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A NEW *GLYPTOCYSTITES* FROM MIDDLE ORDOVICIAN STRATA OF MICHIGAN

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Volume XVII

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CONTENTS

INTRODUCTION

A NEW SPECIES of the rhombiferan cystoid *Glyptocystites* has been recently found in the Middle Ordovician strata of Michigan. It has been named in honor of Dr. George Marion Ehlers, Curator of Paleozoic Invertebrates at the Museum of Paleontology of The University of Michigan, who is now in the year of his retirement furlough.

On August 30, 1960, I talked to Mr. Arthur Slaughter, of the Geological Survey Division of the Michigan Department of Conservation at Escanaba, about exposures of Ordovician rocks in the Northern Peninsula of this state. He mentioned small quarries just south of Trombly, in Delta County, which were operated some years ago for road metal. The following day, with Mr. Herbert W. Wienert, his son Andrew, and my son Bradham, I collected in the western, and older, of the two quarries, in which the fossils were partly weathered from the thin shaly layers. During the morning I found the specimen described in this paper. A few days later we returned with my older son Robert, Jr. for a concerted search, but we found no more cystoids.

As discovered, the specimen was partly embedded in calcareous shale matrix. Successive brief treatments with potassium hydroxide pellets loosened the cement in this adhering rock, which was then carefully removed with brushes, fine chisels, and needles. The cystoid was found to be very well preserved, although, as typical for glyptocystitids, some of the ambulacral plates had scaled off from the theca. Only a short section of the stem was present. Part of this was purposely broken off to clean the basal plates and to photograph the aboral views. It was then cemented in its original position.

The specimen is particularly significant because it becomes the holotype for the fifth known species of *Glyptocystites*. It is also the first specimen of the genus found in the United States; all discovered previously were in Canada.

The manuscript was critically reviewed by Dr. L. B. Kellum and Dr. C. A. Arnold. The specimen is catalogued and deposited in the Museum of Paleontology of The University of Michigan as UMMP No. 37254.

LOCALITY

Small quarry ½ mile south of Trombly, near the center of sec. 14, T. 42 N., R. 23 W., in northwestern Delta County, Michigan. Access to the quarry is from old highway M35, which is on the west side of the Chicago and Northwestern Railway right-of-way; present highway M 35 is along the east side of the right-of-way. Strata exposed in the quarry consist of numerous alternating thin beds of gray to bluish-gray, finegrained limestone and bluish-gray calcareous shale. Both the limestone and shale beds weather to buff. Certain beds are much more fossiliferous than others. Middle Ordovician Trenton group.

TERMINOLOGY OF THE RHOMBIFERA

Because hydrophorideans have been extinct since the Middle Devonian period, their mode of life can only be inferred and the function of their various structures remains a matter of hypothesis. The pore rhombs (or pectinirhombs), which characterize the Rhombifera, are features which seem to have no homologues in living echinoderms.

In the family Glyptocystitidae, pore rhombs develop only along certain sutures, as Bather discovered in 1900 (pp. 58–59, Fig. 20) and revised in 1913 (p. 439, Fig. 45). The absence of pore rhombs marks a pathway around the theca from the peristome to the periproct, as indicated by the dotted area in Figure 2*b*. Bather (1900, p. 439) explained the distribution of pore rhombs by: "The diminution of the thecal cavity, we may suppose, pressed the coil of the gut against the body wall; thus the respiratory function was hindered in the pore-rhombs along this tract, so that they disappeared."

Sinclair (1948, p. 309) called attention to an additional pore rhomb overlooked by Bather, and (p. 308) proposed a very different explanation for the peculiar distribution. Like Bather, he supposed that the rhomb-free area traced the external position of the gut, but, in his opinion, rhombs never existed along this pathway because they developed solely for respiration of the coeloms, which could not, of course, have occupied the space where the gut lay coiled. Although it cannot be proved, except perhaps by discovery of exceptional specimens in which all soft parts have been fossilized, Sinclair's theory of the function of the rhombs and their association with the coeloms is intriguing and seems entirely plausible.

Sinclair further (1948, pp. 306–7) explained the ridge along the inner face of one-half of each rhomb as a device for deflecting the excurrent water, insuring against recycling in this part of the respiratory system. His pattern of ridge distribution in *Glyptocystites,* shown here in Figure 2*b,* does not entirely agree with that in the specimen described here, as will be discussed below.

A more serious hindrance to study of rhombiferans than the suppositions about function is the confused terminology for radii, ambulacra, and thecal plates. In many rhombiferans the peristome is long and angled at the middle, with one ambulacrum extending from the angle and two diverging from each end. This arrangement is found in many other pelmatozoans, and was termed "trimerous" in the edrioasteroids by Foerste (1914, p. 412). Bather (1900, p. 110) tabulated the terms used for crinoids. He preferred to call the ambulacrum from the middle of the peristome the "anterior radius," and, as viewed from above, the others became the "right antero-lateral," "right posterior," "left antero-lateral," and "left posterior." The wide interambulacrum opposite the anterior radius was thus the "posterior interradius." Not only are such designations difficult to use, especially in comparisons, but the orientation implied by "anterior" and "posterior" has not known physiological basis.

A much simpler set of designations had previously been used by Jaekel for crinoids and by Lovén for echinoids. Starting with the "posterior interradius" of Bather's terminology and proceeding clockwise with the peristome uppermost, they numbered the ambulacra from I to V in Roman numerals and the interambulacra from 1 to 5 in Arabic numerals. Thus, the anterior ambulacrum was III and the posterior interambulacrum was 5.

Certain difficulties arise in applying the system to rhombiferans. Whereas in most pelmatozoans the anus or periproct, the hydropore or madreporite, and the gonopore lie in interambulacrum 5, in certain rhombiferans the periproct has shifted to 4. Invariably, however, the hydropore and gonopore, if present, are in 5, the interambulacrum opposite to the ambulacrum which extends from the middle of the peristome. Jaekel (1899, Pl. 15, Fig. 4a) started numbering the ambulacra of *Glyptocystites multipora* from the interambulacrum with the periproct (4), disregarding the trimerous-pentameral symmetry of the ambulacral pattern and the location of the hydropore and gonopore. It seems that the constant association of symmetry, hydropore, and gonopore is more significant than the position of the periproct, and is used as the basis of designation here.

Another problem arises in the Rhombifera in choosing between the terms "radius" and "ambulacrum." This may seem to be a trivial distinction for *Glyptocystites,* which has five ambulacra. But for many genera, which have fewer ambulacra (some only two), a difficulty exists. The thecal plates of Glyptocystitacea with fewer ambulacra correspond directly with the plates of those having five. Therefore, it would appear better to use "radius" to refer to position of thecal plates and reserve "ambulacrum" for the actual ambulacrum, which in glyptocystitaceans grew outward from the peristome and was loosely attached on the thecal plates.

The terms "hydropore" and "gonopore" are used in the conventional manner, with no proof yet presented that one is the adit to the water-vascular system and the other is the exit from the genital system.

The thecal plates in the Glyptocystitacea are basically 24–4 basals and 5 each of infralaterals, laterals, radials, and deltoids or orals. Some species have one or more of these plates divided, but the parts of the divided plate are apparently homologous with the single plate in other species.

TABLE I

COMPARISON OF NAMES FOR SYMBOLS FOR CYSTOID PLATES BY JAEKEL (1899), BATHER (1900), AND REGNÉLL (1945)

Author	Name	Symbol	Name	Symbol
Jaekel	Basalia	b_1 b_2 b_3 b_4	Infralateralia	l_1 l_2 l_3 l_4 l_5
Bather	Aboral circlet	2 1 4 3	Second circlet	6 5 9 8 7
Regnéll	Basals	*B1 B2 B3 B4*	Infralaterals	*IL1 IL2 IL3 IL4 IL5*

Author	Name	Symbol	Name	Symbol
Jaekel	Mediolateralia	l_1' l_2' l_3' l_4' l_5'	Radiolateralia	l_1'' l_2'' l_3'' l_4'' l_5''
Bather	Third circlet	12 11 10 14 13	Fourth circlet	17 16 15 19 18
Regnéll	Laterals	*L1 L2 L3 L4 L5*	Radials	*R1 R2 R3 R4 R5*

Author	Name	Symbol	Name		
Jaekel	Deltoidea	l_1''' l_2''' l_3''' l_4''' l_5'''	Afterlücke	Ambulacra	Finger
Bather	Oral circlet	23 22 21 20 24	Anal area	Subvective groove	Brachiole
Regnéll	Orals	*O1 O2 O3 O4 O5*	Periproct	Ambulacra	Brachiole

As indicated in Table I, three systems of symbols have been used for thecal plates. Each system is based on a hypothetical theca in which: cycles of basals, infralaterals, laterals, and radials encircle the theca and are contiguous; the deltoids or orals are in a row and would be contiguous except for intervening ambulacra or peristome; one basal, one lateral, and one deltoid lie in interradius 5; and one infralateral and one radial lie in radius I. Jaekel (1899) numbered the plates in each cycle clockwise as seen in oral view, starting with the first basal (b_1), the first lateral (l_1'), and the first deltoid (l_1''') in interradius 5, and the first infralateral (l_1) and the first radial (l_1'') in radius I. Bather (1900) started numbering with the basal which invariably contains half of at least one pore rhomb (b_2 of Jaekel) and continued counterclockwise (as viewed orally) in a spiral to the peristome. Regnéll (1945) used Jaekel's system with different symbols. A more logical system than any of these would start with the first basal in interradius 1, the first infralateral in radius I, and so on. Because the confusion can scarcely be dissipated by introduction of still another system, I have used the designations of Regnéll.

One might expect universal agreement on identity of the various plates in *Glyptocystites,* regardless of the system of symbols employed. This is not so. From 1854 until 1945 *Glyptocystites* was known only from its type species, although several other species were erroneously assigned to it. Knowledge of the genus was based on the type. In his detailed "Stammesgeschichte" of 1899, Jaekel gave an analysis of the thecal plates on page 197 in his Figure 36H, here reproduced as Figure 1*a*. In it the ambulacra do not correspond to the radial plates; ambulacrum IV crosses the fourth deltoid (*O4*) and V crosses the fourth radial (*R4*). This difficulty was occasioned by six large plates in the suboral circle. By the time Jaekel reached page 268 in his writing he realized that this analysis could not be correct, so in Figure 54 (here shown as Fig. 1*b*), he altered his plate

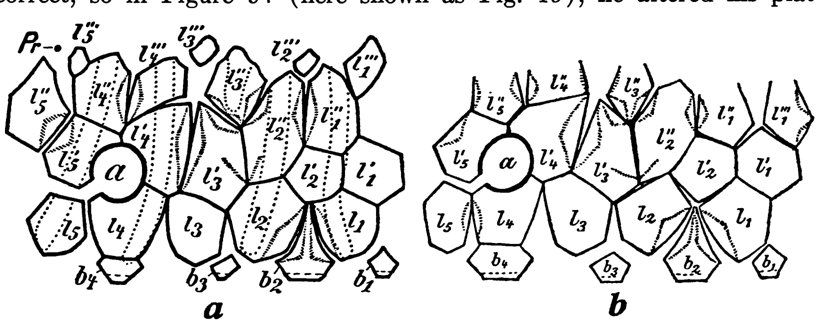

FIG. 1. *Glyptocystites multiporus* Billings. *a,* plate analysis of the genus as proposed by Jaekel, 1899, Fig. 36H. Ambulacra outlined by dots. *b,* Jaekel's revision, published in the same work, first as Fig. 54 and repeated as Fig. 57. Both from Jaekel.

designations so that the radials were crossed by the corresponding ambulacra; he also added two pore rhombs. Still puzzled by the circle of six plates in the radial position, Jaekel identified one as the first deltoid (the plate that he previously had called the fifth radial); apparently unable to resolve the plates in the oral circle, he omitted them.

Bather (1900, Fig. 33) changed the plate analysis for *Glyptocystites multiporus* so that there were only five plates in the radial circle, as shown in Figure *2a* here. His plate 17 corresponds to plates l_1'' and l_5'' in Jaekel's Figure 36H and to plates l_1'' and l_1''' in Jaekel's Figure 54. Sinclair gave a plate diagram for the genus (1948, Fig. 4) adapted from Bather's figure (see Fig. *2b* here).

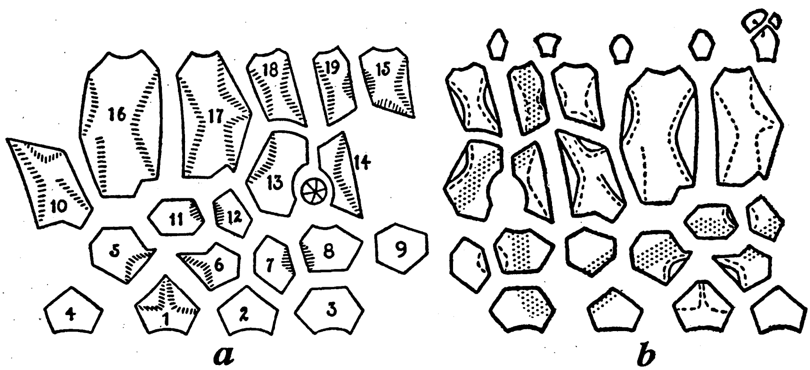

FIG. 2. *a, Glyptocystites multiporus* Billings. Plate analysis offered by Bather, 1900, Fig. 33. From Bather. *b, Glyptocystites.* Revision of Bather's figure by Sinclair, 1948, Fig. 4, in which pore rhombs are indicated by dashed lines and associated ridges by solid lines. After Sinclair, but modified as follows: his numbers (he adopted the system of Bather, shown in Fig. *2a*) have been deleted; the plates have been rearranged to accord with the analyses by Jaekel (see Fig. *1a–b*); and dotted areas have been added to indicate the hypothetical course of the gut, approximately as proposed for the Glyptocystitidae by Bather (1900, pp. 58–59, Fig. 20; 1913, p. 439, Fig. 45) and endorsed by Foerste (1914, pp. 456–57, Fig. 2) and Sinclair (1948, p. 309).

In *Glyptocystites, R1* (Bather's plate 17) is crossed by ambulacrum I. In the specimen described below, the ambulacrum also conceals the line along which *R1* may be divided into two parts (see Fig. 3). The acute apex on the oral side of *L1* leads me to believe that it is bordered there by two plates, which I have called *R1* and *R1a* (see Fig. 4). In other words, I suppose, as did Jaekel, that there are six plates in the radial circle, but I disagree with Jaekel's contention that one of them must be accounted as a deltoid. Other plates, however, such as *L3* are indented along one border; Billings (1858, p. 53) observed of *Glyptocystites* that "all species

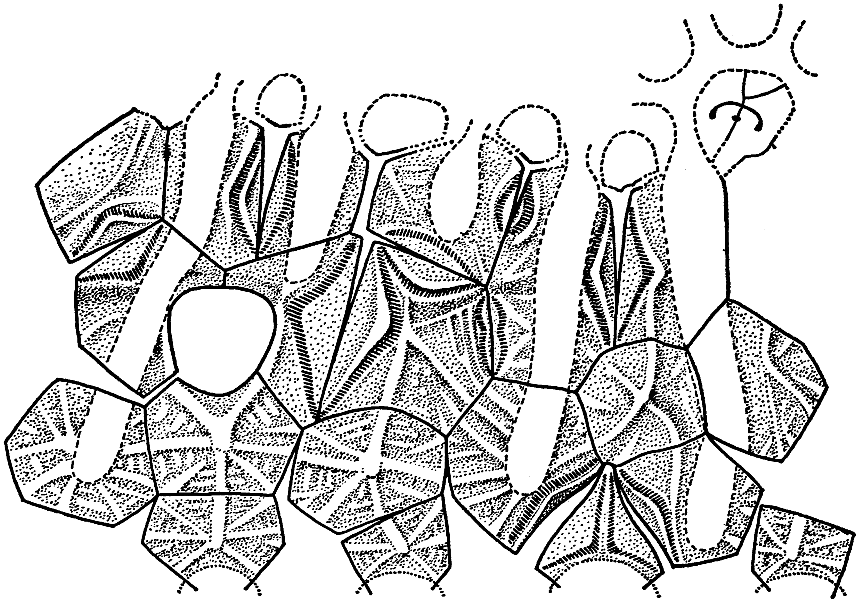

FIG. 3. *Glyptocystites ehlersi,* sp. nov. Plates in much the same arrangement as that in Jaekel's analysis of the genus (see Fig. 1*a*). Dashed lines represent borders of the ambulacra, coarse dotted lines the inferred borders of radials where covered by ambulacra, and fine dotted lines the contact of stem and basals. Each plate drawn with aid of camera lucida to the same magnification, with the specimen oriented to give minimum distortion. Analysis of plates given in Fig. 4, below.

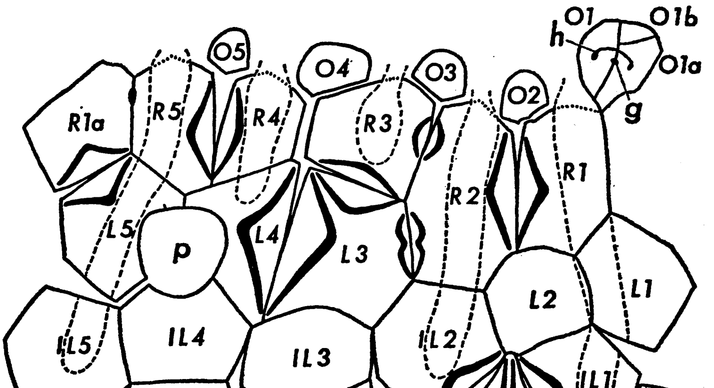

FIG. 4. *Glyptocystites ehlersi,* sp. nov. Plate analysis. In addition to plate symbols, the following abbreviations are used: *g,* gonopore; *h,* hydropore, and *p,* periproct. Dashed lines outline the ambulacra, dotted lines indicate inferred boundaries of plates where covered by ambulacra, and black areas represent pore rhombs.

of the genus yet observed have some (plates) with re-entering angles." The question of whether *R1* is divided or not can be decided only by removing the covering ambulacral plates of I. No worker has yet wished to so mutilate a specimen. As indicated by Sinclair, *O1* is divided into three parts, which I have termed *O1, O1a,* and *O1b*. In the first analysis by Jaekel (see Fig. 1*a*), two deltoids were omitted and his l_1''' and l_5''' are parts of *O1*.

SYSTEMATIC DESCRIPTION

Phylum ECHINODERMATA
Subphylum PELMATOZOA
Class CYSTOIDEA Buch
Subclass HYDROPHORIDEA Zittel
Order RHOMBIFERA Zittel
Superfamily Glyptocystitacea Jaekel
(Regularia Jaekel 1899; Glyptocystidea Bather 1913; Glyptocystitida Regnéll 1945)

Family Glyptocystitidae Jaekel
Subfamily Glyptocystitinae Jaekel
Genus *Glyptocystites* Billings 1854, emend. Sinclair 1948

Glyptocystites ehlersi, sp. nov.

(Pl. I, Figs. 1–15; Pl. II, Figs. 1–4; Pl. III, Figs. 1–4)

Diagnosis.—Large *Glyptocystites* species with elongate pear-shaped theca bearing ornamental and intrarhombic ridges of intermediate prominence. In addition to rhombs *B2/IL1, B2/IL2, L3/L4, L3/R2, L3/R3, R1/R2, R1/R5, R2/R3,* and *R4/R5,* found on all species of the genus, rhomb present along *L5/R1;* rhomb *R1/R5* rudimentary. Ambulacrum III short as in all species; ambulacrum IV of intermediate length as in *G. regnelli.*

Description.—Form: Theca elongate ovoid, with an indentation at the periproct (Pl. I, Figs. 3, 10) causing it to be pear-shaped; larger end aboral. Sides distinctly tapering orad above infralaterals. Deltoids set at an angle; hence theca acuminate to the peristome (Pl. I, Figs. 1, 3). Length 31 mm. Greatest width less than two-thirds the length. Stem 7 mm in diameter at the junction with the theca.

Thecal plates: Basals with about equal junctions with the stem (Pl. I, Fig. 7); *B2* higher than other basals, in contact with *L2* and separating *IL1* from *IL2* (Figs. 3–4; Pl. I, Fig. 12; Pl. III, Figs. 1, 3); *B1* and *B3* pentagonal and *B4* hexagonal as in other species, with long sutures between *B1/IL5, B3/IL3,* and *B4/IL4.* Infralaterals encircling theca except where interrupted by apex of *B2,* all of nearly the same size; *IL2* the only one in contact with the radial series; *IL3* with a convex dorsal border (Pl. I, Fig. 8; Pl. II, Fig. 4) in contact with *L3* and the aboral end of *L4* (Pl. I, Fig. 9); *IL4* bordered orally by *L4,* the periproct, and *L5* (Pl. I, Fig. 9; Pl. II, Figs. 3–4). Ambulacra I, II, and V extending onto and terminating on the respective infralaterals, *IL1, IL2,* and *IL5.*

Ring of laterals interrupted by *IL2* and *R2; L2* rather small, *L1, L4,* and *L5* intermediate and *L3* large. *L4* in contact with *L5* only along a short segment above the periproct (Pl. I, Fig. 9); *L1* orally acuminate. Radials large, forming a complete ring; *R3* containing terminus of ambulacrum III, other radials crossed by the respective ambulacra (Fig. 4). *R1* the largest radial (Pl. I, Fig. 11), probably consisting of two plates (*R1* and *R1a* in Fig. 4) as suggested by the sharp aboral indentation at the junction with *L1,* although position of suture between proposed plates covered by right side of ambulacrum I. *R2* large and elongate, extending to *IL2* and interrupting ring of laterals; *R3* broad, aborally in contact with *L3* and the tip of *L4* (Fig. 4; Pl. I, Fig. 8; Pl. II, Fig. 4); *R4* and *R5* small, both in contact with *L4* (Pl. I, Fig. 9).

Deltoids in interambulacral positions (Pl. III, Fig. 4), their oral borders concealed by ambulacral and peristomial plates. First deltoid divided into three plates, *O1, O1a,* and *O1b* (Fig. 4); aboral plate (*O1a*) extending across posterior interradius, oral plate on the left large (*O1*) and the one on the right small (*O1b*); hydropore and gonopore bisected by suture *O1/O1a* (Pl. III, Fig. 4). *O2* and *O5* smaller than other deltoids.

Ornamentation: Theca with ridges slightly more prominent than those of *G. batheri* but not as strong as those of *G. regnelli.* Each plate with low, inconspicuous tubercles, more or less arranged in rows parallel to the border. Apart from the ridges associated with pore rhombs (discussed under pore rhombs), those of basals and infralaterals more or less arranged radially from the centers of plates, those of laterals and radials strongly modified from this pattern, and the deltoids essentially smooth (Fig. 3). Ridges extending from the center of each basal toward the centers of those adjacent, forming a square around the stem with aborally protuberant corners (Pl. I, Fig. 7). *B2* otherwise unornamented, with much of its surface occupied by two pore rhombs. Rather strong radial ridges on *B1, B3,* and *B4,* with fairly good alignment of low tubercles in rows parallel to the boundary, producing a pattern like a spider's web.

Infralaterals ornamented like most basals, except where *IL1, IL2,* and *IL5* covered by parts of the corresponding ambulacra. A long longitudinal ridge beginning on *IL1* between ambulacrum I and pore rhomb *B2/IL1*, continuing to the center of *L2*, and thence orad to the top of *R1* along the left side of the plate between the ambulacrum and rhomb *R1/R2* (Pl. III, Figs. 1, 3). *IL2* with three parallel ridges perpendicular to the border with *L3* (Pl. I, Figs. 13–15). *IL4* with two ridges diverging from the center and continuing on *L4* and *L5* around the periproct. A long zigzag longitudinal ridge starting on *IL5* and continuing on *L1* and *R1a* (Pl. I, Figs. 10–11).

Laterals and radials with ornamental ridges strongly limited by ambulacra and pore rhombs. *L2* with three strong radial ridges; *L3* with radial ridges to *IL2* and *IL3*. Ridge on *L4* joined to platform on which ambulacrum IV rests (Pl. II, Fig. 4).

Pore rhombs: Ten pore rhombs variously developed (Table II), nine with a ridge along the inner edge of the slits. In the following list, plate bearing the ridge denoted by boldface type: *B2/**IL1*** symmetrical, large (Pl. III, Fig. 3), with 43 disjunct slits in each half; *B2/**IL2*** also with 43 disjunct slits in each half; ***L3**/L4* very well developed, with 63 slits in

TABLE II

DISTRIBUTION OF PORE RHOMBS IN SPECIES OF *GLYPTOCYSTITES**

Rhomb	Species				
	multipora Billings 1854	*grandis* Sinclair 1945	*batheri* Sinclair 1948	*regnelli* Sinclair 1948	*ehlersi*, sp. nov.
B2/IL1 (1/6)	+	+	+	+	+
B2/IL2 (1/5)	+	+	+	+	+
IL4/IL5 (7/8)	+	—	+	?	—
L1/L2 (11/12)	±	2	—	—	—
L1/R1 (12/17)	+	—	?	—	—
L3/L4 (10/14)	+	+	+	+	+
L3/R2 (10/16)	+	+	+	+	+
L3/R3 (10/15)	+	+	+	+	+
L5/R1 (13/17)	+	—	?	—	+
L5/R5 (13/18)	—	—	+	—	—
R1/R2 (16/17)	+	+	+	+	+
R1/R5 (17/18)	+	+	+	+	+
R2/R3 (15/16)	+	+	+	+	+
R3/R4 (15/19)	+	+	+	—	—
R4/R5 (18/19)	+	+	+	+	+

* Data on previously described species from Sinclair, 1948, Table 1. The following symbols are used: +, always present; ±, present only in some specimens; —, never present; ?, not seen; and 2, two rhombs on suture. After the rhomb symbols used in this paper, the symbols of Bather are given in parentheses for quick comparison.

each half, of which the aboral 3 are conjunct (Pl. II, Fig. 4); ***L3***/*R2* with slits not arranged in diverging straight rows ("Halbraute" of Jaekel, 1899, p. 203) as in other species, but in doubly arcuate rows with the oral ends apart (Pl. II, Fig. 2), each half having 26 slits with the aboral one conjunct. ***L3***/*R3* lying athwart the aboral end of ambulacrum III (Pl. II, Fig. 2), each half bearing 27 disjunct slits; *L5*/***R1a*** symmetrical, each half with 38 disjunct slits (Pl. II, Fig. 3); *R1*/***R2*** long and symmetrical (Pl. II, Fig. 1; Pl. III, Fig. 3), each half with 47 disjunct slits; ***R2***/*R3* consisting of two arcs joined orally but not aborally (Pl. II, Figs. 1–2), each half with 18 slits of which the 3 oral are conjunct. *R4*/***R5*** having 37 slits of which 3 oral and 3 aboral are conjunct; *R1a*/*R5* rudimentary, consisting only of 6 short conjunct slits along the oral half of the suture (Pl. II, Fig. 3).

Pore rhombs distributed rather evenly over surface of theca except for a longitudinal strip between *R1*/*R2* and *L5*/*R1a;* strip contains ambulacrum I, hydropore, gonopore, and most of interambulacrum 5.

Ambulacra: Ambulacra I, II, and V long, extending to corresponding infralateral plates; III short, terminating on *R3;* and IV intermediate, crossing *R4* to the oral part of *L4* (Fig. 4). Each ambulacrum consisting of flooring plates, small covering plates, and brachioles. First flooring plates in the ring of deltoid plates (Pl. II, Figs. 1–2, 4; Pl. III, Figs. 1–4). Flooring plates loosely attached to thecal plates, and most broken from specimen except in III (Pl. III, Fig. 2). Where flooring plates missing, the former position of each clearly indicated on the theca by flat surfaces with raised ridges marking the courses of the ambulacral sutures (Pl. III, Fig. 1). Edges of flooring plates forming a gently sinuous line (Pl. I, Figs. 10, 12, 14–15).

Covering plates arranged in a biserial zigzag row along the center of each ambulacrum, at each angle leading to the oval, slightly recessed facet for attachment of a brachiole (Pl. III, Figs. 1–2). Hence, brachioles set alternately on left and right sides of each ambulacrum. No conspicuous openings into ambulacrum at the facets. Each facet located on a suture between two flooring plates, a small orad subtriangular one, with sides converging to an angle on the longitudinal zigzag suture line, and a large aborad subpentagonal plate. Flooring plates thus disposed in two rows, each beginning orad with a large plate in the shape of a quadrant of a circle, followed by a large subpentagonal plate on one side immediately opposite a small subtriangular, then a subtriangular opposite a subpentagonal, and so on (Pl. III, Figs. 1, 3).

Part of a brachiole attached to III (Pl. II, Fig. 2; Pl. III, Fig. 2), and other small segments lying on theca (Pl. II, Fig. 1), each biserial and elliptical in cross section.

Ambulacrum I concealing possible suture *R1/R1a* and definitely lying on suture *L1/L2,* bearing 21 brachioles, including one high on the right side near the peristome (Pl. III, Fig. 4). Ambulacrum II with 20 brachioles, V with 19, IV with 11, and III with 8, including 3 clustered at the aboral end of the ambulacrum just above pore rhomb *L3/R3.*

Hydropore and gonopore: Both structures bisected by the oblique suture *O1/O1a.* Hydropore a long curved slit with expanded ends, concave on side of gonopore but not sufficiently curved to align ends with the gonopore (Pl. III, Fig. 4). Gonopore an elliptical depression in the distal end of a prominence, without apparent opening into the theca (Pl. I, Figs. 1–2, 10–11; Pl. III, Fig. 4).

Peristome: Mouth concealed beneath plates of peristome. Peristomial plates larger than covering plates of ambulacra, those of one side meeting those on the other along a straight line, not interfingered.

Periproct: Subtriangular with rounded corners, bordered by *L4, L5,* and *IL4.* No plates preserved. Aboral side of opening beveled to liplike edge formed by ridges on *IL4* (Pl. I, Figs. 3, 9; Pl. II, Figs. 3–4).

Remarks.—Glyptocystites ehlersi is closely related to *G. regnelli* Sinclair, particularly in having ambulacrum IV conspicuously shorter than I, II, and V and in lacking pore rhomb *R3/R4,* features unknown in the other species of the genus. It differs from *G. regnelli,* however, in its larger size, more acuminate oral end, lower ridges, larger and longer rhomb *R2/R3,* presence of rhomb *L5/R1a* (Table II), lack of grooves across suture *R3/R4,* and more numerous brachioles on the long ambulacra. These differences I consider too great to be explained as ontogenetic. Sinclair (1948, p. 312) gives the length of ambulacrum IV as "about two-thirds the length of I, II, and V." I would estimate the corresponding length in *G. ehlersi* to be more nearly one-half that of the long ambulacra (Pl. I, Fig. 9). Sinclair says (p. 312) that the long ambulacra have 13 brachioles and III has about 6; the long ambulacra in my specimen have 19, 20, and 21 brachioles, and III has 8. *G. regnelli* is said by Sinclair (p. 306) to have no rhomb *L5/R1,* whereas my specimen has a very well developed rhomb *L5/R1a,* extending along nearly the entire suture (Pl. II, Fig. 3). Sinclair did not comment on the development of rhomb *R1/R5* in *G. regnelli,* only noting its presence (p. 306), so it cannot be compared with the very rudimentary rhomb in *G. ehlersi.*

Sinclair stated (1948, p. 310), in his discussion of the genus, that "the ambulacrals [flooring plates] are very simple pentagonal plates alternately arranged. Jaekel's figure ... showing accessory plates is not in agreement with my specimens, and I suspect that the drawing was influenced by the condition in the Callocystidae." As discussed above, the flooring plates in *G. ehlersi* on each side are of two contrasting sizes. I find the arrangement in my specimen fully in accord with that shown by Jaekel (1899, Pl. 15, Fig. 4a) for *Glyptocystites multipora* and by Regnéll (1945, Figs. 15, 16a–d) for the callocystitid *Lovenicystis angelini* (Jaekel).

Sinclair also indicated (1948, Fig. 4; here modified as Fig. 2*b*) that the ridge associated with rhomb *L5/R1a* lies on plate *L5*, but I have found the ridge in *G. ehlersi* to be on *R1a* (Pl. I, Fig. 10), where it apparently is shown in Sinclair's figure of *G. batheri* (1948, Pl. 4, Fig. 2).

The adjective "montidisjunct" was introduced by Sinclair (1948, p. 306) to describe pore rhombs in which the slits are disjunct and one plate bears a ridge between the row of slits and the suture. The term is misleading, because in rhombs with associated ridges some of the slits may be conjunct. For example, as shown in Pl. I, Figs. 14–15, rhomb *R2/R3* has a ridge on *R2*, but, as further shown in Pl. II, Figs. 1–2, some of the slits at the orad end are distinctly conjunct. Therefore, I have avoided using "montidisjunct" in the description of *Glyptocystites ehlersi*.

Type.—Holotype, UMMP 37254.

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PLATES

Photographs of holotype of *Glyptocystites ehlersi,* sp. nov., UMMP No. 37254. Except as noted, all photographs are unretouched. In each photograph, the specimen was illuminated by the large ringlight described by H. W. Wienert (1959). Kodak Commercial Ortho film was used.

EXPLANATION OF PLATE I

(All figures natural size)

In each stereogram, the sutures on the left figure have been emphasized by pencil. Before Figures 1–7 were photographed, part of the stem was removed. Specimen lightly coated with sublimate of ammonium chloride.

FIGS. 1–3. Inclined oral views of radii I, III, and V. These views show particularly well the raised gonopore and the long hydropore slit in interradius 5. The periproct is the large opening at the right in Fig. 3.

FIGS. 4–5. Inclined aboral views of interradii 4 and 1. Fig. 4 shows the relation of *IL4* to the periproct above and *B4* below, and Fig. 5 the acuminate, rhomb-bearing *B2* bordered by *IL2* and *IL1*.

FIG. 6. Oral view, showing the trimerous arrangement of ambulacra. The hydropore and gonopore lie in the posterior interradius. Compare with Pl. III, Fig. 4.

FIG. 7. Aboral view, in which the rhomb-bearing basal, *B2,* lies above the stem.

FIGS. 8–9. Lateral views centered on interradii 3 and 4. Near the middle of Fig. 8 is the large lateral, *L3,* with its three associated pore rhombs; compare with Pl. II, Fig. 4. Although their plates are incomplete, the extents of the long ambulacrum V (at the left of the periproct) and the short ambulacrum IV (at the right) are apparent in Fig. 9 as slightly depressed flat areas.

FIGS. 10–12. Lateral views centered on interradius 5, radius I, and interradius 1. Fig. 10 shows the long ambulacra I and V and pore rhomb *R1a/R5;* compare with Pl. II, Fig. 3. *R2,* the elongate radial extending down to *IL2,* is crossed by the preserved plates of ambulacrum II, as shown in Fig. 11. The pore rhomb *R1/R2,* between the long ambulacra I and II, is in the upper half of Fig. 12; pore rhombs *B2/IL2* and *B2/IL1* are just above the stem; compare with Pl. III, Figs. 1 and 3.

FIGS. 13–15. Lateral views centered on radius II, interradius 2, and radius III. Fig. 13 shows ambulacrum II crossing *R2* and terminating near the middle of *IL2;* compare with Pl. II, Fig. 1. Fig. 14 is a good view of the short ambulacrum III, which terminates above pore rhomb *L3/R3;* compare with Pl. II, Fig. 2, and Pl. III, Fig. 2. In Fig. 15, the prominent vertical row of plates in the center consists of *R3, L3, IL3,* and *B3.*

PLATE I

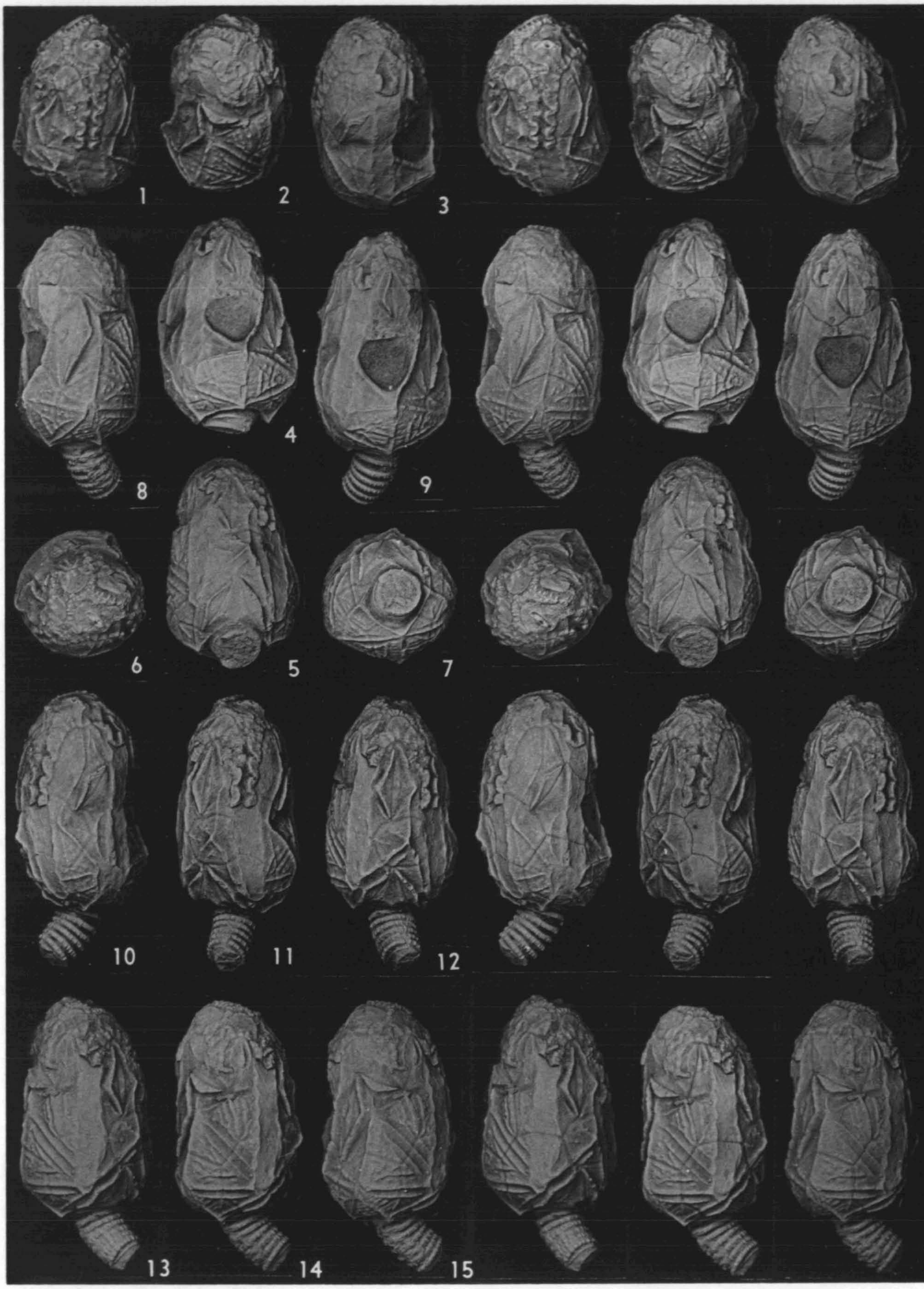
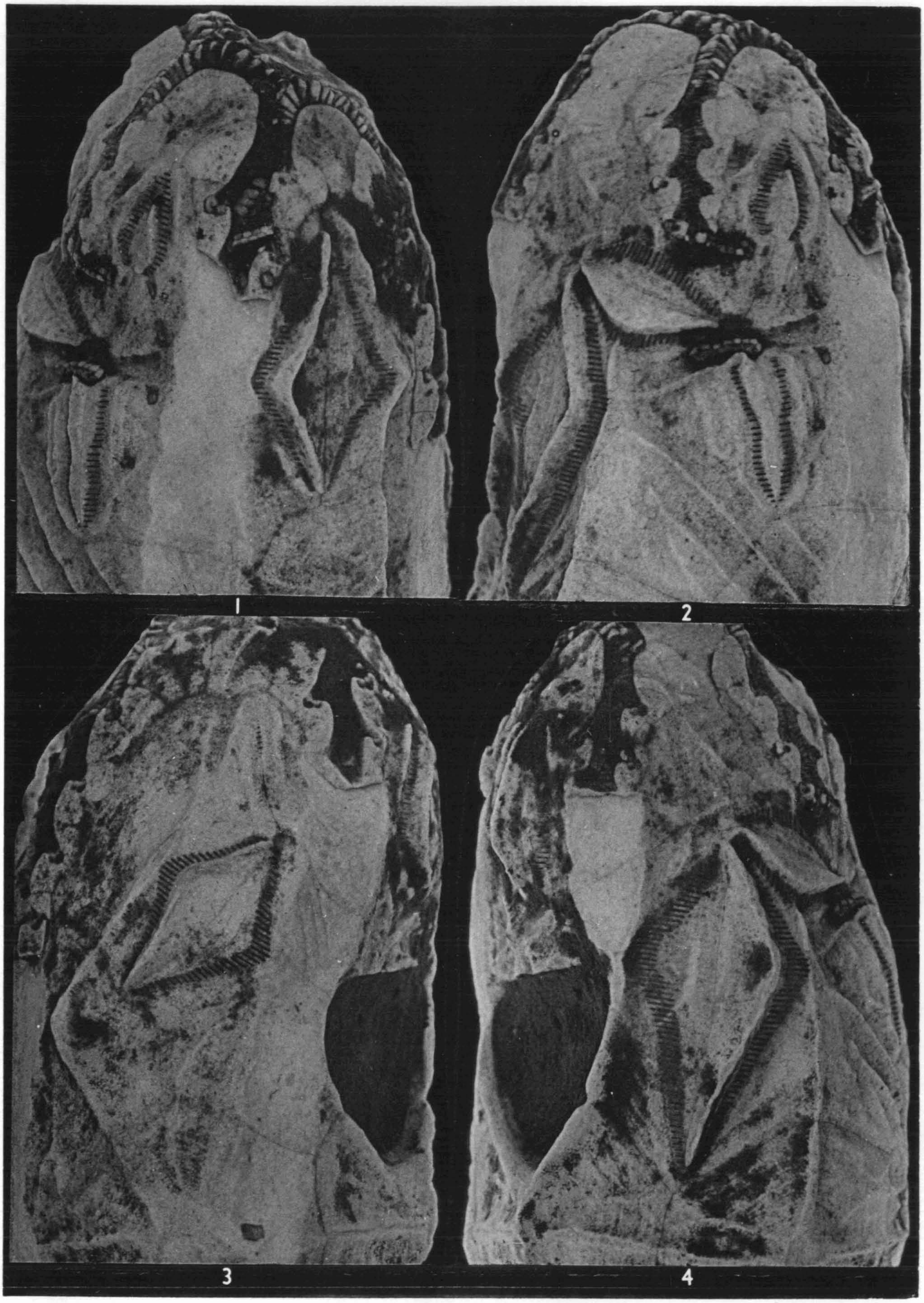


PLATE II



EXPLANATION OF PLATE II

(Specimen photographed while submersed in zylol; all figures × 3)

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FIG. 1. Lateral view on radius II, showing pore rhombs *R2/R3* at the upper left between ambulacra II and III, *L3/R2* at the far left, *L3/R2* at the lower left, and *R1/R2* at the right of ambulacrum II. Projection above ambulacrum II at the top of the figure is the gonopore.

FIG. 2. Lateral view on radius III, showing the small covering plates and facets for brachiole attachment on ambulacrum III and pore rhombs *L3/L4* at the left, *L3/R3* near the middle; *L3/R2* at the lower right, and *R2/R3* at the upper right.

FIG. 3. Lateral view on interradius 5, showing periproct at the right, the large pore rhomb *L5/R1a* near the center, and the rudimentary rhomb *R1a/R5* in the upper one-fourth of the figure.

FIG. 4. Lateral view on radius IV, showing periproct at the left, ambulacrum IV near the middle, and ambulacrum III at the upper right. The large pore rhomb in the center is *L3/L4*.

EXPLANATION OF PLATE III

(All figures × 3)

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FIGS. 1, 3. Lateral views on interradius 1. Specimen in Fig. 1 coated lightly with sublimate of ammonium chloride and in Fig. 3 submersed in xylol. Views show pore rhombs *B2/IL1* and *B2/IL2* just above stem and *R1/R2* in the upper part of figure. In Fig. 1, flooring plates of ambulacrum I are shown at upper right, and ridges marking sutures of flooring plates at lower right where ambulacral plates are missing.

FIG. 2. Lateral view on radius III, showing ambulacrum III and pore rhombs *R2/R3, L3/R2, L3/R3,* and *L3/L4.* Specimen lightly coated with sublimate of ammonium chloride. Compare with photograph of specimen submersed in xylol shown in Pl. II, Fig. 2.

FIG. 4. Oral view of specimen submersed in xylol, showing particularly well the peristome, hydropore, and gonopore.

PLATE III