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

BY

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VOLUME XIX

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

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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 $IBrBr_3$ in each interray, smooth tegminal plates except for one central tubercle, and six arms in each ray formed on axillary PBr_2, $SBrBr_1$, and free $TBrBr_3$ on the inner quarter-rays. *Corocrinus pettyesi* is characterized by basal flanges on the *BB* and by very large *RR* and X_1 (anal *x*), nearly twice the size of $PBrBr_1$, provided with double ridges extending onto *BB*.

CONTENTS

INTRODUCTION

ALTHOUGH 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 SE¼, 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 Periechocriniticae 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*$_1$,

5 $PBrBr_2$, 10 $SBrBr_1$, 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.

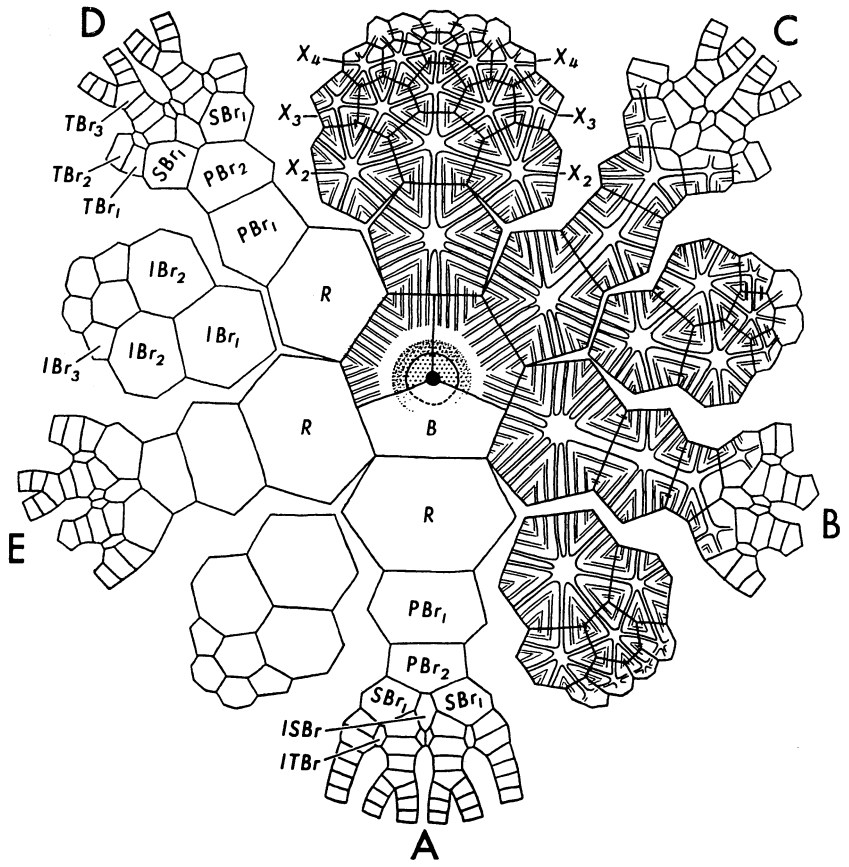


FIG. 1. *Gennaeocrinus romingeri*, sp. nov. Labeled plate diagram, with pattern of ornamentation indicated on some rays and interrays.

RR very large, together with the similar X_1 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*, IBr_1, PBr_1, X_2, and X_1; those of B and E rays (Pl. I, Figs. 3–4, 6–7) bounded by a pair of *BB*, 2 *RR*, 2 $IBrBr_1$, and PBr_1; that of A ray (Pl. I, Figs. 3, 7) in contact with 1 *B*, 2 *RR*, 2 $IBrBr_1$, and PBr_1. Each plate ornamented with a thick ridge from its center to PBr_1 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 X_1, five or six lateroventrally onto $IBrBr_1$ or IBr_1 and X_2, and about four dorsally onto PBr_1; ridge much higher than costae and nearly three times as wide as each costa.

$PBrBr_1$ 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*, X_2, PBr_1, IBr_2, and IBr_1, hence five-sided; those of other rays bounded by *R*, 2 $IBrBr_1$, 2 $IBrBr_2$, and PBr_1, hence six-sided as normal for the genus. Each PBr_1 ornamented with a thick median ridge extending from *R* to PBr_2 and with regularly spaced costae normal to the sides, about four extending onto *R*, five or six onto each IBr_1, four or five onto each IBr_2, and four onto PBr_2.

$PBrBr_2$ axillary (Fig. 1); those of the two posterior (C and D) rays each bordered by PBr_1, X_2, X_3, 2 $SBrBr_1$, $ISBr_1$, and IBr_2, hence seven-sided; those of other rays normally bordered by PBr_1, 2 $IBrBr_2$, 2 $SBrBr_1$, and $ISBr_1$, hence six-sided (subpentagonal except for narrow dorsal contact with small $ISBr_1$). Each PBr_2 ornamented with strong ridges in form of Y, radiating from center to PBr_1 and $SBrBr_2$, and with a few costae normal to sides bordering PBr_1 and $IBrBr_2$ or IBr_2, X_2, and X_3.

$SBrBr_1$ axillary (Fig. 1); those of half-rays at sides of posterior (CD) interray each bordered by PBr_2, X_3, X_4, 2 $TBrBr_1$, $ITBr_1$, and $ISBr_1$; others bordered by PBr_2, IBr_2, 2 $TBrBr_1$, $ITBr_1$, $ISBr_1$, and (in some) by IBr_3, hence six- or seven-sided. Each SBr_1 ornamented with pronounced ridges in form of Y, outlining the branching of the ray.

$TBrBr_1$ incorporated in calyx, other *TBrBr* free. $TBrBr_3$ on inner quarter-rays axillary, so that each ray bears 6 arms (Pl. I, Fig. 8).

$ISBrBr_1$ very narrow. $ITBrBr_1$ small. Other interbrachials small and irregular, their boundaries indistinct.

$IBrBr_1$ about the same size as $PBrBr_1$, normally hexagonal, bordered by 2 *RR*, 2 $PBrBr_1$, and 2 $IBrBr_2$. In AB interray of holotype (Pl. I, Fig. 3), IBr_1 larger than other $IBrBr_1$, bordered ventrally by 3 $IBrBr_2$ and hence seven-sided. IBr_1 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_2, 2 $IBrBr_3$, SBr_1, 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 $IBrBr_2$ (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 $IBrBr_1$ 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.

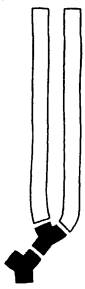
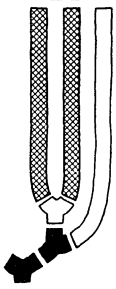
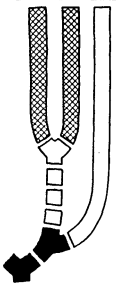
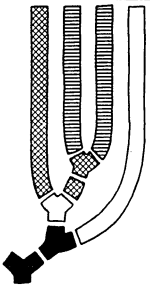
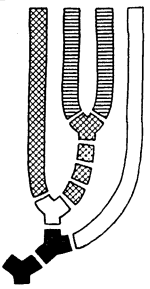
Tegmen.—Tegmen (Pl. I, Fig. 2) gently arched, divided into lobate ambulacral areas by radiating interambulacral channels or grooves. Openings for arms large, proximodistally elongate, set atop tegmen rather than on beveled junction of dorsal cup and tegmen. Numerous small plates with indistinct sutures. 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*$_2$ and *SBrBr* shown in solid black, *TBrBr* in outline, *QBrBr* doubly cross-hatched, and quinque-brachials horizontally ruled.

Type / Character	A	B	C	D	E
Pattern					
Axillary *SBr*	SBr_1	SBr_1	SBr_1	SBr_1	SBr_1
Axillary *TBr* in Quarter-ray, Outer					
Axillary *TBr* in Quarter-ray, Inner		TBr_1	TBr_4	TBr_1	TBr_1
Axillary *QBr* in Eighth-ray (Second from mid.)				Br_2	Br_4
Arms per Ray	4	6	6	8	8

Branching types are known to occur as follows:

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

B—*carinatus* Wood, *carinatus crassicostatus* Goldring, *comptus* Rowley, *comptus spiniferus* Rowley, *facetus* Rowley, *goldringae* Ehlers, *peculiaris* Goldring (some rays).

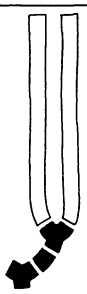
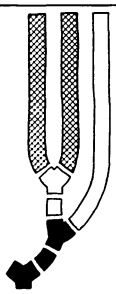
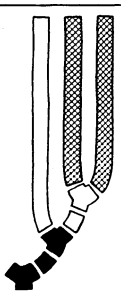
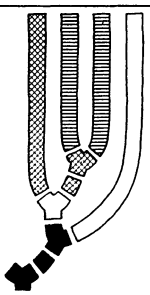
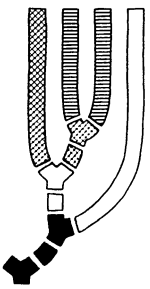
C—*romingeri,* sp. nov.

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 $IBrBr_3$ in each interray, whereas *G. kentuckiensis* has uneven or interrupted costae and four or five $IBrBr_3$ in each interray. The new species is readily separated from

TABLE I (*Cont'd*)

Character \ Type	F	G	H	I	J
Pattern					
Axillary *SBr*	SBr_2	SBr_2	SBr_2	SBr_2	SBr_2
Axillary *TBr* in Quarter-ray — Outer			TBr_2		
Axillary *TBr* in Quarter-ray — Inner		TBr_2		TBr_1	TBr_2
Axillary *QBr* in Eighth-ray (Second from mid.)				Br_2	Br_2
Arms per Ray	4	6	6	8	8

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

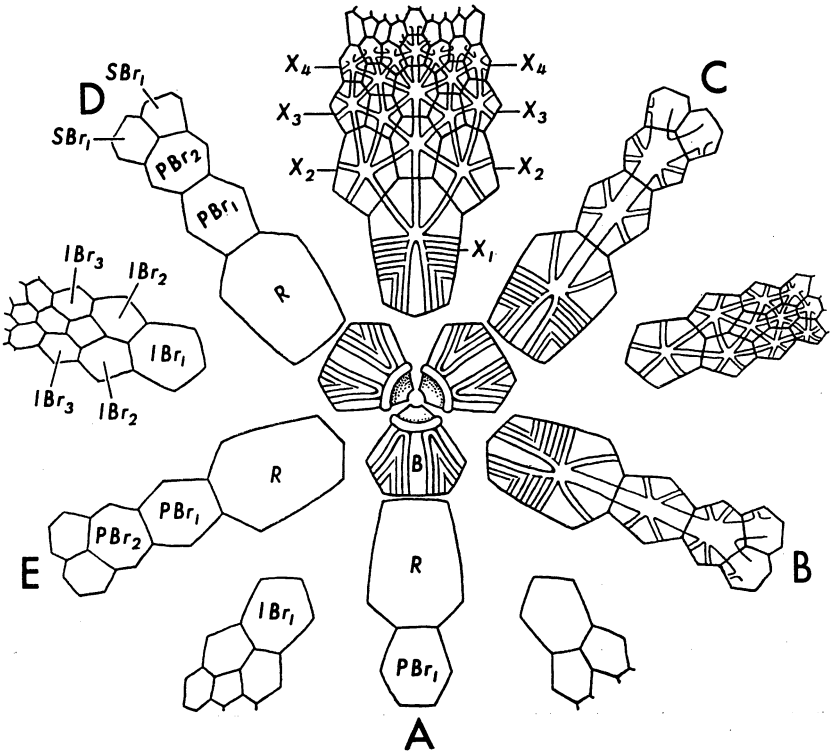


FIG. 2. *Corocrinus pettyesi,* sp. nov. Labeled plate diagram, with pattern of ornamentation indicated on some rays and interrays.

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 $SBrBr_1$, X_1 (anal *x*), 3 XX_2, 5 XX_3, 7 XX_4, 9 XX_5, 4 $IBrBr_1$, 8 $IBrBr_2$, 12 $IBrBr_3$, and 12 $IBrBr_4$ (Fig. 2). Pseudohexameral symmetry as viewed dorsally (Pl. II, Figs. 4, 7), with X_1 equivalent to *RR*, median X_2 to $PBrBr_1$, lateral XX_2 to $IBrBr_1$, median X_3 to $PBrBr_2$, and lateral XX_3 to $IBrBr_2$.

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_1. *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 $IBrBr_1$ or IBr_1 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 $R\text{-}X_1\text{-}B$ 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. $PBrBr_1$ 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 $PBr_1\text{-}PBr_2$ 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_2, 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. $IBrBr_2$ 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_2 below, X_4 above, and 2 XX_3 and 4 XX_4 at the sides; outer X_3 slightly smaller, hexagonal, bordered by 2 *PBrBr* of the adjoining ray, X_2, X_3, and 2 XX_4; intermediate X_3 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 E16585*a–b*.

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Manuscript submitted July 3, 1964

PLATES

EXPLANATION OF PLATE I

(Figures × 3, except as noted)

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Gennaeocrinus romingeri, sp. nov. 144

FIGS. 1–2. Dorsal (basal) and ventral (tegminal) 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 $IBrBr_2$, 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 TBr_3. Facet for articulation with column is depressed in *BB* circlet.

PLATE I

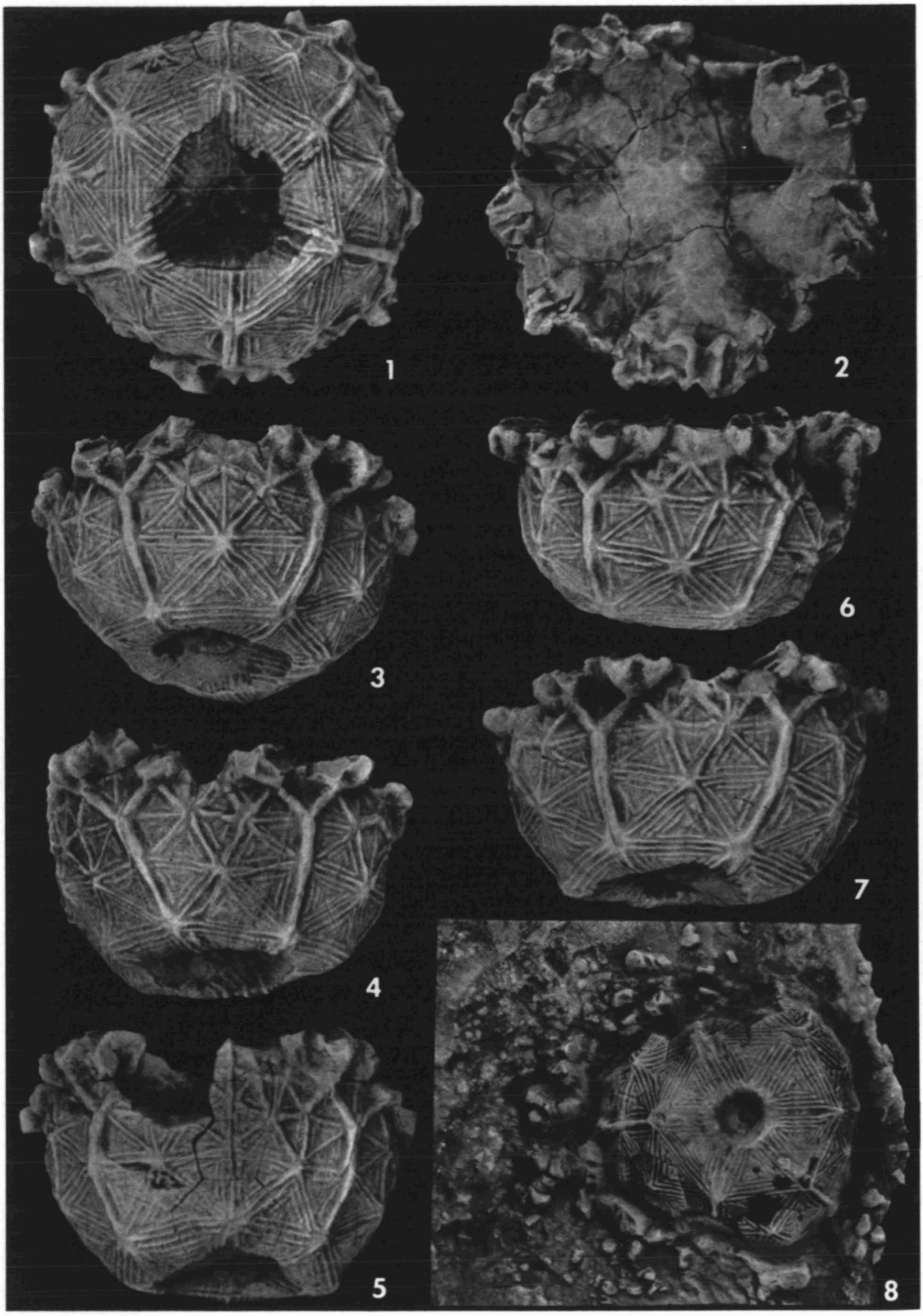
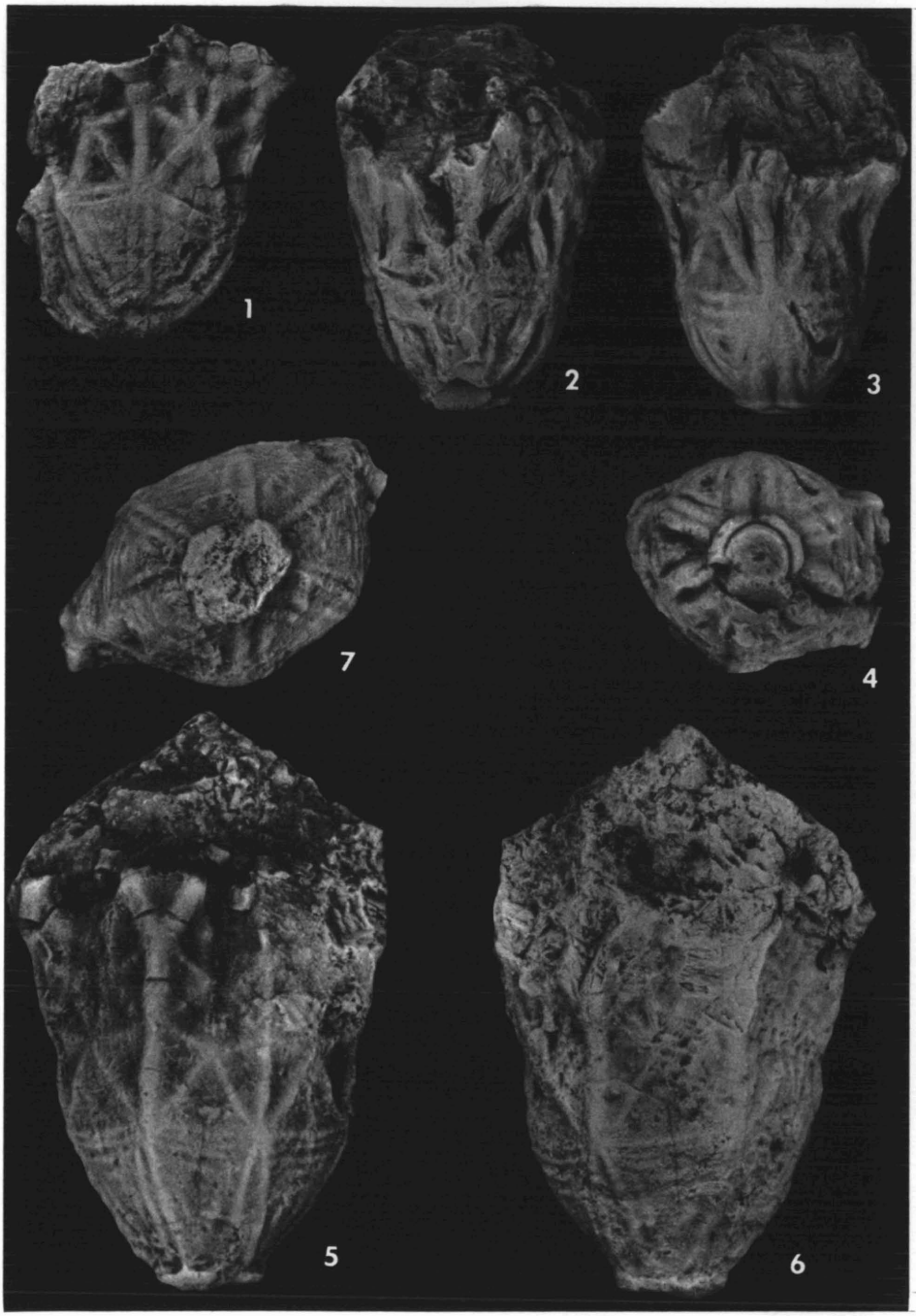


PLATE II



EXPLANATION OF PLATE II

(All figures × 3)

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Corocrinus pettyesi, sp. nov. 150

FIG. 1. Lateral view of paratype, BMNS E16585*a*, an incomplete cup. The interray at the right has 4 *IBrBr*$_3$, one of which is very small.

FIGS. 2–4. Two lateral and dorsal (basal) views of paratype, BMNS E16585*b*. 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 *SBrBr*$_1$.