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NOTES ON *JAEKELOCYSTIS HARTLEYI* AND *PSEUDOCRINITES GORDONI*, TWO RHOMBIFERAN CYSTOIDS DESCRIBED BY CHARLES SCHUCHERT IN 1903

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Volume XVI

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INTRODUCTION

TWO RHOMBIFERAN CYSTOIDS described by Charles Schuchert in 1903, *Jaekelocystis hartleyi* and *Pseudocrinites gordoni,* have been restudied. For each species, erroneous statements are corrected and new information is presented on the arrangement of thecal plates, distribution of ambulacra, pattern of ambulacral covering plates, and details of the pore rhombs, hydropore, and periproct.

In reviewing the cystoids in the collection of the Museum of Paleontology, I had occasion to compare specimens of *Jaekelocystis hartleyi* and *Pseudocrinites gordoni* against Schuchert's original descriptions in 1903 and his elaborations and illustrations in 1904. Certain discrepancies between the characteristics noted in these specimens and the statements by Schuchert induced me to examine the type specimens of both species. This in turn led to the notes presented here.

For instance, in his description of *Jaekelocystis,* Schuchert (1904, pp. 222–23) stated that the theca has eighteen plates, "plate 19 [*R4*] of other genera is not developed in this genus," and the "fifth row [orals] has deltoid 23 [*O1*]." Such a reduction of plates would make *Jaekelocystis* very different from other callocystitids, which have full complements of radials and orals. In other cystoids of the subfamily Apiocystitinae, however, the five orals are small and mostly obscured by the ambulacra. In many, moreover, *R4* is a relatively small plate at the right of *L5,* as well exemplified by *Lepocrinites manlius* Schuchert, *Lepadocystis moorei* (Meek), and *Tetracystis chrysalis* Schuchert.

To investigate the possibility that *Jaekelocystis hartleyi* might possess an *R4* and small oral plates beneath its ambulacra, I examined two specimens in the Museum of Paleontology of The University of Michigan, S5728*a* and *b*. In the first specimen part of a plate is exposed between *R3* and ambulacrum IV. Its aboral edge (Pl. II, Fig. 6) does not appear to be aligned with suture *L4/L5* on the opposite side of the ambulacrum, leading me to believe that the plate in question was not a continuation of *L5*. In the second specimen, which I shall mention later, the area around the periproct and ambulacrum IV and V was concealed by adhering bryozoans.

Thereupon, I borrowed the type specimens from the United States National Museum, which consist of the holotype and thirty-eight other specimens catalogued under one number, USNM No. 35055. In most of them, all of the area at the right of *L5* is covered by ambulacrum IV. Several, however, show a longitudinal suture at the right of the ambulacrum, which one might (as evidently did Schuchert) presume to be the *L5/R3* suture, but which one could as readily explain as the *R3/R4* suture (assuming the *L5/R4* suture to be hidden beneath ambulacrum IV). Insofar as these specimens are concerned, the interpretation of plates depends wholly upon the choice of hypotheses regarding what lies under the ambulacrum: an extension of *L5* or a narrow *R4*.

One of the type specimens, nevertheless, clears up the speculation on the presence of *R4*. It is USNM No. 35055*l*, in which the oral part of ambulacrum IV is broken out of the theca, revealing plate *R4* clearly outlined by sutures (Pl. IV, Fig. 4). In the broken area can also be seen a suture along the oral side of *L5* and a junction of two small oral plates (interpreted as *O4* and *O5*) between *L4* and the peristome.

In regard to oral plates, all or nearly all of *O1*, the large hydropore-bearing plate, is clearly visible in each specimen. In addition, a few specimens show a small segment of plate between *O1* and ambulacrum I. Because the ambulacra are deeply entrenched in the theca, their flooring plates lie at about the general level of the thecal plates, making distinction of flooring plates from the small oral plates difficult. For example, in most specimens, one cannot be certain which of the small plates at the left of the peristome are flooring plates of ambulacra I and II and which are exposed parts of *O2* and *O3*.

To gain additional evidence on the arrangement of plates around the peristome, I ground off the ambulacra and the outer, ornamented part of the thecal plates from specimen UMMP No. S5728*b*. The results (Pl. IV, Figs. 1–3) are not conclusive for the junctions of all plates, inasmuch as the calcite of the thecal plates is marked with cleavage planes which strongly resemble sutures. In Figure 1*b*, I have indicated my interpretation of the plate boundaries in the peristomial region.

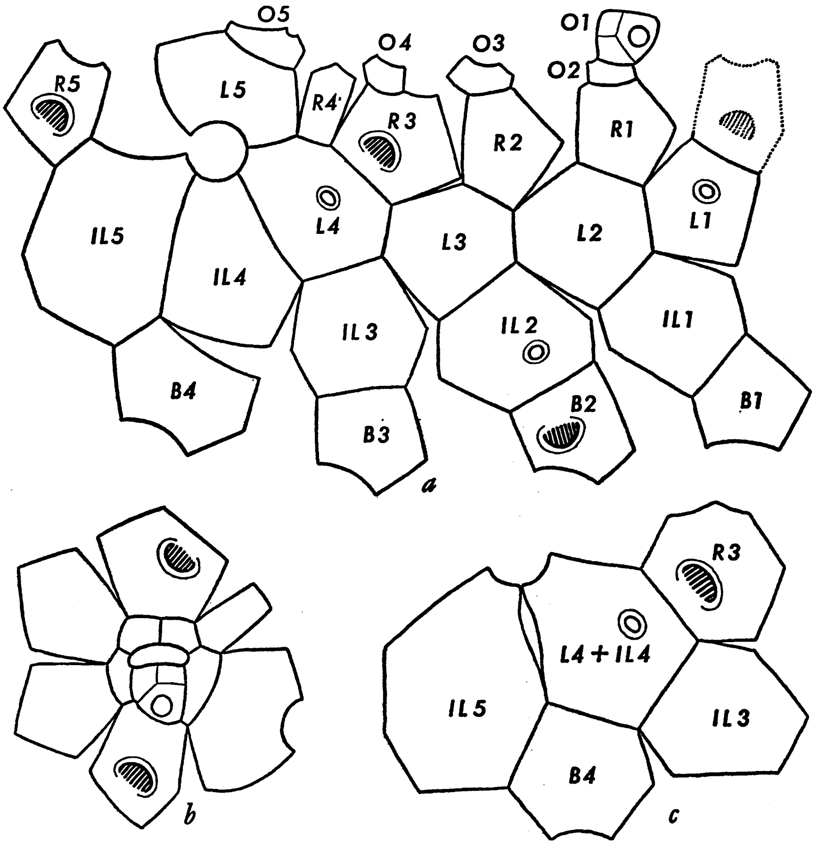

FIG. 1. *Jaekelocystis hartleyi* Schuchert. *a,* composite plate diagram and symbols based on holotype and several paratypes. *b,* plates of the peristomial region, based on UMMP No. S5728*b* (see Pl. IV, Figs. 1–3, 5). *c,* plates in the region of radius IV, USNM No. 350556*b,* in which plates *L4* and *IL4* are fused.

As I studied the type specimens and compared them closely with the descriptions, I noted other features which, in my opinion, were inadequately or erroneously treated in the writing and illustrations of Schuchert. Hence, a review of *Jaekelocystis hartleyi* seems in order.

At about the same time, I had occasion to refer to a specimen of *Pseudocrinites gordoni* Schuchert in the Museum of Paleontology of The

University of Michigan. I discovered that the slits in the pore rhombs, the arrangement of ambulacral covering plates, the numbering of the ambulacra, and the disposition of thecal plates differ somewhat from those reported by Schuchert. Then I studied the type specimens from the United States National Museum, to discover if these differences also existed in them. They did. Therefore, I have included a review of *Pseudocrinites gordoni* in this paper.

If specimens of *Jaekelocystis hartleyi* were available for sacrifice, one might attempt progressive disassembly of ambulacra and theca by means of prolonged application of ultrasonic vibrations. This approach might also yield additional information on the inner structures of the species.

For the opportunity to study the type specimens of the two species of rhombiferan cystoids, I am very grateful to Dr. G. A. Cooper, Dr. Remington Kellogg, and Dr. Porter M. Kier, of the United States National Museum. This manuscript was critically read by Dr. L. B. Kellum and Dr. C. A. Arnold.

Specimens are from the collections of the United States National Museum (USNM) and the Museum of Paleontology of The University of Michigan (UMMP).

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SCHUCHERT'S DESCRIPTIONS

Some general remarks on Schuchert's interpretations (1903 and 1904) of hydrophoridean structures apply in particular to his species *Jaekelocystis hartleyi* and *Pseudocrinites gordoni*. These concern (1) designation of thecal plates and ambulacra, (2) plate diagrams, and (3) terminology for the structures commonly referred to as hydropore and gonopore.

Schuchert followed Bather's system of numbering thecal plates in sequence. Details of this system have been recently discussed (Kesling, 1961, pp. 59–76). As indicated in his analysis of *Tetracystis, Trimerocystis,* and *Pseudocrinites* (1904, Fig. 33), Schuchert numbered ambulacra by the system used in part by Jaekel (1899); that is, he started to the left of the periproct rather than the hydropore and gonopore.

Whether the plates shown in Schuchert's diagrams (1904, Figs. 27, 29) are regarded as generalized for the species or definite for a specimen, they could not be fitted together to form a theca because the borders of adjacent plates are unequal in length. In some parts of the diagrams, it is not clear which plates are in contact. Furthermore, for some plates the shapes shown in the diagrams and in the figures do not agree.

Schuchert did not follow the conventional designations of hydropore and gonopore, referring to the hydropore as the "madreporite" and to the gonopore as the "hydropore." He wrote (1904, p. 209): "Just beneath the mouth is the small porous plate known as the *madreporite,* which is connected with the stone canal. Usually in contact with the madreporite is a very minute pore, the *hydropore* or parietal pore, and in well-preserved specimens this is closed by a pyramid of plates." Because Schuchert presented no evidence for a stone canal, one assumes that such a structure was supposed rather than seen. I do not criticize his terms "madreporite" and "hydropore," inasmuch as the function of the two structures still remains in doubt, but wish only to explain his usage, which leads to some confusion when compared with those of other authors.

In addition to these general interpretations, there are some specific points in Schuchert's work to which I wish to direct attention. In regard to *Jaekelocystis hartleyi*:

1. Ambulacral covering plates in Schuchert's drawing (1904, Pl. 37, Fig. 6) are arranged in two rows of constant width with the plates of one side directly opposed to those on the other. My photographs (Pl. III, Figs. 1–2) clearly depict a different pattern. In examination of the type specimens I found none which remotely resembled the drawing of Schuchert.

2. Each brachiole facet is separated from the ambulacral covering plates, according to Schuchert's diagram (1904, Pl. 37, Fig. 6). Actually (see my Pl. III, Fig. 2), each facet is the terminus of a series of small covering plates leading from the midline of the ambulacrum.

3. Schuchert stated (1904, p. 225): "Anal pyramid small, ... composed of 6 pieces." But in his drawing in the same publication (Pl. 37, Fig. 7), the pyramid was shown with seven plates. Among the type specimens, I failed to find one with more than six plates in the anal pyramid.

4. The boundaries of plate *IL5* in the holotype, USNM No. 35055*a*, were incorrectly retouched in Schuchert's figure (1904, Pl. 37, Fig. 4). Compare with my photograph in Pl. I, Fig. 10.

5. References to ambulacra in the descriptions of abnormal specimens are inconsistent. For example, Schuchert said of one (1904, p. 224): "RI is but half the normal length and RII is almost aborted ...." The only specimen which has two ambulacra of these lengths is 35055*g* (see Pl. I, Figs. 2–4, 13–14), in which ambulacrum V is short and IV very short.

Of another, Schuchert wrote (*ibid.*): "RV is forked, the branch developing on the left." Only one of the type specimens, USNM No. 35055*d* (see Pl. II, Figs. 16–20), has a branched ambulacrum. The ambulacrum is IV. In other words, the branched ambulacrum in 35055*d* corresponds to the shortest in 35055*g*, but the former was designated "II" and the latter "V" by Schuchert. Other contradictions are present in the account of the species.

In regard to *Pseudocrinites gordoni*:

1. Schuchert said (1904, p. 230): "Anal pyramid depressed, consisting of 7 somewhat ornamented plates surrounded by a circle of 8 larger plates of irregular size and definite sculpture," but his Figure 29 showed seven surrounding plates. I fail to understand what was meant by "depressed," because the anal pyramid is merely flush or slightly elevated, not sunken below the level of the surrounding theca. One of the type specimens, USNM No. 35071*h*, has additional periproct plates, so that the precise numbers of pyramid and surrounding plates are dubious inclusions in the definition of the species.

2. In his plate diagram (1904, Fig. 29) Schuchert indicated that plates *L5* and *IL4* are separated. In each of the type specimens these plates are in contact.

3. In a drawing (1904, Pl. 39, Fig. 11) Schuchert portrayed the ambulacral covering plates as irregular and separated from the brachiole facets. Actually, as shown here in Plate VII, Figures 2–5, the covering plates have remarkable regularity, and a double row of small covering plates leads to each brachiole facet.

4. In the figure of the holotype (1904, Pl. 36, Fig. 8) the outline of the periproct, the *R3/R4* suture, and the ornamentation are incorrectly retouched. Compare with the photograph in my Plate V, Figure 16.

5. In his retouched figures (1904, Pl. 36, Figs. 8–12) Schuchert showed the slits in the pore rhombs as conjunct or nearly so. The half-rhombs on plates *IL2, L1,* and *L4* have the slits exposed only in a narrow channel between ridges; the pores connecting these slits with those corresponding on the opposite plate pass beneath the suture. Only where the surface overlying the central part of the rhomb has been broken or worn off are the pores expressed as slits from one plate onto the other. Well-preserved pore rhombs have slits like those photographed in Plate VI, Figures. 1–3.

In view of the several needs for restatement, I present my concept of *Jaekelocystis hartleyi* and *Pseudocrinites gordoni* herewith.

SYSTEMATIC DESCRIPTIONS

Class CYSTOIDEA Buch
Subclass HYDROPHORIDEA Zittel
Order RHOMBIFERA Zittel
Family Callocystitidae Bernard
Subfamily Apiocystitinae Jaekel
Genus *Jaekelocystis* Schuchert

Type species.—By original designation, *Jaekelocystis hartleyi* Schuchert, 1903, p. 230.

Jaekelocystis hartleyi Schuchert

(Figs. 1–3; Pl. I, Figs. 1–18; Pl. II, Figs. 1–20; Pl. III, Figs. 1–2; Pl. IV, Figs. 1–7)

Jaekelocystis hartleyi Schuchert, 1903, p. 231; 1904, pp. 224–25, Pl. 37, Figs. 4–8.

Form.—Theca ovoid to ellipsoidal, with ambulacra deeply entrenched to the level of the adjacent thecal plates. Periproct area greatly (Pl. I, Figs. 7, 15) or slightly (Pl. I, Figs. 4, 10, 18) protuberant. Greatest width at the level of lateral plates, about three-fourths the height. Some specimens slightly compressed in the plane of radius III and interradius 5 (Pl. II, Figs. 1, 12). Height ranging from 11½ (Pl. II, Figs. 7–10) to 16½ mm (Pl. II, Figs. 11, 13–15). Stem about 4 mm in diameter at junction with the theca.

Ornamentation.—Each plate with chamfered edges and numerous shallow pits or dents. Dents on most plates discrete, but on a few (as on *L1* shown in Pl. I, Fig. 10) some dents confluent to produce a rather vermiform sculpturing. A narrow rim around each half of each pore rhomb; in the larger and shallower half, on *B2* (Pl. II, Fig. 11), *R3* (Pl. II, Fig. 13), or *R5* (Pl. II, Fig. 14), the distal part of the rim slightly more prominent than the proximal; in the smaller and deeper half, on *IL2* (Pl. II, Fig. 11), *L4* (Pl. I, Fig. 12), or *L1* (Pl. I, Fig. 10), rim distinct, forming a small circle or oval.

Thecal plate arrangement.—Basals and infralaterals (Fig. 1*a*) completely encircling the theca. *B1, B2,* and *B3* pentagonal and *B4* hexagonal, as usual in callocystitid cystoids. *IL1, IL2,* and *IL3* about equal in size, hexagonal; *IL4* vertically elongate, pentagonal, bounded on the right by *IL3* and *L4,* orally by the periproct, on the left by *IL5,* and aborally by *B4;* and *IL5* large, octagonal (more or less rectangular with beveled corners), bounded orally by *L5* in the center with *R5* and the periproct at the corners, aborally by *B1* in the center with *IL1* and *B1* at the corners, and laterally by *L1* and *IL4.*

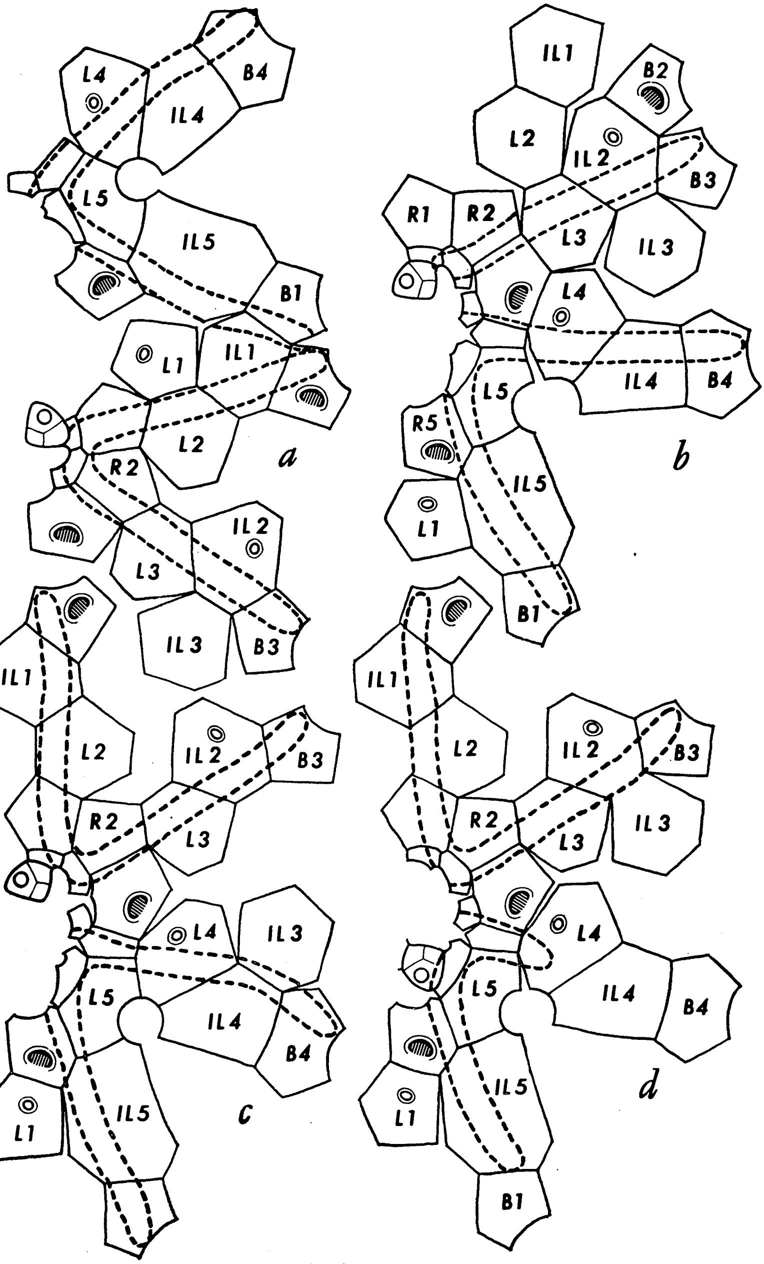

FIG. 2. *Jaekelocystis hartleyi* Schuchert. Generalized plate diagrams with relative positions of ambulacra indicated for four specimens. *a,* holotype, USNM No. 35055*a* (see Pl. I, Figs. 8–12). *b,* paratype, USNM No. 35055*e,* in which ambulacrum I is not developed (see Pl. I, Fig. 1; Pl. II, Figs. 7–10). *c,* paratype, USNM No. 35055*f,* in which all ambulacra are fully developed and in the mean positions for the species (see Pl. II, Figs 11–15). *d,* paratype, USNM No. 35055*g,* in which ambulacrum V is short and IV is very short (see Pl. I, Figs. 2–4, 13–14).

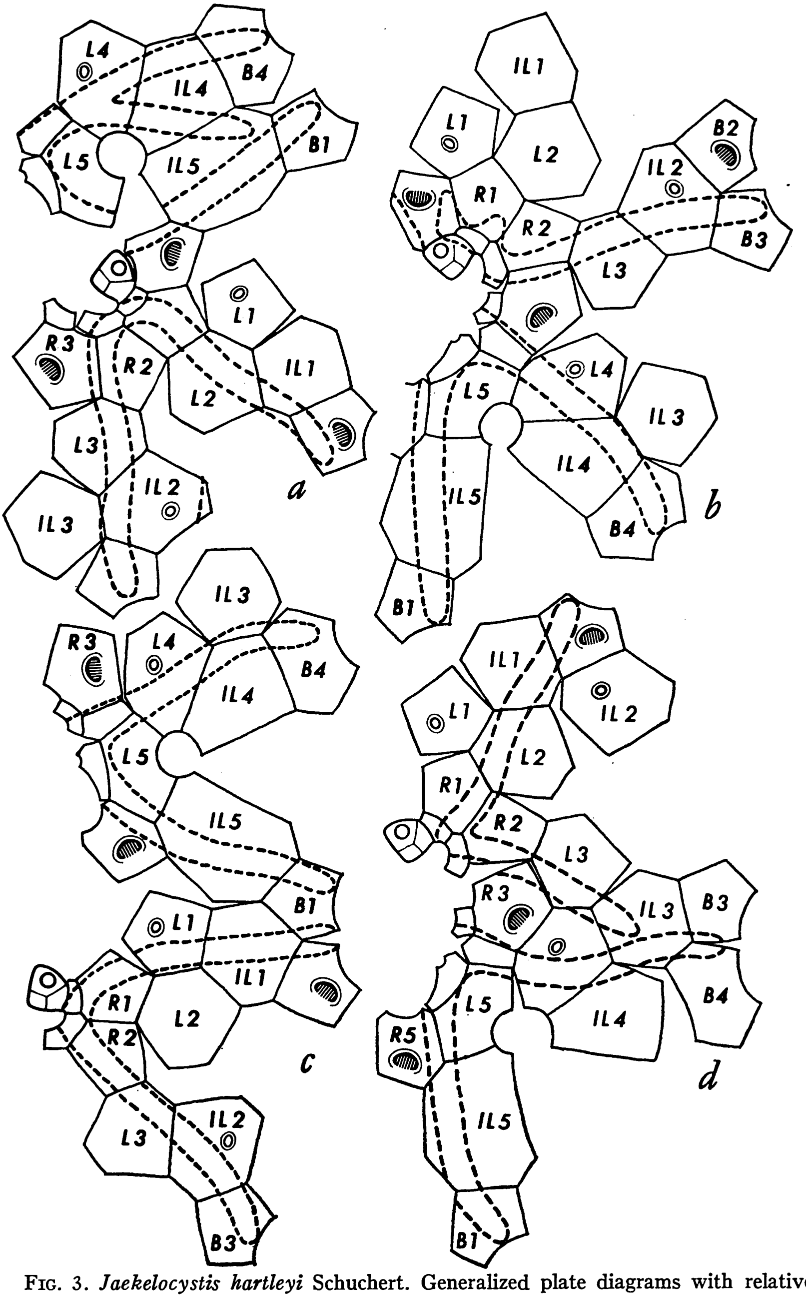

FIG. 3. *Jaekelocystis hartleyi* Schuchert. Generalized plate diagrams with relative positions of ambulacra indicated for four specimens. *a,* paratype, USNM No. 35055*d,* in which ambulacrum IV bifurcates and I encroaches onto pore rhomb *B2/IL2* (see Pl. II, Figs. 16–20). *b,* paratype, USNM No. 35055*i,* in which ambulacrum I is scarcely developed (see Pl. I, Fig. 17); the area on the left side of plate *R5* may be adhering bryozoa instead of ambulacrum. *c,* paratype, USNM No. 35055*h,* in which plate *L2* is straddled by ambulacra I and II but not touched by either. *d,* paratype, USNM No. 35055*c,* in which ambulacrum II abuts against IV on plate *IL3.*

Laterals interrupted between *L5* and *L1* by *R5; L1* pentagonal; *L2* and *L3* hexagonal; *L4* broad, with seven unequal sides, surrounded by *IL4, IL3, L3, R3, R4, L5,* and the periproct; and *L5* broad, hexagonal, aborally in contact with *IL5* and *L4* with a deep median indentation for the periproct. Radials interrupted between *R4* and *R5* by *L5;* all radials subpentagonal, all but *R4* with the apex directed aborally. *R1, R2,* and *R5* nearly equal; *R3* broader; *R4* small, with nearly parallel sides, in all specimens partly or completely covered by ambulacrum IV. Orals (Fig. 1*b*) encircling the mouth, mostly hidden by ambulacra. *O1* large, elevated, tripartite, with the conspicuous, shallow, funnel-shaped hydropore situated in the right aboral division; *O2* and *O5* at the sides of *O1,* separating it respectively from *R1* and *L5;* and *O3* and *O4* on the opposite side of the mouth from *O1*. Nearly all of *O2* and *O5* covered by ambulacra, and only parts of *O3* and *O4* visible between ambulacra II and IV. Exposed parts indicate that the orals vary considerably in shape and size.

In one specimen, USNM 35055*b*, the plates at the right of the periproct have an anomalous arrangement (Fig. 1*c*). Plates *L4* and *IL4* in other specimens are here represented by a single plate, which extends from the base of *R3* down to the top of *B4*. Like *L4* in normal specimens, this plate shares a pore rhomb with *R3*. The adjacent plates on the right are affected by this fusion so that *IL3* projects orally to *R3,* separating *L3* from the combination *L4* + *IL4* plate.

This specimen proves that the number, shape, and disposition of plates in the theca is not invariable. Inasmuch as the plates in the other forty specimens examined vary only slightly in shape and are set in a pattern like that of the holotype (Fig. 1*a*), there is no reason to question the significance of plate arrangement as a specific character. It is well to bear in mind, however, especially when classifying individual specimens, that anomalies do occur.

Pore rhombs.—Rhombs *B2/IL2, L4/R3,* and *L1/R5* present, as in other callocystitids with only three rhombs. Each half-rhomb discrete, set far back from the suture. Half-rhombs on *B2, R3,* and *R5* semicircular to elliptical, shallow, with slits distinctly exposed, surrounded by a narrow rim higher on the distal side than the proximal. Half-rhombs on *IL2, L1,* and *L4* small, circular to oval, surrounded by a narrow well-developed rim, somewhat phialine in some specimens; each of these half-rhombs much narrower than the band of pores beneath it, as disclosed in worn specimens with the pores laid bare, so that it expands downward from the opening, like an inverted funnel, to serve as the conduit for the rhomb. About eight pores to each rhomb.

Ambulacra.—Four ambulacra in most specimens, a few with only three, none with more than four. In those rhombiferan cystoids with five ambulacra and the periproct located at the right of the hydropore, as for example *Glyptocystites* (see Kesling, 1961, Fig. 4), only one ambulacrum intervenes between the hydropore and periproct and one ambulacrum is short. The intervening ambulacrum is V and the short one is III. By homology, the ambulacrum between the hydropore and periproct in *Jaekelocystis* is V, and ambulacrum III is not developed. Thus, the ambulacra, clockwise from the hydropore, are I, II, IV, and V.

All ambulacra deeply entrenched in the theca, extending little, if any, above the general level of adjacent thecal plates. Ambulacra varying in relation to thecal plates. In USNM No. 35055*f*, with all ambulacra fully developed and in the mean positions for the species (Fig. 2*c*): I and II united at the left of the peristome (Pl. II, Fig. 11) and IV and V at the right (Pl. II, Fig. 15) around the oral end of the periproct; I extending across *R1, L2,* and *IL1,* terminating on the right side of *B2;* II extending across the *R2/R3* suture, *L3,* and *IL2,* terminating on the right side of *B3;* IV across *R4/L5, L4,* and *IL3/IL4* to right side of *B4;* and V across *L5/R5* and *IL5* to *B1*. Holotype, USNM No. 35055*a* (Fig. 2*a*), with ambulacra in about the same positions, but with V displaced slightly to the left, its terminus touching that of I. USNM No. 35055*g* (Fig. 2*d*) with ambulacrum V short, ending on *IL5* (Pl. I, Figs. 3–4), and IV very short, ending on *L4* (Pl. I, Figs. 3, 14). In USNM No. 35055*h* (Fig. 3*c*), I and II straddle plate *L2,* but neither touch it. In USNM No. 35055*c* (Fig. 3*d*), II terminating on *IL3,* there abutting against IV. USNM No. 35055*d* (Fig. 3*a*) displaying two unusual features: ambulacrum I crossing the center of pore rhomb *B2/IL2* (Pl. II, Fig. 20), and IV bifurcating on *L4,* the longer branch extending across *IL4* and *B4* (Pl. II, Figs. 13, 15) and the shorter across *IL4* onto *IL5,* there nearly reaching V (Pl. II, Fig. 19). Ambulacrum I is rudimentary in USNM No. 35055*i* (Fig. 3*b;* Pl. I, Fig. 17) and absent in USNM No. 35055*e* (Fig. 2*b;* Pl. II, Figs. 7, 9). With the exceptions of *IL4/IL5, IL5/L1, L1/R5, L2/L3,* and *R1/R5,* all sutures of the infralateral, lateral, and radial plates crossed by ambulacra in one or another specimen.

Each full-length ambulacrum with about 16 or 17 brachiole facets on each side, alternating with those opposite; shorter ambulacra with proportionally fewer facets. Each facet circular, raised above rest of flooring plates, and connected to the center of the ambulacrum by a short double series of minute covering plates (Pl. III, Fig. 2).

Flooring plates arranged in a regular pattern (Pl. III, Fig. 1). Edge of ambulacrum rather sinuous, with indentations between brachiole facets. Exposed (outer) parts of flooring plates about equal in size. Sutures perpendicular to the edge of the ambulacrum, alternately through the centers of facets and midway between them.

Covering plates depressed below the level of the flooring plates. In the central part of the ambulacrum, plates of left and right sides meeting in a zigzag junction. Plates narrow, with parallel sides, forming a series of about ten on each side between facets, occupying a triangular area with the longest plate at the midpoint of the series and the shortest at the ends. From each angle of the zigzag junction, a double series of minute plates leading outward and aborally to a brachiole facet.

Brachioles preserved in only a few specimens, short, arched over the center of the ambulacrum.

Hydropore and gonopore.—Only one opening in plate *O1,* by its size and structure apparently the hydropore or a combination of hydropore and gonopore. Opening large at the surface, slightly concave with its border elevated above surrounding theca (Pl. I, Figs. 1, 5, 8; Pl. II, Fig. 1). Upper part of opening covered by a grill-like sieve plate (Pl. IV, Figs. 5–6), with radiating slots on the margin and small perforations in the center. Conduit leading from the opening through the plate, decreasing rapidly in diameter with depth, hence funnel-shaped; conduit may be part of stone canal. Lower part of conduit with a few radiating septal-like structures (Pl. IV, Fig. 7).

Plate *O1* apparently divided into three parts (Fig. 1*a, b;* Pl. IV, Fig. 5), but hydropore not divided by a suture, as in most callocystitids.

Peristome.—Mouth, or oral opening, rather large, elongate (Pl. IV, Figs. 1–3, 5), overlain by a series of small plates connecting the junction of ambulacra I and II at the left with the junction of IV and V at the right. Plate *O1* elevated above plates *O3* and *O4* opposite.

Periproct.—Plates of the periproct preserved in very few specimens, consisting of six subtriangular plates of an anal pyramid with no auxiliary surrounding plates. Pyramid low, almost flat, set well below the level of the thecal plates. Opening through the theca circular (Pl. IV, Figs. 2, 4), bounded in USNM No. 35055*b* by three plates (Fig. 1*c*) but in all others by four plates (Fig. 1*a*).

Remarks.—*Jaekelocystis hartleyi* presents two puzzling features. One is the close bond between the thecal plates and the deeply entrenched ambulacral flooring plates. In many callocystitids the flooring plates are rather loosely set onto the thecal plates, and readily scale off from them. Because the ambulacra vary greatly in their form and relative positions in *J. hartleyi* (Figs. 2*a–d*, 3*a–d*), it is obvious that the ambulacra encroached onto the theca and entrenched themselves during the growth of each individual. They did not grow into existing grooves across the theca. The rhombiferans, one assumes, had their plates ensheathed in an integument, like their living relatives, the crinoids. Thus, there must have been integument around the theca as well as around the ambulacra during the life of the cystoid. Apparently, some histolytic action of the integument around each ambulacrum dissolved a deep channel in the thecal plates of the precise dimensions to accommodate the flooring plates. But if this was the process of ambulacral growth, each cystoid would still have two tissue layers separating thecal and ambulacral plates: the integument investing each kind of plate. Why, then, are ambulacra and theca so firmly fused? The only explanation plausible is that the integuments of thecal and ambulacral flooring plates became calcified. Whether this occurred during the life of the cystoid or during fossilization cannot be determined.

The other enigma of this species is the form of the hydropore or, perhaps, the combination hydropore-gonopore. In other genera of the Callocystitidae, the hydropore is typically an elongate slot and the gonopore a small circular opening nearby, both bisected by a suture across plate *O1*. Inasmuch as the hydropore and gonopore are in close proximity in other cystoids of the family, I suppose that the single opening in *J. hartleyi* is a confluence of the two. Nevertheless, the location, size, and shape are exceptional. Other callocystitids have not been studied by polished surfaces, so that subsurface details of their openings are unknown. Possibly, they also have some sort of sieve plate.

Although the ambulacral variations have already been commented upon, I might point out that (1) no specimen has been found with any development of ambulacrum III; (2) no specimen has more than one ambulacrum absent; (3) in 41 specimens studied, only one had a branched ambulacrum; and (4) in only one specimen did an ambulacrum encroach onto a pore rhomb. In looking over the well-preserved type specimens, one is apt to consider only the differences. Actually, most of the specimens vary only a little in the positions of their ambulacra.

Subfamily Staurocystinae Jaekel
Genus *Pseudocrinites* Pearce

Type species.—Pseudocrinites bifasciatus Pearce, 1843, p. 160, by designation of Haekel, 1896, p. 135.

The genera in the Staurocystinae are not clearly separated. In particular, *Trimerocystis* Schuchert (1904, pp. 237–39) is remarkably similar to *Pseudocrinites,* except that it possesses a third ambulacrum. The type and only known species, *Trimerocystis peculiaris,* is based on only the holotype.

Because *Trimerocystis* depends upon the interpretation of one specimen, let us examine the conditions of its erection. Schuchert wrote (1904,

p. 239): "Though *Trimerocystis* is based on a single specimen, having obvious relations to *Pseudocrinites clarki,* it cannot be regarded as a monstrosity of that species, because the two forms do not occur in the same bed .... Under these circumstances, and in order that the generic definition of *Pseudocrinites* may stand, the writer has deemed it advisable to erect a new genus for this 3-rayed type." It is hard to believe that a taxon can be based on its stratigraphic occurrence or that classification can be designed to conform with previous wording. Such taxonomic practise is unacceptable today.

Schuchert did, however, base his new genus in part on the presence of a third ambulacrum and the plate arrangement, stating (1904, p. 238) that "whereas plates 10 [*L3*] and 16 [*R2*] in *Pseudocrinites* are situated in the third and fourth rows, in *Trimerocystis* they have passed one circle lower, being, respectively, in the second and third rows." This supposed plate arrangement, evidently described by Schuchert from his diagram (his Fig. 34), is open to challenge. His "photographs" (1904, Pl. 35, Figs. 1–3) of the holotype show a different arrangement, not all of which can be explained as the result of the bold (and, I have reason to believe, inaccurate) retouching. In his "photographs," Fig. 1 shows *B4* continuing to the right of ambulacrum IV and Fig. 3 has *B2* extending to ambulacrum II, but Fig. 2 discloses only one plate between ambulacra II and IV, thus accounting for only three basal plates. Presumably, in Fig. 2 the suture *B3/B4* was overlooked in retouching. The plate diagram in the text exhibits sutures *IL2/R2* and *R1/R3* and plates *L2* and *L3* definitely separated by *R2* and *IL2,* but Fig. 3 has *L2* between *IL2* and *R2, R2* between *R1* and *R3,* and *L2* and *L3* with a long vertical suture at their contact. Moreover, in the plate diagram, *B3/L3* is distinctly a curved suture and *L3* and *R3* are not in contact, whereas in Fig. 2 plate *IL2* intervenes between *B3* and *L3* and the suture *L3/R3* is long.

From these observations, one may conclude that in the plate diagram, Schuchert's plate "10" is actually part of *IL3,* his "16" actually *L3,* and his "17" a combination of *R1* and *R2*. With these corrections, the diagram of *Trimerocystis peculiaris* no longer differs, except in minor details, from those of *Pseudocrinites gordoni* (Schuchert's Fig. 29) and *P. perdewi* (his Fig. 32).

Although the holotype of *Trimerocystis peculiaris* needs restudy to confirm its pattern of thecal plates, the above analysis strongly suggests that the type of that species is an abnormal specimen of *Pseudocrinites* with a supernumerary ambulacrum. If that be true, then *Trimerocystis* is a junior synonym of *Pseudocrinites* and therewith invalid.

Pseudocrinites gordoni Schuchert

(Figs. 4–5; Pl. V, Figs. 1–17; Pl. VI, Figs. 1–3; Pl. VII, Figs. 1–5; Pl. VIII, Figs. 1–8)

Pseudocrinites gordoni Schuchert, 1903, pp. 235–36; 1904, pp. 229–31, Figs. 29; Pl. 36, Figs. 8–12; Pl. 39, Figs. 11–13.

Pseudocrinites abnormalis Schuchert, 1904, pp. 231–32, Fig. 30; Pl. 35, Figs. 10–12.

Synonymy.—As Schuchert himself suggested by the specific name, *Pseudocrinites abnormalis* appears to be founded upon an abnormal individual. There is also an implication that Schuchert did not propose the species for a genetic entity, but for convenience in referring to the holotype specimen. He stated (1904, pp. 231–32): "This species has the general expression of *P. gordoni,* except that the outline of the theca is regularly oval instead of nearly circular. It differs also in having the basal pectinirhomb on plates 5 and 6 [*IL1* and *IL2*] instead of on plates 1 and 5 [*B2* and *IL2*]. That the two forms are really closely related is shown by the arrangement of the anal plates . . . Because of this close resemblance the writer regards the present specimen as abnormal in development, or a monstrosity, but thinks it best to give it a name, for easy reference." The holotype and only known specimen of *P. abnormalis* came from the same strata as the type specimens of *P. gordoni.*

Sinclair has pointed out a similar transposition of a pore rhomb in *Glyptocystites multipora,* and stated (1948, p. 306): "It seems that the position of a rhomb was not fixed with reference to a particular suture, but only with reference to a given area of the theca." In the very young stage of ontogeny, the incipient rhomb, whether present as a simple pore or as a more complex structure, undoubtedly antedated the secretion of thecal plates, inasmuch as the plates were modified to accommodate the pores and not *vice versa.* Thus, the basal rhomb in the holotype of *Pseudocrinites abnormalis* may have been only slightly offset from the normal position when the specimen was very young, but as plates were formed it came to lie between *IL1* and *IL2* instead of the regular location between *B2* and *IL2.*

Form.—Theca shaped like a round or oval inflated disc, with ambulacra forming a rim around the periphery. Small specimens, such as USNM No. 35071*g* (Pl. V, Figs. 6–7), tend to be oval as compared with larger, nearly circular specimens, such as UMMP No. 5729 (Pl. V, Figs. 1, 3) or the holotype, USNM No. 35071*a* (Pl. V, Figs. 16–17). Largest specimen known, the holotype, slightly more tumid than others.

Theca with two convex circular faces, one around radius I, centered on *L2, L1,* and *IL2* and continuing the gonopore (Fig. 4*a–b*) and the other around interradius 3, centered on *L4, IL4,* and *IL3* and containing the periproct (Fig. 4*c*).

Ornamentation.—Plates in the aboral three-fourths of the theca with low ridges radiating from their centers to the corners and other subparallel ridges normal to each edge. Thus, the surface appears to be covered by striate rhombs, each made up of two triangular segments on adjacent plates and outlined by the radiating ridges. Plates in the oral one-fourth of the theca covered by low ridges in a vermiform pattern (Pl. V, Figs. 16–17).

Rim around the narrow area of slits on the half-rhombs on *IL2, L4,* and *L1* (Fig. 4*a–c*; Pl. VI, Figs. 1–3); inner edge of this rim low and discontinuous on *L4* in the holotype (Pl. V, Fig. 16; Pl. VIII, Fig. 3). Distal rim on the half-rhombs on *B2, R3,* and *R5* (Fig. 4*a–c*; Pl. VI, Figs. 1–3).

Thecal plate arrangement.—Plates varying greatly in size, many with long, curved edges. Oral plates raised to the level of the ambulacra, their exposed parts difficult to differentiate from the ambulacral flooring plates. Oral circlet very small, as indicated by extent of surrounding plates (Fig. 4*a*).

Basals forming a closed circlet. Sutures *B2/B3* and *B1/B4* concealed by ambulacra II and V respectively. *B1, B2,* and *B3* pentagonal, *B4* hexagonal, with *B1* and *B4* elongate along their junction and *B2* sharply acuminate orally. Infralaterals forming a circlet except that *IL1* and *IL2* touch only at their corners. *IL1* and *IL2* of medium size, pentagonal; *IL3* large, hexagonal, broad; and *IL4* and *IL5* large, vertically elongate. As usual in the family, *IL4* lying atop *B4; IL4* also in contact with *IL5, L5,* periproct, *L4,* and *IL3. IL2* crossed by ambulacrum II and *IL5* by V.

Laterals large, forming a circlet except that *L3* and *L4* touch only at their corners; *L4/L5* and *L1/L5* sutures short. *L1* broad, pentagonal; *L2* hexagonal; *L3* pentagonal; *L4* slanting, trapezoidal except for indentation to accommodate part of periproct; and *L5* vertically elongate, with a deep indentation for the periproct, extending to the oral circlet. *L3* crossed by ambulacrum II and *L5* by V.

Radials ranging greatly in size. Circlet interrupted by *L5* between *R4* and *R5*. Sutures *R1/R5, R3/R4,* and *R4/L5* sigmoid; suture *R2/R3* concealed by ambulacrum II. *R1* subquadrate, narrow; *R2* elongate, its sides tapering orally; *R3* large, subtrapezoidal, its longest side in contact with *L4; R4* very small, wedge-shaped, acuminate aborally; and *R5* subtrapezoidal, its longest side in contact with *L1.*

Plate arrangement unusual in that each of four points serves as the approximate apex for four plates: *B2–IL2–L2–IL1, IL3–L4–R3–L3, L1–L2–R1–R5,* and *L4–L5–R4–R3.* Thus, for the same number of plates, *Pseudocrinites* has fewer sutures than other cystoids of the family.

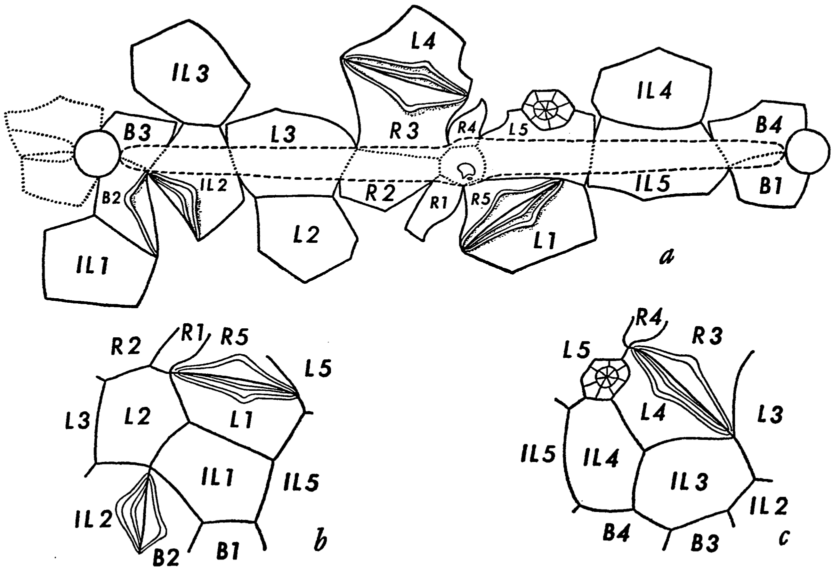

FIG. 4. *Pseudocrinites gordoni* Schuchert. *a,* diagram of plates arranged along the two ambulacra (outlined by a dashed line, with ambulacrum II at the left and V at the right). Dotted lines within the ambulacral area indicate the supposed positions of sutures; those at the left end repeat plates *B1* and *B4* and the end of ambulacrum V. The small oral plates cannot be accurately differentiated from ambulacral flooring plates, and are here included in the ambulacral area. The large hydropore and the small gonopore are shown in the center of the figure. *b* and *c,* plates as exposed on the sides centered on radius I and interradius 3. Based on the holotype, USNM No. 35071*a* (see Pl. V, Figs. 16–17).

In USNM No. 35068, the holotype of Schuchert's *P. abnormalis,* plates *B2, IL1, IL2,* and *L2* affected by the translocation of the basal pore rhomb from *B2/IL2* to *IL1/IL2. B2* smaller than *B1,* rather bluntly acuminate orally, its apex fitting into a notch in *IL1. IL1* and *IL2* vertically elongate, as compared with normal specimens, with a long vertical suture between them. *L2* relatively short, its aboral edge extending to the left from the end of the *L1/L2* suture. A common apex for *B2–B3–IL2–IL1* instead of the normal *B2–IL2–L2–IL1.* Other plates with about the same shape and arrangement as in normal specimens.

Pore rhombs.—Rhombs *B2/IL2, L4/R3,* and *L1/R5* present in normal specimens. In the USNM No. 35068, rhomb *B2/IL2* replaced by *IL1/IL2.* Each rhomb large, elongate.

L4/R3 the longest rhomb, its length about 3/5ths the width of the theca; *L1/R5* slightly shorter; and *B2/IL2* the shortest. Rhombs slightly protuberant at the obtuse angles on *B2, R3,* and *R5,* and decidedly protuberant on *IL2, L1,* and *L4.* Slits restricted to a narrow marginal band on *IL2, L1,* and *L4,* surrounded by a ridge (Pl. VI, Figs. 1–3). Slits on *B2, R3,* and *R5* extending from the distal bordering ridge nearly to the edge of the plate. Slits on rhombs nearly equally spaced, regardless of the size of the rhomb (Table I). Slits slightly more closely spaced in the center of each rhomb (a little over 6/mm) than at the sides (a little less than 6/mm). Worn specimens show slits of one half-rhomb connected with those of the opposite beneath thin shelf-like parts of the plates.

TABLE I

SLITS IN PORE RHOMBS OF SPECIMENS OF *Pseudocrinites gordoni* SCHUCHERT

Specimen	Rhomb	Length (mm)	Slits	Spacing	Plate, Figure
USNM 35071*a*	*L4/R3*	17.1	106	6.2/mm	
USNM 35071*a*	*L1/R5*	16.1	101	6.3/mm	VIII, 4
UMMP 5729	*L4/R3*	15.5	98	6.3/mm	VI, 1
UMMP 5729	*L1/R5*	13.5	84	6.2/mm	VI, 3
USNM 35071*d*	*L4/R3*	11.5	70	6.1/mm	VIII, 5
USNM 35071*c*	*L4/R3*	11.3	70	6.2/mm	
USNM 35071*e*	*L4/R3*	10.0	60	6.0/mm	VIII, 8
USNM 35071*f*	*L4/R3*	9.6	58	6.0/mm	VIII, 7
USNM 35071*g*	*L4/R3*	8.0	50	6.3/mm	VIII, 6
USNM 35071*f*	*L1/R5*	7.6	48	6.3/mm	
UMMP 5729	*B2/IL2*	8.0*	48*	6.0/mm	VI, 2
USNM 35071*h*	*L4/R3*	8.0*	48*	6.0/mm	

* Slits not clearly exposed throughout the rhomb. Figures are for slits counted in the length given.

Ambulacra.—Ambulacra not entrenched, their steep sides rising abruptly from the periphery of the theca (Fig. 5). Ambulacrum intervening between hydropore and periproct (at the left of the periproct) accounted as V, to accord with the arrangement in rhombiferans with a full complement of ambulacra and the periproct in radius 4; the opposite ambulacrum accounted as II, assuming it to be homologous to the one diametrically opposed to V in other rhombiferans. This analysis first suggested by Jaekel (1898, p. 284) in his definition of the genus. Ambulacra in the same positions relative to thecal plates in all specimens, with a minor exception in USNM No. 35068, Schuchert's *"P. abnormalis."* II lying atop the *R2/R3* suture and crossing over *L3* and *IL2;* its terminus in USNM No. 35068 wholly on *B3,* but in all other specimens concealing the *B2/B3* suture. V crossing *L5* and *IL5,* terminating on the *B1/B4* suture (Fig. 4*a*).

Outline slightly indented in oral region, where each ambulacrum adjoins similarly elevated oral plates of the theca. Thence each extends from oral region to or nearly to the stem, tapering very gradually throughout its length; in a few specimens, one or both ambulacra a bit longer, their tips diverted to the side of the stem. Ambulacrum in cross section rectangular, serving as a high platform for attachment of the numerous brachioles.

Flooring plates massive (Fig. 5), of two distinct sizes. As viewed from the side, flooring plates expressed as a palisade of equally spaced elements, their sutures passing alternately between and through the centers of the

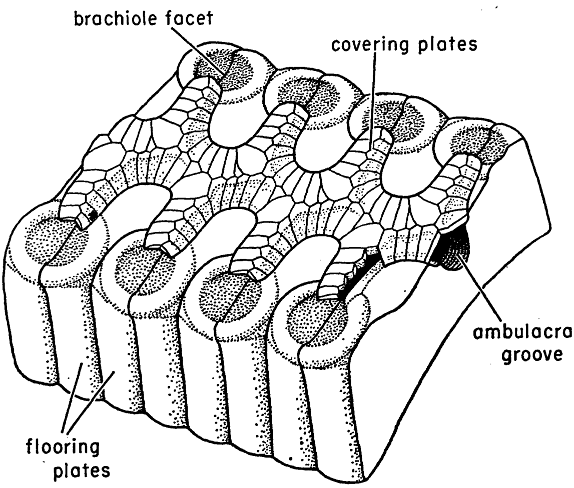

FIG. 5. *Pseudocrinites gordoni* Schuchert. Diagrammatic reconstruction of part of an ambulacrum, showing the relationships of the massive flooring plates and the relatively thin covering plates. The brachioles fitted onto the ambulacrum at the shallow cuplike facets formed by adjacent flooring plates.

brachiole facets (Pl. VII, Fig. 1; Pl. VIII, Figs. 6–8). As viewed from above, exposed parts divulging the differences in size and shape of the two alternating kinds of plates: the smaller shaped as a semicircle containing the oral half of a facet and its bordering rim, and the larger linguiform, not only enclosing the aboral half of a facet but also filling an embayment between branches of the covering plates (Pl. VII, Figs. 2–5). Parts of flooring plates extending beneath the covering plates unknown.

Covering plates numerous, regularly arranged, those of left and right sides meeting at a midambulacral zigzag suture with strongly obtuse angles (Fig. 5). A tapering branch leading from each angle to a brachiole facet (Pl. VII, Fig. 4). In most specimens, the covering plate lying on the aboral side of the junction of a branch with the midambulacral suture much bigger than other plates and elevated as a boss (Pl. VII, Figs. 2–4). In the holotype, the largest and presumably oldest specimen known, certain additional plates raised as smaller bosses (Pl. VII, Fig. 5).

Brachiole facets numerous, alternating on left and right sides, decreasing slightly in diameter toward the end. Each facet a shallow round to oval basin with a surrounding rim. Rims of adjacent facets tangent. In large specimens, facets spaced in the proximal part of the ambulacra about 1.2 to 1.3 mm between centers, in the distal part about 1.0 mm. In small specimens, spacing decreasing distally from 1.1 or 1.2 to 1.0 mm. At a height of approximately 0.5 mm above the theca, each pair of flooring plates occupying 1.0 mm of the length of the ambulacrum, regardless of the part of the ambulacrum or the size of the specimen. Hence, all facets beginning about 1.0 mm apart, and future increase in this spacing related directly to outward growth of the flooring plates.

Hydropore and gonopore.—Hydropore and gonopore well developed and conspicuous, presumably on *O1* as in other cystoids. but boundaries of orals not established. Hydropore a lobate depression on the upper surface of the complex produced by ambulacra and oral plates at the oral end of the theca, whereas gonopore a small round structure on the steep side of the complex (Pl. VII, Fig. 1). Hydropore apparently covered by a plate with closely spaced diagonal slits, spaced about 1/16 mm apart (Pl. VII, Fig. 1). Gonopore apparently closed by a valvular pyramid, as described by Schuchert (1904, p. 227) for the genus.

Periproct.—Anal pyramid low, nearly flat, consisting of nine triangular to subtriangular plates in USNM No. 35071*h* (Pl. VIII, Fig. 1) but only seven in other specimens studied (Pl. VIII, Figs. 2–3). Pyramid surrounded by eight auxiliary plates, each more highly sculptured than the adjacent thecal plates, with the four oral plates narrow and subtrapezoidal and the left aboral plate large and hexagonal or pentagonal.

Periproct fitting into a deep subpolygonal recess in *L5,* bounded on the right by an indentation in *L4* and aborally by the end of *IL4* (Figs. 4*c*).

Remarks.—The spacing of ambulacral flooring plates (and, therefore, brachiole facets) and slits of the pore rhombs seem to have specific significance. Flooring plates, once formed, maintained their same spacing, and grew only outward. Increase in the length of ambulacra was made by addition of flooring plates, not by expansion of plates already present. Small specimens thereby possess fewer flooring plates and brachiole facets than large ones. The growth and expansion of the thecal plates appears to have required a continuous readjustment and repositioning beneath the nonexpanding bases of the flooring plates. At any rate, the width of the bases of flooring plates is the same for specimens of all sizes, and deserves consideration as a specific character.

Slits of the pore rhombs also retain their original spacing after formation, being about the same distance apart in small and large specimens. From a comparison of rhombs in specimens of different size (Pl. VIII, Figs. 4–8), one can only conclude that the rhomb increased in size by successive additions of slits at the ends and lengthening (distally) of previously formed slits. As in the case of the ambulacral flooring plates, it is the spacing, rather than the number, which is constant for the species.

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PLATES

EXPLANATION OF PLATE I

All figures × 2)

FIG. 1. Stereogram centered on peristome, USNM No. 35055*e*. Ambulacrum I is not developed (see plate diagram in Fig. 2*b* in the text). Other stereograms of this specimen are shown in Pl. II, Figs. 7–10.

FIGS. 2–4, 13–14. Stereograms centered on peristome, interradii 4, 5, and 1, and radius III, USNM No. 35055*g*. Ambulacrum V is short and ambulacrum IV very short (see plate diagram in Fig. 2*d* in the text).

FIGS. 5–7, 15–16. Stereograms centered on peristome, interradius 4, radius III, and interradii 5 and 1, USNM No. 35055*b*. Plates *L4* and *IL4* are confluent (see plate diagram in Fig. 1*c* in the text).

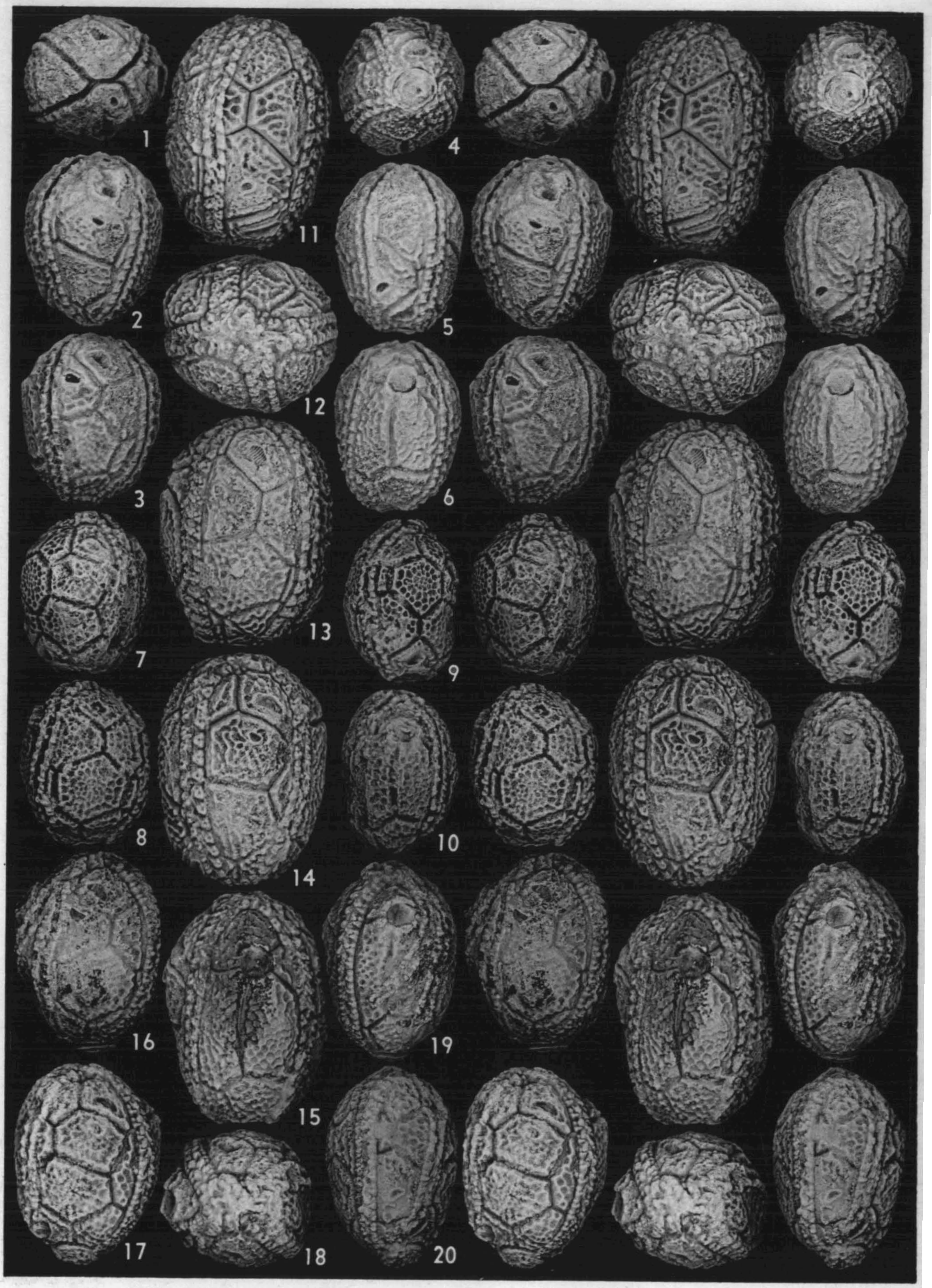
FIGS. 8–12. Stereograms centered on peristome, interradii 4, 5, and 1, and radius III, holotype, USNM No. 35055*a*. Ambulacra V and I are in contact at their distal ends (see plate diagram in Fig. 2*a* in the text).

FIG. 17. Stereogram centered on interradius 1, USNM No. 35055*i*. Ambulacrum I is very short (see plate diagram in Fig. 3*b* in the text).

FIG. 18. Stereogram centered on interradius 5, USNM No. 35055*j*. This specimen clearly shows the contacts of plates *R5, O1,* and *O2*.

PLATE I

PLATE II



EXPLANATION OF PLATE II

All figures × 2)

FIGS. 1–6. Stereograms centered on peristome, interradius 5, radius III, base, and interradii 1 and 4, UMMP No. S5728*a*. The hydropore is shown very well in Fig. 1.

FIGS. 7–10. Stereograms centered on interradius 5, radius III, and interradii 1 and 4, USNM No. 35055e. Ambulacrum I is not developed (see plate diagram in Fig. 2*b* in the text). A stereogram centered on the peristome is shown in Pl. I, Fig. 1.

FIGS. 11–15. Stereograms centered on interradius 1, peristome, radius III, and interradii 5 and 4, USNM No. 35055*f*. All ambulacra are fully developed and in the mean positions for the species (see plate diagram in Fig. 2*c* in the text).

FIGS. 16–20. Stereograms centered on radius III, interradius 5, peristome, and interradii 4 and 1, USNM No. 35055*d*. This is the only specimen known in which one of the ambulacra bifurcates (see plate diagram in Fig. 3*a* in the text).

EXPLANATION OF PLATE III

FIG. 1. Stereogram centered on radius I, USNM No. 35055*k*, showing ambulacrum I. × 4.

FIG. 2. Stereogram of part of ambulacrum I, crossing plates *R1, L2, IL1, IL2,* and *B2,* USNM No. 35055*k*. × 20.

PLATE III

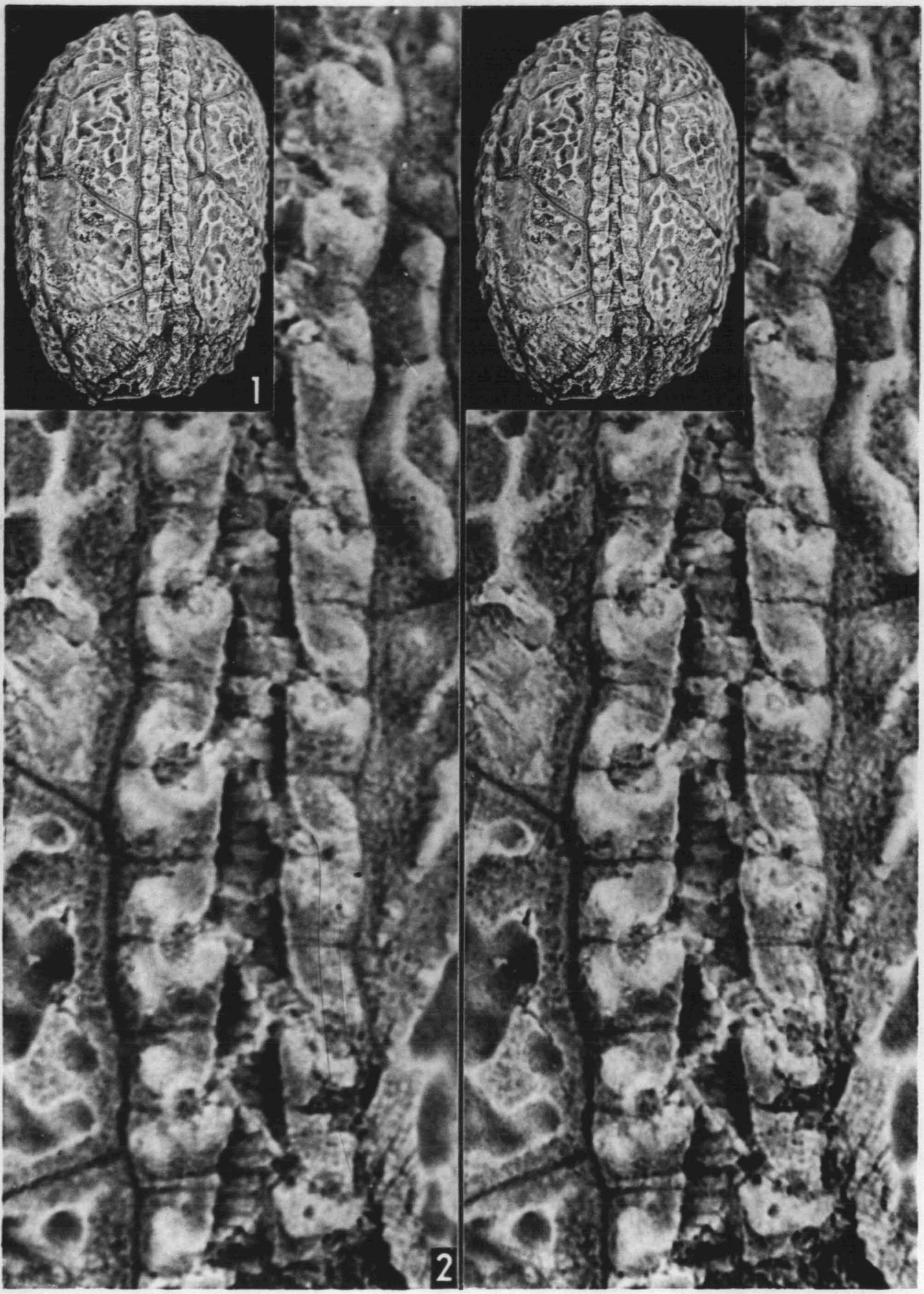
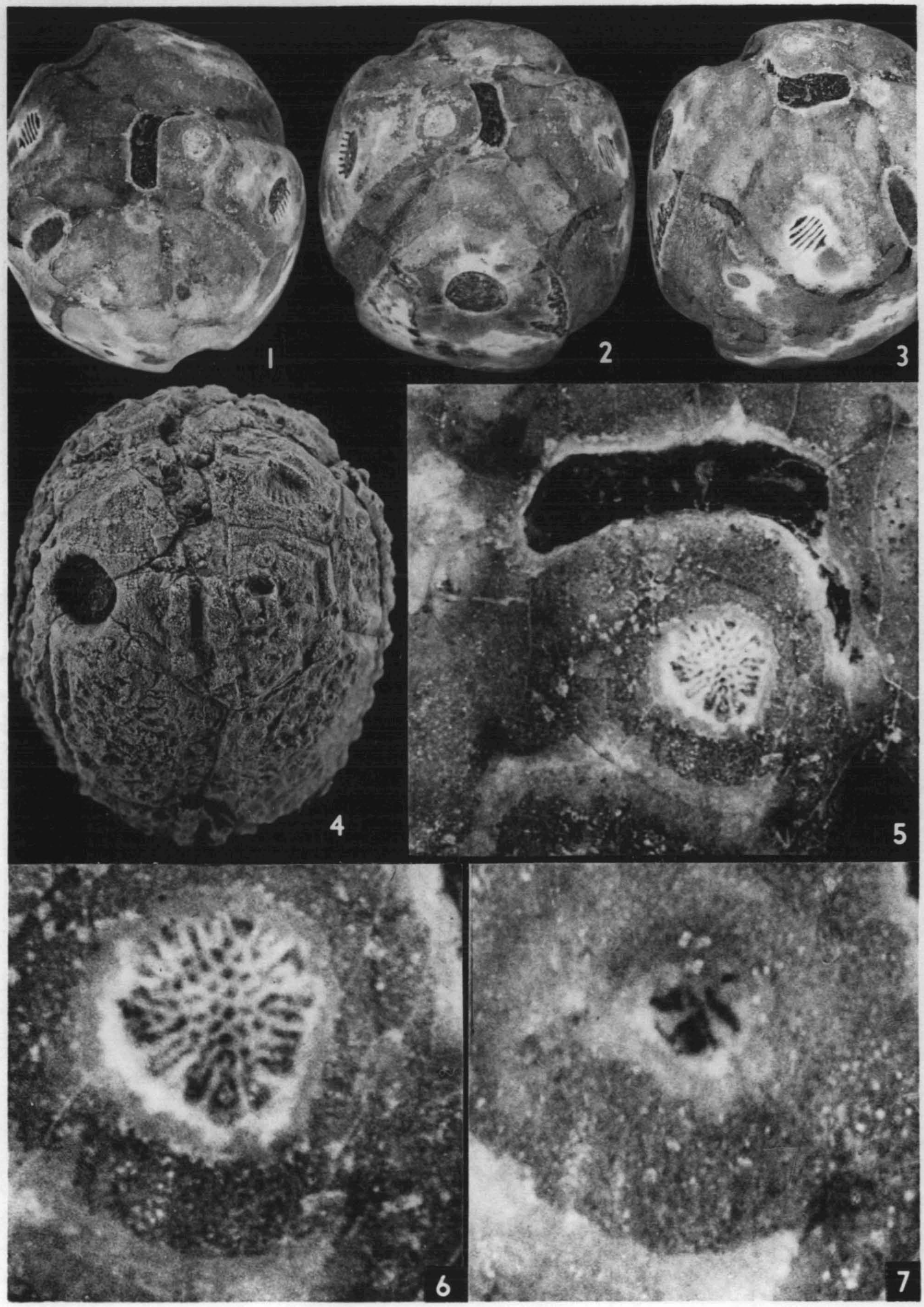


PLATE IV



EXPLANATION OF PLATE IV

FIGS. 1–3. Inclined oral views centered on interradii 1 and 4 and radius III, UMMP No. S5728*b*, photographed while submersed in xylol. In these views, the ambulacra and ornamentation have been ground off to show the pattern of thecal plates. As shown in Fig. 1 (and also in Fig. 5), plate *R2* appears to be in contact with *O2* in this specimen and plate *R1* appears to be narrow, contrary to the pattern in most of the type specimens (compare Fig. 1*a* with 1*b* in the text). × 5.

FIG. 4. Inclined view centered on radius IV, showing sutures outlining plate *R4* revealed where ambulacral plates are missing, USNM No. 35055*l*. Specimen lightly coated with sublimate of ammonium chloride. × 5.

FIG. 5. View of peristome (the horizontal dark slot), hydropore (the sievelike structure near the center), and thecal plates *O1* (right center) and *O2* (left center), UMMP No. S5728*b*, prepared as in Figs. 1–3 above, photographed while submersed in xylol. × 20.

FIGS. 6–7. Views of hydropore, ground and polished to levels slightly below the surface (Fig. 6) and deeper in plate *O1* (Fig. 7), UMMP No. S5728*b*, photographed while submersed in xylol. × 40.

EXPLANATION OF PLATE V

(All figures × 1)

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FIGS. 1–5. Stereograms centered on interradius 3, peristome, radius I, base, and radius II, UMMP No. 5729.

FIGS. 6–13. Stereograms centered on radius I and interradius 3, paratypes, USNM Nos. 35071*g*, 35071*d*, 35071*f*, and 35071*e*.

FIGS. 14–17. Stereograms centered on interradius 3 and radius I, paratype, USNM No. 35071*c*, and holotype, USNM No. 35071*a*.

PLATE V

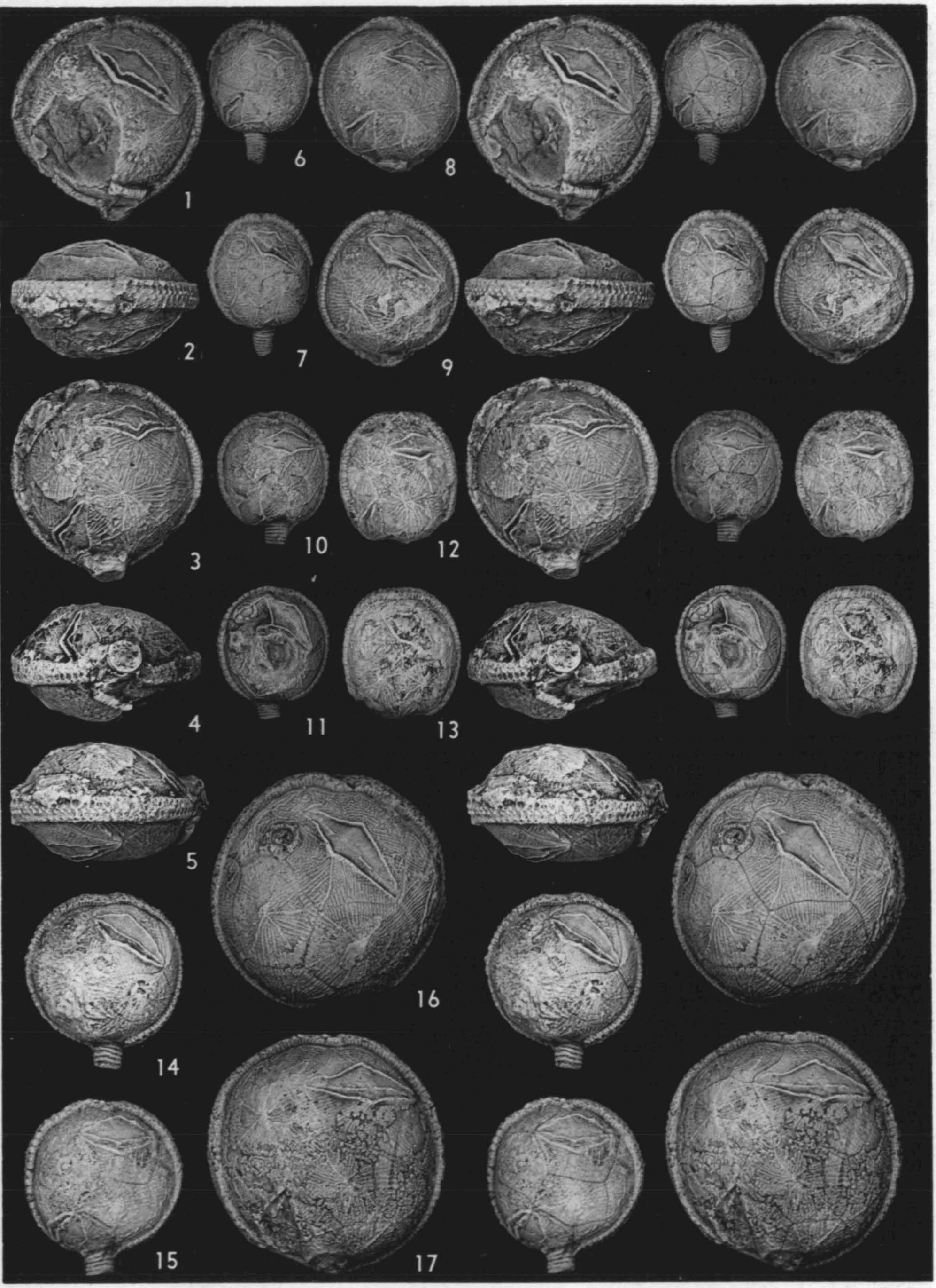
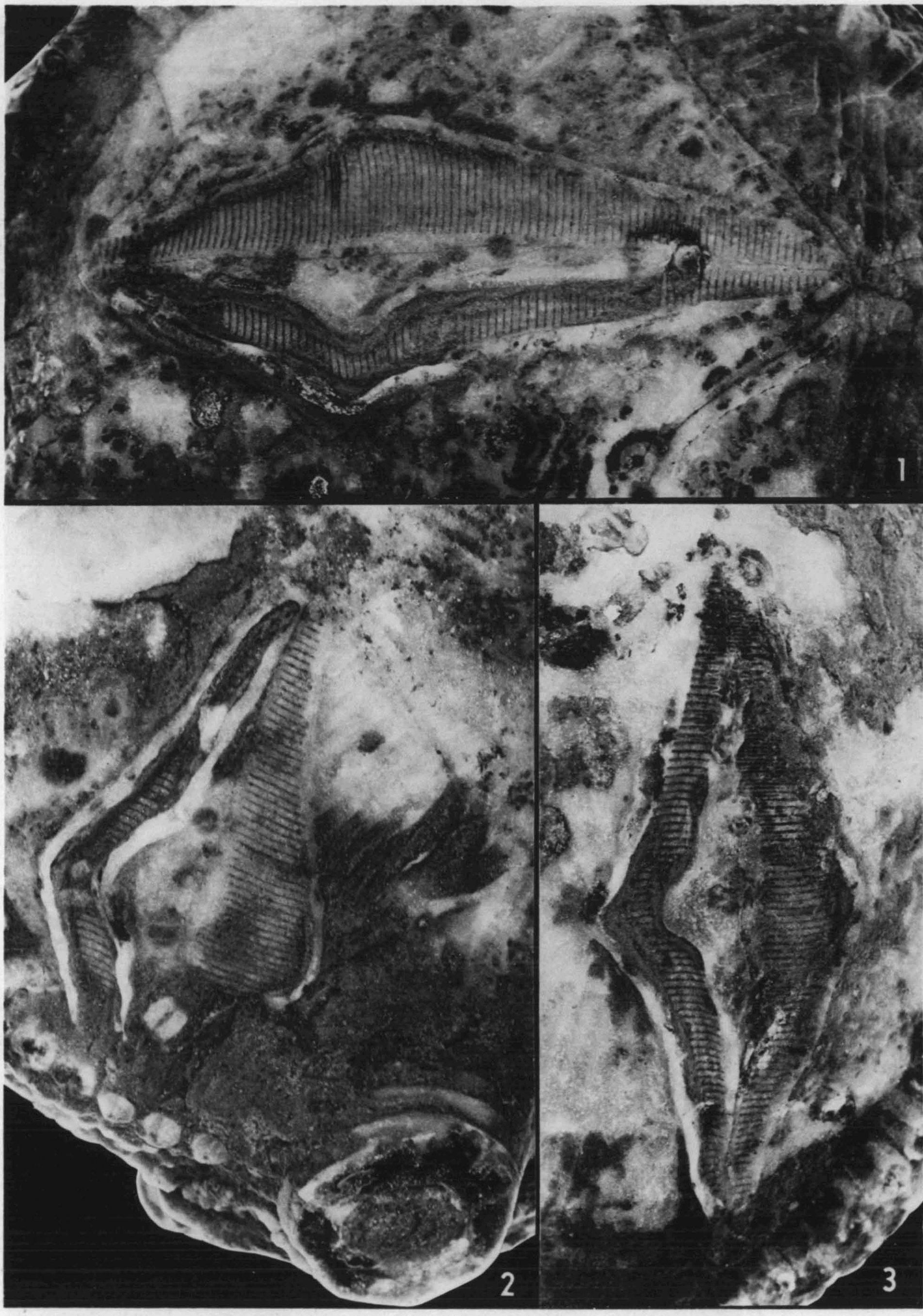


PLATE VI



EXPLANATION OF PLATE VI

(All figures × 6⅔)

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FIGS. 1–3. Pore rhombs *L4/R3, B2/IL2,* and *L1/R5,* UMMP No. 5729, submersed in xylol. Compare with stereograms of the specimen coated with sublimate of ammonium chloride, Pl. V, Figs. 1, 3.

EXPLANATION OF PLATE VII

(All figures × 10)

FIG. 1. View centered on radius III of oral region, USNM No. 35071*b*. The small mound near the center is the hydropore, and the palisade-like structures extending laterally from it are flooring plates of the two ambulacra.

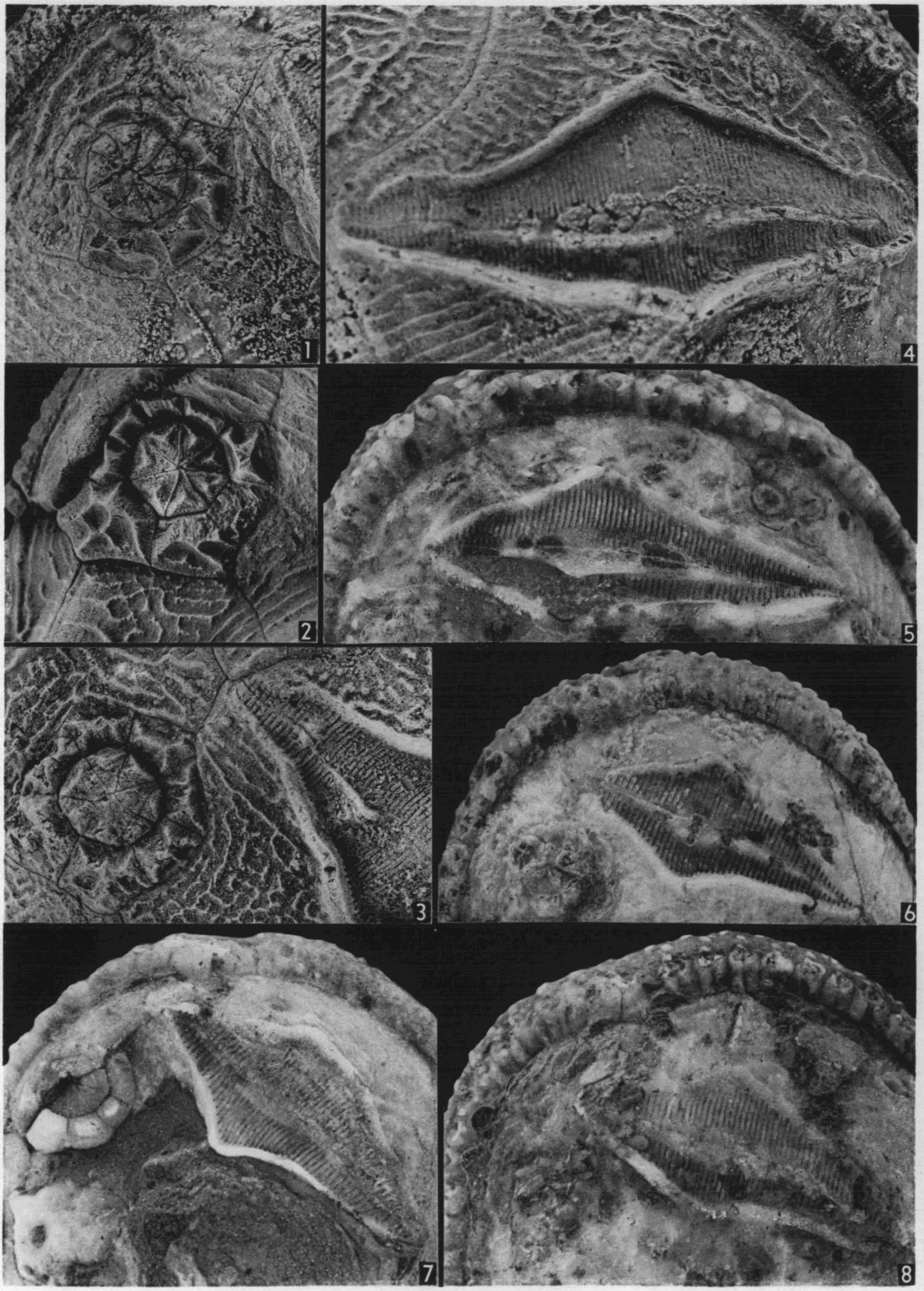
FIGS. 2–3. Two views of an ambulacrum, USNM No. 35071*i*. The oral direction in each figure is toward the right.

FIG. 4. View of an ambulacrum, USNM No. 35071*h*. The oral direction is toward the left. In the right central part of the figure some of the plates have been outlined in ink.

FIG. 5. View of an ambulacrum, holotype. USNM No. 35071*a*. The oral direction is toward the left. In this large, and presumably old specimen, the ambulacral covering plates display more tuberosities than do smaller specimens; compare with Figs. 2–4 above.

PLATE VII

PLATE VIII



EXPLANATION OF PLATE VIII

(All figures × 5)

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FIGS. 1–3. Periprocts of three specimens, USNM Nos. 35071*h*, *b*, and *a*.

FIG. 4. Pore rhomb *L1/R5*, holotype, USNM No. 35071*a*. Compare with stereogram of complete specimen, Pl. V, Fig. 17.

FIGS. 5–8. Pore rhombs *L4/R3* in four specimens, USNM Nos. 35071*d*, *g*, *f*, and *e*, submersed in xylol. Compare with stereograms of complete specimens coated with sublimate of ammonium chloride in Pl. V, Figs. 9, 7, 11, and 13.