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A LOWER CAMBRIAN EDRIOASTERID

Stromatocystites walcotti

(With One Plate)

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In 1910, while the writer was studying the stratigraphy of western Newfoundland, he was much surprised to find in the Lower Cambrian a number of cystids that seemed to be related to the edrioasterids. These and other Lower Cambrian fossils were collected for the United States National Museum, and the study of the edrioasterids was kindly turned over to the writer by the Secretary of the Smithsonian Institution. In admiration of the long-continued and excellent work which the latter has done on the Cambrian, in the midst of seemingly endless administrative duties, the new species herein described is given the name *Stromatocystites walcotti.*

It was thought at first that these fossils represent a new genus, but after seeing two specimens of *Stromatocystites pentangularis* from the Middle Cambrian of Bohemia, which are in the Peabody Museum collection in Yale University, it became clear that the Newfoundland form is a species of *Stromatocystites.* Accordingly, we will begin with a definition of that genus, in the main as given by Pompeckj.[1]

Stromatocystites (redefined)

Text fig. 1 E

This is a flat and depressed cystid, and it is this spread-out condition that has suggested the name. Theca free, unstalked, subpentagonal in outline, and composed of numerous comparatively large, non-imbricating, and usually five- and six-sided plates. In a theca 35 mm. in diameter there may be 1,000 plates. Upper surface convex, lower one concave. Ossicles of the upper side bearing, along each angulation of their margins, usually 2 to 3 diplopore depressions that extend across the sutures of adjoining plates; on the

[1] J. F. Pompeckj, Jahrb. d. k. k. Geol. Reichs., Vienna, 45, 1895, pp. 505-508, pl. 13, figs. 1-6. Also see F. A. Bather, Treatise on Zoology, Part III, Echinoderma, p. 206, fig. 1.

inner sides they are seen as two tiny apposed hydrospire elevations. Plates of the lower side very finely pitted, but it is not thought that these pits bear pores going through the plates to the body cavity.

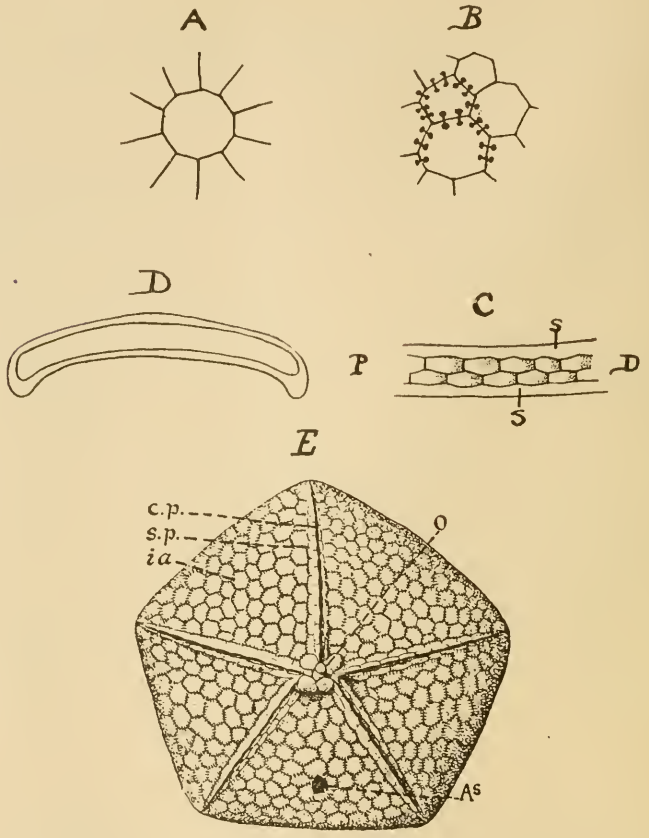


FIG. 1.—A, *Stromatocystites walcotti*, n. sp. The centrodorsal plate, and the first circle of 10 plates in outline, × 5. B, *S. walcotti*, n. sp. Some of the plates of the upper side, showing the diplopore spiracles, as seen from their inner surface, × 5. C, *S. walcotti*, n. sp. Part of an ambulacrum showing the flooring plates, × 5. *D*, distal, *P*, proximal end; *s*, ridges of the side plates. D, *S. walcotti*, n. sp. The animal in section, × 2. E, *S. pentangularis* Pompeckj. A restoration of the upper surface by F. A. Bather, somewhat enlarged. *As*, anus; *O*, peristomial plates, *c. p.*, covering plates, *s. p.*, side plates, *ia*, interambulacrals.

Ambulacra restricted to the upper side, straight and narrow, bounded on either side by a column of about 11 to 13 narrow elongate plates; ambulacral groove deep and seemingly floored by two columns of elongate, narrow, and alternating flooring pieces; the two columns

of alternating covering plates highly arched over the ambulacrum, about as wide as long, and from 11 to 13 in number. Pompeckj sees podial perforations, but in the writer's specimens none such appear to be present. Mouth on upper side, covered by a number of imperforate plates, of which 4 are large and peripheral, with several smaller ones between them. In addition, there are others of the ambulacra. Anus in the bivium of the upper side, and covered by a pyramid of about 9 small ossicles.

Genotype.—S. pentangularis Pompeckj, Middle Cambrian of Bohemia.

STROMATOCYSTITES WALCOTTI, new species

Plate 1, figs. 1-4; text fig. 1 A-D

This new diplopore-like edrioasterid is the oldest one known, being from the upper portion of the Lower Cambrian. When alive, these animals sat somewhat anchored upon the sandy mud, but they were in no way cemented to sea bottom nor to foreign objects. The loose anchoring was by means of the sharply bent and closely folded, projecting marginal rim, which was pressed down into the mud, assisted by the concavity of the under side of the theca (see fig. 1 D). Impressions of this rim are of common occurrence on the weathered rock surfaces, though the calcareous plates are usually dissolved away by the percolating waters (pl. 1, figs. 2 and 4). The plates of the rim were somewhat thicker and far more irregular in shape and size than those of either the lower or upper discs. In fact, there is a tendency to form a ring of large plates, with many smaller irregular ones about them. None of the plates are imbricating. The under side of the animal is slightly concave, while the upper one is depressed convex. The body cavity is very shallow, probably less than 3 mm. in depth.

Stromatocystites walcotti is subpentagonal in outline, with the greater diameters varying between 18 and 22 mm. The ambulacra are restricted to the upper surface, are comparatively narrow, but with distinct and sharply elevated, nearly parallel sides which are deep and straight and terminate in the angles of the pentagon. The ambulacra are roofed over by small covering plates whose detail is not preserved. The ambulacral grooves are distinctly floored by two columns of elongate alternating plates, numbering between 11 and 14 in each row. None of these plates is perforated (see pl. 1, figs. 1-3 and text fig. 1 C). The side plates are not well preserved, but they

appear to be narrow elongate pieces and about as many as there are ambulacrals, with which they alternate. The mouth area is not preserved.

The interambulacral areas of the upper disc are composed of slightly convex, usually six-sided plates, which are rather large in comparison with the size of the animal. Of these there appear to be between 120 and 130. From one to two, and at times three, diplopores cross the sutures of each plate angulation, and these are far more distinctly seen on the inside of the plates because of the pairs of sharp but tiny spiracle elevations (text fig. 1 B, and pl. 1, fig. 3). The anal pyramid is unknown.

The plates of the under side of the animal are also non-imbricating and apparently in the main six-sided; they appear to be somewhat smaller than those of the upper side. Their number seems to be between 140 and 160. In the center of the under surface there is a comparatively large centrodorsal plate, about 2 mm. in diameter, around which there is a ring of 10 elongated plates (pl. 1, figs. 2 and 4, text fig. 1 A). All of the plates of the under surface are finely pitted, and these are arranged obscurely in lines across the sutures of adjoining plates. They are too delicate to be remnants of vanishing diplopores, and are probably nothing more than the similar pittings seen in many cystids (pl. 1, fig. 3).

As the specimens come in two sizes and on different horizons of the Lower Cambrian, the name *Stromatocystites walcotti* is applied to the larger form above described, of which 6 individuals are known. The smaller ones are far more common, 25 being at hand, and they vary in diameter from 9 to 15 mm. Because of their smaller size they are here distinguished as variety *minor*. All that is preserved of these smaller specimens is the impressions of the marginal plates (pl. 1, fig. 4).

Locality and horizon.—In the Olenellus beds of the Lower Cambrian (Taconian) of East Arm of Bonne Bay, western Newfoundland. The type material is in the collection of the U. S. National Museum, catalogue numbers 66443, 66444.

Remarks.—Bather states that *Stromatocystites* "was probably sessile on its under surface but perhaps not fixed permanently." The word sessile may be interpreted as meaning sitting upon, or attached to something, and it is in the former sense that we must here accept the significance of sessility. In both the European and American forms, the under thecal surfaces do not show the slightest scar or modification such as would follow if the animals were firmly attached

or cemented to the ground. Of course they were not errant animals, but were, rather, stationary in habit and loosely anchored to the muddy and sandy sea bottom by the concave under side and the downward projecting margin of the theca. This naturally was a rather precarious footing in a shallow sea, and undoubtedly the storm waves often pulled them away from their moorings.

In regard to disposition among the Echinoderma, *Stromatocystites* is at first sight somewhat perplexing. On the one hand, it is clearly related to the diplopore-cystids in its thecal structure, and the five ambulacra appear to be nothing more than modified recumbent brachioles attached to the thecal plates. Yet it is not one of these cystids, because *Stromatocystites* was a free animal devoid of a stalk, though retaining at times centrodorsal plates. On the other hand, the genus is clearly on the line of evolution to the sessile edrioasterids, but is an unattached although not an errant form. That *Stromatocystites* is already plainly on the line toward the edrioasterids is indicated by the structure of the ambulacra. This is seen in the modification from the diplopore-cystids, where the free brachioles are composed of two columns of alternating thick ossicles having their ambulacral furrows covered over by two rows of roofing plates. These four columns of ossicles are, in the genus under consideration, the equivalents of the roofing and flooring plates of the ambulacra, but there are in addition, the two columns of side plates, a new development not present in the brachioles of diplopore-cystids. In these features we therefore seem to see how a diplopore-cystid changed into the loosely anchored *Stromatocystites,* at the same time trending in development toward the true edrioasterids.

In 1905, Jean Miquel described a new form as *Stromatocystites cannati,*[1] from a single specimen. It comes from the Middle Cambrian of the Montagne Noire of France, and is peculiar in having a much modified lower rim. Miquel says that the margin has very large rectangular plates, and that each of the sides of the pentagonal disc has from 3 to 5 of them. As the specimen is somewhat crushed, and as an uncrushed side of the pentagon has 5 large marginal plates, this may be taken as the actual number, so that there were about 25 much modified ossicles in the anchoring rim of the lower side. The lower thecal side is not described and is probably unknown. "The ambulacra," Miquel says, "attain the extremity of the circumference, and accentuate the angles of the pentagon; they

[1] Bull. Soc. géol. France, 4th ser., vol. 5, 1905, p. 482, pl. 15, fig. 5.

are formed of two ranges of plates, small, regularly arranged, with a quite large size, which decreases from the mouth of the animal to their extremity. The species has in general form much analogy with *S. pentangularis* Pompeckj." It differs clearly from this form "by the size of the ambulacra and by the arrangement of the thecal margin."

Even this meager description shows that it is not a *Stromatocystites,* but that it is plainly an edrioasterid. The marginal plates are already those of edrioasterids.

Relation to asterids.—The edrioasterids are particularly interesting fossils because the oldest forms seem to indicate the stock out of which they arose, and at the same time appear to be near the forms that gave rise to the asterids. Bather was the first to point out this phylogeny and he has written at length about it. We will therefore follow his argument.

The oldest known asterids are of Middle Ordovician time, but here there are already large forms in considerable variety, and the structural differentiation among them is great.[1] This of course must mean a much older origin for the asterids. On the other hand, edrioasterids go back to the late Lower Cambrian, and if the asterids arose in the edrioasterids, we must look for small, subpentagonal, diplopore-cystid-like, ancestral asterids certainly as early as the Middle Cambrian and probably as far back as the Lower Cambrian.

The origin of the starfish line may have been brought about, according to Bather,[2] as follows: "If we imagine an edrioasteroid with loose attachment, liable to be overturned by currents . . . . then all we have to suppose is that some of the overturned individuals were able to survive the accident. This they would be able to do if they had fairly well developed podia, such as are indicated by the anatomical evidence. . . . . Indeed, it is hard to see how locomotion could have been avoided."

The home of *Stromatocystites,* in both Europe and America, was a shallow sea near a shore, where there was rapid accumulation of sand and mud. Many of the strata of the Lower Cambrian of Newfoundland are rippled, and the organic and facial evidence is of shallow seas, certainly less than 200 feet in depth, with the probability of even less than 100 feet. In such a sea, the greater storm waves could easily pick up the bottom and roll it about, carrying along with

[1] See Schuchert, Revision of Paleozoic Stelleroidea, Bull. 88, U. S. Nat. Mus., 1915, pp. 27-31.

[2] Bather, Geol. Mag., dec. 6, vol. 2, 1915, p. 403.

it the *Stromatocystites*. The animals had to battle constantly against this danger, and through the aid of their breathing podia probably did dig themselves out when accidentally covered by the muds. Such treatment often repeated, as it must have been, might well have been the stimulus that brought about forms that learned how to creep around on their nutrient ambulacral surface through the aid of their breathing podia. In this way breathing podia were changed into locomotor podia like those of asterids. At the same time, the passive funnel-like mouth of *Stromatocystites* evolved into the active predatory organ of asterids.

In the permanently overturned condition, with the mouth beneath the disc, such as occurs in a form similar to *Stromatocystites,* Bather states that the hydropore and anus would have to migrate along the posterior interradius toward the aboral pole, and in consequence the stone-canal would become elongated. The ambulacra and the covering plates became the ambulacra and adambulacra of asterids. On the other hand, the side plates of edrioasterids appear to be new structures not present in diplopore-cystids, and they may well be the equivalents of the inframarginalia of primitive Paleozoic asterids. The mouth frame in edrioasterids is composed of 15 plates (the five interradials are here fused plates, so that originally there were 10 of them), while in starfishes the more primitive form of 20 pieces is often retained. All were originally ambulacral and interambulacral (=adambulacral) structures.

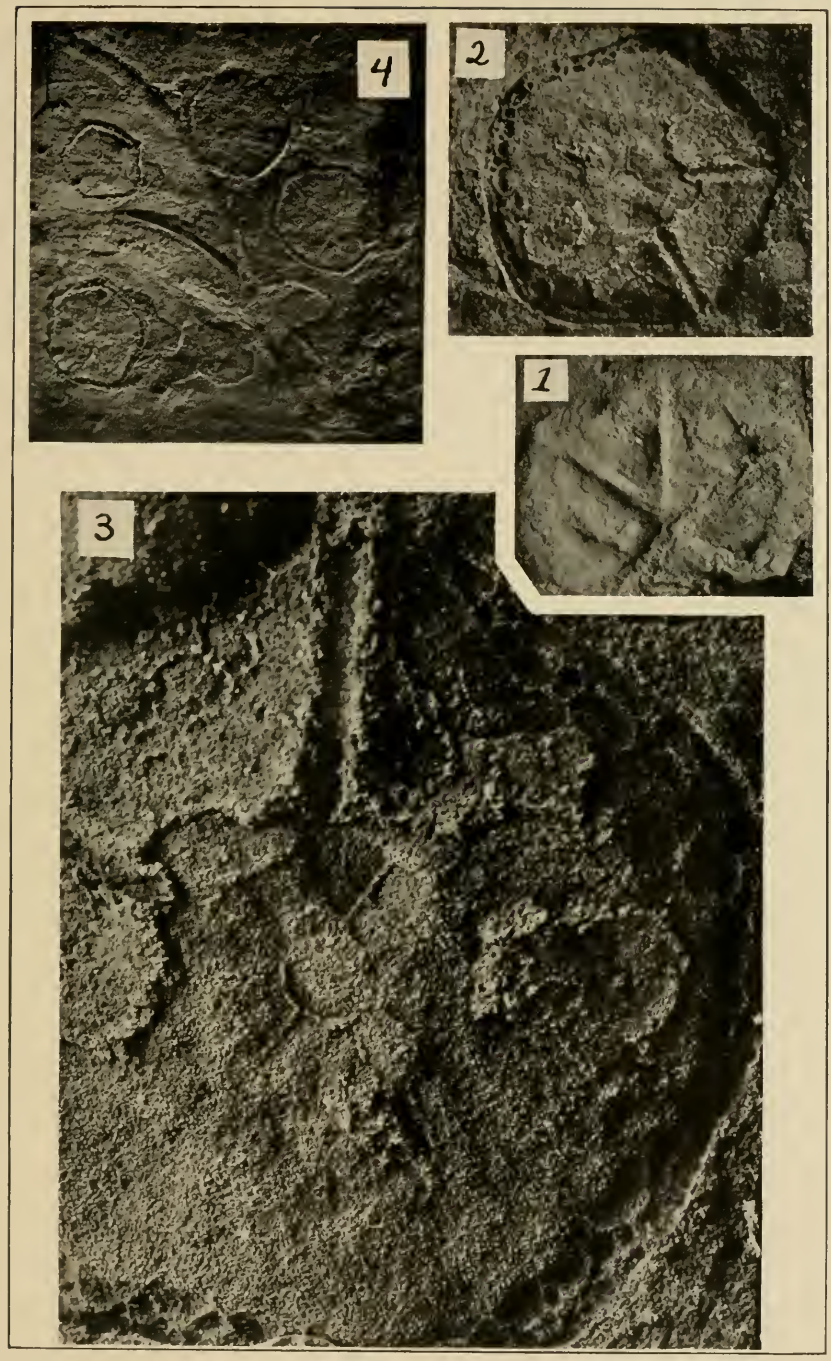
PLATE 1

FIG. 1.—*Stromatocystites walcotti,* n. sp. A slightly slickensided specimen from the upper side, × 2.

FIG. 2.—*S. walcotti,* n. sp. A natural mold, × 2. Showing the centrodorsal plate and the ossicles of the rim. On the right is preserved some of the filling of the body cavity, which retains the imprint of the inner sides of the plates of the upper surface.

FIG. 3.—Same specimen as fig. 2, × 5. To show the pitting of the plates of the lower side, and the spiracles of the plates of the upper side.

FIG. 4.—Four impressions of the lower side of *S. walcotti minor,* n. var. Natural size.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