, $X_1$, $X_2$, 2 $XX_3$, $PBr_2$, and $PBr_1$, hence seven-sided; the central $X_2$ bordered by $X_1$, 2 $XX_2$, and 3 $XX_3$, hence six-sided (Pl. I, Fig. 5). Five $XX_3$ of about equal size, the lateral plates bordered by $PBr_2$ and $SBr_1$. Five $XX_4$ in a narrow band between $SBrBr_1$. Five $XX_5$, very small, extending between $TBrBr_1$. All plates of posterior interray ornamented with costae normal to their sides: $X_1$ with seven or eight on each side, $X_2$ with three to seven, $X_3$ with one to three, and $X_4$ and $X_5$ with one. Median costa of interray slightly elevated above general level of costae, as are middle costae to sides of $XX_3$ and $XX_4$, giving them a stellate appearance (Pl. I, Figs. 1, 5).

Dorsal cup terminating at level of $TBrBr_1$, $IBrBr_4$, and $XX_5$, there encircled by about 35 small plates.

Dimensions of holotype: diameter of cup through $TBrBr$, 18.4 mm; height of cup to top of $PBrBr_2$, 7.0 mm; width of $X_1$, 5.3 mm; greatest diameter $BB$ circlet, 6.7 mm.

Tegmen.—Tegmen (Pl. I, Fig. 2) gently arched, divided into lobate ambulacral areas by radiating interambulacral channels or grooves. Openings for arms large, proximodistally elongate, set atop tegmen rather than on beveled junction of dorsal cup and tegmen. Numerous small plates with indistinct sutures. Anal opening posterior, very near edge of tegmen. Tegmen nearly smooth, ornamented by very faint crests, apparently connecting centers of plates. Large central tubercle; no ambulacral spines or nodes. Column, distal parts of arms, and pinnules unknown.

Remarks.—As shown in Table I, the pattern of branching of the rays is distinctive in this crinoid, alone sufficient to distinguish it from all other described Gennaeocrinus species. The bowl-shaped dorsal cup is unusual
TABLE I
Pattern of Branching in Rays of *Gennaeocrinus* Species

In plate diagrams, individual plates indicated only as far as the last axillary plate. *PBrBr* and *SBrBr* shown in solid black, *TBrBr* in outline, *QBrBr* doubly cross-hatched, and quinque-brachials horizontally ruled.

<table>
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<th>Character</th>
<th>Type</th>
<th>Pattern</th>
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<td>A</td>
<td><img src="image" alt="Branching Type A" /></td>
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<tr>
<td>Axillary <em>SBr</em></td>
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<td><em>SBr</em></td>
</tr>
<tr>
<td>Axillary <em>TBr</em> in Quarter-ray &amp; <em>QBr</em> in Eighth-ray (Second from mid.)</td>
<td><em>TBr</em></td>
<td><em>TBr</em></td>
</tr>
<tr>
<td>Arms per Ray</td>
<td>4</td>
<td>6</td>
</tr>
</tbody>
</table>

Branching types are known to occur as follows:

A—*goldringae* Ehlers (some rays; rays incomplete, perhaps additional bifurcations were present but not preserved).


C—*romingeri*, sp. nov.

D—*kentuckiensis* (Shumard).

E—*eucharis* Hall, *nyassa* Hall.

for the genus, more closely resembling that of the related *Megistocrinus*, but it is approached by *Gennaeocrinus kentuckiensis* (Shumard). The steep walls and flat base are accentuated by the absence of flanges on the BB. *G. romingeri* has even costae and three *IBrBr* in each interray, whereas *G. kentuckiensis* has uneven or interrupted costae and four or five *IBrBr* in each interray. The new species is readily separated from
THUNDER BAY CRINOIDS

TABLE I (Cont'd)

<table>
<thead>
<tr>
<th>Type</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
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<tr>
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<td>Axillary TBr in Quarter-ray</td>
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<tr>
<td>Axillary QBr in Eighth-ray (Second from mid.)</td>
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<td></td>
<td>Br₂</td>
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<tr>
<td>Arms per Ray</td>
<td>4</td>
<td>6</td>
<td>6</td>
<td>8</td>
<td>8</td>
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</tbody>
</table>

F—arkonensis Whiteaves, variabilis Kesling and Smith (some rays).
G—mournantae Goldring (A, B, and E rays), variabilis Kesling and Smith (some rays).
H—decorus Goldring.
I—kentuckiensis (Shumard).
J—mournantae Goldring (C and D rays).

G. carinatus Wood and G. carinatus crassicostatus Goldring by the absence of the flange-like ridges on the BB and spoon-shaped processes on the RR.

Types.—Holotype, UMMP 30519; paratype, BMNS E16586.

Genus Corocrinus Goldring 1923

Type species.—By original designation, Corocrinus ornatus Goldring (1923, p. 202).
**Corocrinus pettyesi**, sp. nov.
(Fig. 2; Pl. II, Figs. 1–7)

*Dorsal cup.*—Cup vase-shaped (Pl. II, Figs. 2–3, 5–6), tapering below *RR* and flaring above *PBrBr*₁, composed of 3 *BB*, 5 *RR*, 5 *PBrBr*₁, 5 *PBrBr*₂, 10 *SBrBr₁*, *X₁* (anal *x*), 3 *XX₂*, 5 *XX₃*, 7 *XX₄*, 9 *XX₅*, 4 *IBrBr₁*, 8 *IBrBr₂*, 12 *IBrBr₃*, and 12 *IBrBr₄* (Fig. 2). Pseudohexameral symmetry as viewed dorsally (Pl. II, Figs. 4, 7), with *X₁* equivalent to *RR*, median *X₂* to *PBrBr*₁, lateral *XX₂* to *IBrBr₁*, median *X₃* to *PBrBr₂*, and lateral *XX₃* to *IBrBr₂*.

*BB* large, equal, flat-based with flanges forming an expanded collar around the circlet (Pl. II, Figs. 3, 5–6). As viewed dorsally (Pl. II, Fig. 7),
forming a hexagon; as viewed laterally, cuplike, rising above expanded collar. Each $B$ ornamented with two conspicuous V-shaped ridges (Pl. II, Figs. 4, 7); each V divergent upward from the basal flange, with one branch normal to the distal border of the plate and the other branch extending to the distolateral border (Fig. 2); a less conspicuous V-shaped costa within and concentric to each ridge.

$RR$ very large, together with $X_1$ forming a cuplike circlet (Pl. II, Fig. 5). Each $R$ about as high as both $PBrBr$ in the ray, its width three-fourths the height. $RR$ of $A$, $C$, and $D$ rays six-sided, with very long sutures with adjacent $RR$ or $X_1$, intermediate suture with $B$, and relatively short sutures with $PBr_1$, $IBr_1$, and $X_2$ or $IBr_2$. $RR$ of $B$ and $E$ rays seven-sided, their ventral ends broadly acuminate between $BB$, otherwise the same size and shape as other $RR$. From median point about two-thirds the height from the base, large median ridge extending upward to $PBr_1$, small ridges to $IBrBr$, or $IBr$, and $X_2$, two ridges divergent downward to $B$ or $BB$, and a costa normal to each side of the plate. Below and parallel to this pair of costae, three additional costae on each side; the upper two reaching the divergent ridges, but the lower one joining a costa paralleling the divergent ridge to form a narrow triangle around each $R-R-B$ or $R-X_1-B$ junction. $BB$ and $RR$ the most highly ornamented plates of the cup; as seen dorsally (Pl. II, Fig. 7), divergent ridges of $RR$ joined to V-shaped ridges of $BB$ to make a petaliform design. Lateral costae of $RR$ forming four rings around cup; the upper one complete, the next two interrupted by the divergent ridges, and the lower one attaining only the costae parallel to the divergent ridges (Pl. II, Figs. 5–6).

$PBr_1$ of each ray narrow, hexagonal, very slightly larger than $PBr_2$. $PBrBr$ of $C$ and $D$ rays bordered laterally by $X_2$, $X_3$, $IBr_1$, and $IBr_2$; those of other rays bordered laterally by 2 $IBrBr_1$ and 2 $IBrBr_2$. Each plate with a broad median ridge occupying over half the $PBr_1$-$PBr_2$ suture and lesser ridges radiating from the center to each of the sides.

$PBr_2$ of each ray septagonal, its height and width nearly equal. Plates of $C$ and $D$ rays bordered laterally by $X_3$, $X_4$, $IBr_2$, and $IBr_3$; others bordered laterally by 2 $IBrBr_2$ and 2 $IBrBr_3$. Each $PBr_2$ ornamented with a broad Y-shaped ridge along the branching of the ray and with small ridges to other adjacent plates.

$SBrBr_1$ of each ray in contact, no intervening $ISBr$; each about three-fourths the size of $PBr_1$, laterally bordered by $IBrBr$ of the third and fourth ranges or by $XX$ of the fourth and fifth ranges. Plates roughly hexagonal, shape somewhat variable. No plates known beyond $SBrBr_1$, but plates not axillary.
IBr$_1$ of each interray about the same size as an adjacent PBr$_1$, hexagonal, bordered by 2 RR, 2 PBrBr$_1$, and 2 IBrBr$_2$, ornamented with radiating small ridges normal to each side.

IBrBr$_2$ hexagonal, the two of each interray equal, bordered by IBr$_1$, PBr$_1$, PBr$_2$, 2 IBrBr$_3$, and the opposite IBr$_2$. IBrBr$_3$ about two-thirds the size of IBr$_1$, higher than wide; higher IBrBr plates decreasing gradually in size, occupying narrow interray area with sides subparallel above IBrBr$_2$. Small ridges radiating from centers to sides of plates, becoming fainter in upper ranges. Median IBr$_3$ pentagonal, followed by hexagonal median IBr$_4$ and IBr$_5$; lateral IBrBr$_3$ and IBrBr$_4$ hexagonal (Fig. 2).

$X_1$ (anal $x$) large, with the same size, shape, and pattern of ornamentation as RR of B and E rays; forming a high circlet with RR. The median ridge leading upward through the anal series much narrower than the corresponding median ridge in RR. Median $X_2$ considerably smaller than PBr$_1$ of each ray, about half the height of $X_1$, hexagonal, its width less than its height. Lateral XX$_2$ about the same size as PBrBr$_1$, hexagonal, higher than wide, each bordered by R, $X_1$, $X_2$, 2 XX$_3$, and PBr$_1$. Five XX$_3$ in zigzag range; median $X_3$ octagonal, higher than wide, slightly smaller than median $X_2$, bordered by $X_3$ below, $X_4$ above, and 2 XX$_3$ and 4 XX$_4$ at the sides; outer $X_4$ slightly smaller, hexagonal, bordered by 2 PBrBr of the adjoining ray, $X_2$, $X_3$, and 2 XX$_4$; intermediate $X_5$ smaller yet, pentagonal, bordered by 2 XX$_2$, 2 XX$_3$, and $X_4$ (Fig. 2). Seven XX$_4$ in zigzag range, all hexagonal; median $X_4$ smaller than any $X_3$. Nine XX$_5$ in irregular range, the outermost bordered by SBr$_1$, the next inserted among 3 XX$_4$, and the median $X_5$ hexagonal. Other XX small and irregular. Median ridge of the posterior interray larger than other ridges; XX plates ornamented with ridges radiating from centers to sides, decreasing upward and becoming indistinct at about the fifth range.

Dimensions of holotype: height from BB to top of SBrBr$_1$, 18.7 mm; diameter of BB circlet just above basal ridge, 5.0 mm; diameter of cup at RR-PBrBr$_1$ level, 12.0 mm (mean); height of RR and $X_1$, 7.0 mm (mean).

Remarks.—This species can be distinguished from the type species, Corocrinus ornatus Goldring (1923, pp. 203–5, Pl. 26, Figs. 2–4, Text-fig. 47), from the Middle Devonian Ludlowville Formation of New York, by its much larger RR and $X_1$, parallel rings of costae around the RR-$X_1$ circlet, collar-like ridge on the BB, and narrower interrays.

Types.—Holotype, UMMP 30529; paratypes, BMNS E16585a–b.
LITERATURE CITED


*Manuscript submitted July 3, 1964*

PLATES
EXPLANATION OF PLATE I
(Figures × 3, except as noted)

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Figs. 1–2. Dorsal (basal) and ventral (tegmina) views of holotype, UMMP 30519. In each view, posterior (CD) interray uppermost.

Figs. 3–5, 7. Inclined lateral views of holotype centered on AB, BC, CD, and AE interrays. The AB interray (Fig. 3) contains 3 IBvBr2, in contrast to other interrays which have only 2 plates.

Fig. 6. Lateral view of holotype centered on DE interray.

Fig. 8. Dorsal (basal) view of paratype, BMNS E16586, × 2. The CD interray is at the right. The A ray shows axillary TBr2. Facet for articulation with column is depressed in BB circlet.
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EXPLANATION OF PLATE II
(All figures × 3)

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Fig. 1. Lateral view of paratype, BMNS E16585a, an incomplete cup. The interray at the right has 4 IBrBr₆, one of which is very small.

Figs. 2–4. Two lateral and dorsal (basal) views of paratype, BMNS E16585b. This specimen was deeply sculptured in what would seem to have been a cleaning attempt by some previous investigator. As a result, it is impossible to identify the rays.

Figs. 5–7. Two lateral and dorsal (basal) views of holotype, UMMP 30529. The posterior (CD) interray is on the right side of Figure 5. The crinoid is unknown beyond SBrBr₇.