CONTRIBUTIONS FROM THE MUSEUM OF PALEONTOLOGY

THE UNIVERSITY OF MICHIGAN

VOL. XIX, No. 9, pp. 115–133 (4 pls., 1 fig.) NOVEMBER 26, 1964

A DRASTIC REAPPRAISAL OF "*LEPIDASTERELLA BABCOCKI* SCHUCHERT" AS *HELIANTHASTER GYALINUS* CLARKE A STREPTOPHIURAN AULUROID

BY
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A DRASTIC REAPPRAISAL OF *"LEPIDASTERELLA BABCOCKI* SCHUCHERT"—AS *HELIANTHASTER GYALINUS* CLARKE, A STREPTOPHIURAN AULUROID

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ABSTRACT

Study of a previously undescribed specimen of "*Lepidasterella babcocki* Schuchert" clearly shows that original descriptions of both genus and species are based upon an external mold of the oral side, not the aboral side of the holotype. This stelleroid does not belong to the subclass Asteroidea, as supposed by Schuchert (1915), Ruedemann (1916), and Spencer (1927). Instead, it is placed in the order Streptophiurae of the subclass Auluroidea. The genus *Lepidasterella* Schuchert 1915 and the species *L. babcocki* Schuchert 1915 are considered junior synonyms, respectively, of *Helianthaster* Roemer 1863 and *H. gyalinus* Clarke 1908.

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INTRODUCTION

FOR MANY YEARS, a stelleroid labeled "*Lepidasterella babcocki* Schuchert" was on display at our Museum of Paleontology. The catalogue card states only that it was presented by J. F. Pepper and that it came from drift in a field near Pulteney, Steuben County, New York. The late Mr. Pepper was an alumnus of The University of Michigan, receiving his B.S. degree in 1925 and his M.S. in 1926. Presumably, he acquired the specimen while working in the area as a geologist of the United States Geological Survey in 1934–35 or in the late 1940's. Inasmuch as only three specimens had previously been referred to the species, this individual held special interest.

Recently, in studying some Devonian five-armed stelleroids, I desired to compare their arm structure with that of the many-armed *"Lepidasterella."* Accordingly, I removed the specimen (Pl. I, Fig. 1) from its exhibit case and examined it with a microscope. In all respects, it conforms to the descriptions and figure of the holotype of *Lepidasterella babcocki* presented by Charles Schuchert in 1914. To my surprise, however, certain of the "arms" (called "rays" by Schuchert) terminate in cavities in the sandy matrix. These cavities proved to be external molds of the arms, which have been disintegrated. The "rays" referred to in the original description are merely the external molds of the oral surfaces of the arms. Latex casts duplicate the original form of the arms (Pl. I, Fig. 2; Pl. II, Fig. 2; Pl. III, Figs. 1–2; Pl. IV, Figs. 1–2).

From comparison of this specimen and its cast with the specimens and a cast described and illustrated by Clarke in 1906 as *"Helianthaster* sp. nov." and in 1908 as *"Helianthaster gyalum,"** I conclude they are one species. Ruedemann in 1916 classified Clarke's *gyalum* as a second species of *Lepidasterella.* In my opinion, *Lepidasterella* is not generically different from *Helianthaster,* nor is *Lepidasterella babcocki* specifically different from *Helianthaster gyalinus,* which must prevail by priority.

At the subclass level of taxonomy, I retain Auluroidea as a distinct and useful division in the Stelleroidea, despite its omission in the system proposed by Spencer in 1951.

After direct comparison with other stelleroids, I have no doubt that *Helianthaster gyalinus* Clarke belongs to the subclass Auluroidea. Although the preservation as external molds in sandy matrix leaves much detail to be desired, the oral structure of the arms is strikingly similar to that in other species of the order Streptophiurae. In essence, this assignment is a reversion to the original classification as an ophiuran brittle-star by Clarke in 1908—for at that time the auluroids were included in the Ophiuroidea, and it was not until 1910 that the subclass Auluroidea was created by Schöndorf. Placement of *"Lepidasterella babcocki"* in the Asteroidea by Schuchert (1915), Ruedemann (1916), and Spencer (1927) stemmed from serious misunderstanding of the nature of the fossils.

Typescript of this paper was critically read by Professor Lewis B. Kellum and Professor Chester A. Arnold of the Museum of Paleontology.

The specimen illustrated and discussed herein is deposited and cata-

* The trivial name proposed by Clarke, *gyalum,* is a noun rather than an adjective, obviously from Greek γυαλον, n. ("a hollow vessel"); to form an adjective and therewith conform to rules of nomenclature Greek—ινος ("having the properties of") should be added as a suffix to the stem, so that the name becomes *gyalinus* (masculine to agree with the gender of *Helianthaster*).

logued in the Museum of Paleontology of The University of Michigan as No. 30527.

PRESERVATION OF SPECIMENS

The specimens which are known of this auluroid are listed in Table I. Of those previously studies and described, all but one have been illustrated. The descriptions and figures correspond to the condition of the specimen in our museum.

TABLE I

KNOWN SPECIMENS OF *HELIANTHASTER GYALINUS* CLARKE

Publication	Name Assigned	Number of Specimens	Found By	Formation	Locality
Clarke, 1906	*Helianthaster* sp. nov.	2	D. D. Luther	Portage (Cashaqua)	Hunt's Quarry, Interlaken
Clarke, 1908	*Helianthaster gyalum*	3	S. G. Williams	Portage	Earl's Quarry, Ithaca
Schuchert, 1915	*Lepidasterella babcocki*	1	Mrs. G. W. Babcock	Lower part of U. Dev.	Near Ithaca
Herein	*Helianthaster gyalinus*	1	J. F. Pepper	Drift	Steuben Co., N. Y.

The central oval area is devoid of structure (Pl. I, Fig. 1). Radiate structures representing the arms terminate proximally between pits (Pl. IV, Figs. 3–4). Each radiate structure consists of a raised median ridge, bordered on each side by a series of quadrate elevations, the whole outlined on the sides by deeply incised scalloped grooves. Between adjacent quadrate elevations, sharp furrows lead laterally into the grooves. From the distal ends of certain scallops within the grooves, conical cavities or holes extend into the matrix. Between proximal parts of the radiate structures, in ambital positions, at about the level of the quadrate elevations, narrow triangular areas are regularly dented by subcircular depressions (Pl. IV, Fig. 4).

The holes extending outward are obviously natural molds of spines, and the grooves from which they originate are molds of adambulacral series. Hence, no original structures of the starfish are represented, only the external molds or impressions of the plates and ossicles. Each of the radiate structures is the mold of the oral surface of an arm. The median ridge along each radius is the filling of the ambulacral groove, the quadrate elevations are the molds of the ambulacral series, and the sharp furrows between the elevations are the molds of ridges on the ambulacral plates (Pl. IV, Figs. 3–4). The scallops within the lateral grooves were made by the oral edges of adambulacral plates. The proximal pits between arms are the mouth frame, or oral armature.

Some of the external molds of the oral surfaces of arms terminate distally in cavities in the matrix (Pl. I, Fig. 1). Latex injected into these cavities reproduce the total form of that section of the arm, yielding data on the dorsal and lateral parts of the arm and showing relationships of the major arm plates (Pl. IV, Fig. 1).

From a latex cast of the fossil, the oral side of the starfish is reproduced with sufficient detail to identify the principal features (Pl. I, Fig. 2). The sandy matrix does not preserve the mold of fine details of ornamentation, if such existed. One ambital area is wider than the others and contains a disc-shaped plate, which is here interpreted as the madreporite (Pl. II, Figs. 1–2).

What conditions prevailed at the time of burial and fossilization cannot be proved. Nevertheless, it seems significant that oral sides, only, are preserved as molds in the sandy stratum. Perhaps, the auluroid was entombed in its natural position, with the mouth and ambulacral grooves ventral; then, within the porous matrix, the body decayed and the hard skeletal structures dissolved; the large central area and adjacent parts of the arms collapsed under the weight of overlying sediments; and finally, the fine sand was lithified to preserve the mold of the oral surface and the tips of the arms.

PREVIOUS WORK

This stelleroid first came to scientific attention in 1906 in an incidental report by John Mason Clarke, who illustrated it (pl. opp. p. 36), called it "*Helianthaster* sp. nov.," and stated (p. 37) that the specimen possessed twenty-four arms, which "expose the ventral surface, each ambulacral joint bearing a single pair of spines." He deposited the specimens in the New York State Museum.

The first formal name was given by Clarke two years later, in 1908; he called it *Helianthaster gyalum* and compared it with *H. rhenanus,* the type species. He described the arm plates as viewed from the oral side and gave a lucid account of the oral framework. From his description, it is clear that Clarke understood the nature of his fossil material. His terminology, however, probably contributed to some of the confusion that characterizes later work. He stated (p. 62) that the slab from Earl's Quarry "carries three individuals all in ventral aspect, and all casts"; he illustrated this slab (his Pl. 13) and a counterpart of one of the specimens (his Pl. 12), which he called a mold. As the terms for fossil remains are commonly used, the counterpart of original features of the animal is the *mold* and the replica of original features (prepared from the mold) is a *cast*. Nevertheless, despite his reversed terms, Clarke was aware that the fossils were the impressions or counterparts of the ventral sides of the arms, for he stated (p. 64), "The separation of these series of ventral plates [left and right ambulacrals] is exhibited on the mold as a solid uninterrupted ridge representing a longitudinal slit."

Correcting his previous statement (1906, p. 37), Clarke also reported (1908, p. 64) that "the lateral plates are well defined and bear several spines each." This observation was overlooked or discredited by later workers; even Spencer (1927, p. 367) assigned this stelleroid to his Taeniactininae, which he differentiated from other subfamilies of the Taeniactinidae by having "one large spine on each adambulacral." Clarke interpreted a depression near the oral frame of one specimen as the madreporite; on the cast made from this specimen, this structure is a large mound across one of the arms. From the indistinct outline of this depression, I am led to believe that it was produced during compaction of the sediment by some hard object deposited in a layer a little above or below the stelleroid, not adjacent to it.

Charles Schuchert (1914) presented his new species *Lepidasterella babcocki* in the Fossilium Catalogus. Neither description nor illustration accompanied the name, which constituted, therefore, a *nomen nudum*. The following year (1915) Schuchert formally described and figured the species, based on the previously undescribed holotype (said to be in the possession of Mrs. G. W. Babcock) and the two specimens from Hunt's Quarry at Interlaken (which Clarke in 1906 had assigned to his "*Helianthaster* sp. nov." and in 1908 to *H. gyalum*). (See Table I.) Schuchert assigned his *Lepidasterella babcocki* to the Phanerozonia and the family Lepidasteridae (Table II) because he believed that it possessed marginal plates in addition to ambulacrals and adambulacrals. His interpretation of structures is explained in Table III.

In the same publication (1915), Schuchert classified the other three specimens on which Clarke (1908) based his *Helianthaster gyalum* (Table I) as *Palaeosolaster* (?) *gyalum* and placed them in the Cryptozonia and the family Palaeosolasteridae (Table II) because in his opinion they lacked true marginal plates but possessed the aboral arm structure of the Asteroidea.

It is revealing of Schuchert's concepts that for illustration he selected the actual fossil for "*Lepidasterella babcocki* " (1915, Pl. 25, Fig. 2) and

TABLE II

PREVIOUS CLASSIFICATIONS OF *HELIANTHASTER GYALINUS* CLARKE

Author, Year	Name Assigned	Taxonomic Placement
Clarke, 1906	*Helianthaster* sp. nov.	
Clarke, 1908	*Helianthaster gyalum*	Ophiuran
Schuchert, 1915	*lepidasterella babcocki*	Asteroidea, Phanerozonia, Family Lepidasteridae
Schuchert, 1915	*Palaeosolaster* (?) *gyalum*	Asteroidea, Cryptozonia, Family Palaeosolasteridae
Ruedemann, 1916	*Lepidasterella babcocki*, *Lepidasterella gyalum*	Phanerozonian
Spencer, 1927	*Lepidasterella babcocki*	Family Taeniactinidae (in 1951 placed in Asteroidea, order Hemizonida, suborder Gnathasterina)

TABLE III

COMPARISON OF TERMS USED BY SCHUCHERT (1915) TO DESCRIBE HIS "*LEPIDASTERELLA BABCOCKI*" WITH THOSE USED HEREIN FOR *HELIANTHASTER GYALINUS* CLARKE

Schuchert	Herein
Rays	Arms
Abactinal side	External mold of oral (actinal) side
"Narrow but high column of radial plates"	Filling (mold) of ambulacral groove
Supramarginals	External molds of ambulacrals
Inframarginalia	Edges of external molds of adambulacrals
No ambital areas	Ambital areas
Madreporite unknown	Madreporite oral
Disk "covered by small many-sided plates that originally appear to have been closely adjoining"	Disk plates known only from oral side of ambital areas
Actinal area unknown	Most of specimen consisting of external mold of oral (actinal) side

a cast prepared from a fossil for *"Palaeosolaster (?) gyalum"* (1915, Pl. 34). Both specimens which he illustrated consist of external molds of the oral surface, and agree in the number and basic structure of arms. By regarding the external mold of *"Lepidasterella babcocki"* as the aboral side of preserved arms, and the cast of *"Palaeosolaster (?) gyalum"* as the oral side of preserved arms, Schuchert became convinced that these stelleroids were not only two distinct species but belonged to different groups of the Asteroidea! It was presumably an oversight which led to the name *"babcocki"* as a patronym for the species based on the holotype discovered by *Mrs.* G. W. Babcock (Schuchert, 1915, p. 161).

Rudolph Ruedemann (1916, pp. 38–42) placed Clarke's *Helianthaster gyalum* in the genus *Lepidasterella,* and presented observations upon *L. babcocki* and *L. gyalum.* He stated (p. 38), "... the holotype [of *L. babcocki*] is a natural mold of the abactinal [aboral] side in sandstone," without further comment. As explained above, the holotype does not show either the aboral side or the mold of the aboral side; instead, it is a mold of the oral side. In describing one of the two specimens of *L. babcocki* from Hunt's Quarry mentioned by Schuchert (my Table I), Ruedemann continued, "... this specimen retains the abactinal surface itself. As the figure clearly shows, the plates of the radial and of the supramarginal columns stand out clearly as tumid projections." The figure (his Pl. 10, Fig. 6) shows only some obscure rows of projections along the arms, which certainly do not "stand out clearly." Ruedemann himself admitted (p. 38) that "their sutures can not be made out because the surface is covered by a granular test." Nevertheless, he sketched (his text-fig. 14) a purported "portion of the abactinal side of a ray" in which sutures are sharply incised.

Ruedemann also commented upon structures of *L. gyalum* (Clarke). The anomalous depression which Clarke had interpreted as a madreporite was accepted as such by Ruedemann (p. 40), who pointed out that it must have been aboral to have lain across oral ossicles. For this species, he illustrated (text-fig. 15) a "portion of abactinal side of ray, drawn from gutta-percha squeeze" which in essential respects duplicated his figure for *L. babcocki* (text-fig. 14). As a possible explanation for his illustration, it should be explained that Ruedemann did not see the original specimens; he based his observations on a (p. 39) "counterpart of a beautiful slab with three specimens" which he studied by "numerous plasticene impressions." From the data he gives on the original slab, it is certainly the one from Earl's Quarry found by S. G. Williams (Table I). The gutta-percha squeeze of the supposed "abactinal side of ray" was actually a gutta-percha mold made from a cast, which had been made from the original external mold of the oral surface and forwarded to Ruedemann—a mold from a cast from a mold—duplicating in generalized manner the original surface of the slab. It should also be borne in mind that gutta-percha produced poor counterparts, yielding only gentle domes and ridges from deep pits and sharp grooves. The "radial column" in Ruedemann's figure was the filling of parts of the ambulacral groove, his "supramarginal columns" were impressions of the ambulacrals, and his "adambulacrals" were partly inner and partly outer surfaces of adambulacrals. Ruedemann (text-figs. 17–18) presented stylized drawings of the oral frame with attached syngnaths. Comparison with the specimen described here strongly suggests that the whole of the mouth frame in the Earl's Quarry specimens, which Clarke (1908) and Ruedemann (1916) studied, was considerably distorted so that the inward extensions figured so prominently in Ruedemann's drawings were actually the inward-facing edges of the orals ("oral armature" of Ruedemann, "mouth-angle plates" of Spencer) and the orals themselves were considerably broader than indicated.

The chief contributions by Ruedemann were his discovery of alate interbrachial ambital structure and his comparison of *Lepidasterella* and *Helianthaster*. Although he assigned the starfish to the former genus, Ruedemann seems to have had some doubts about the distinction of the two genera. He stated (p. 40), for example, "The structure . . . of the rays is identical with that of *Lepidasterella*, which is a *Helianthaster* with twenty-four instead of thirteen arms." And (p. 42), "The fact remains that the arrangement of arm plates is exactly alike in *Helianthaster rhenanus* and *Lepidasterella gyalum*." Apparently, Ruedemann distinguished the two only on the number of arms.

W. K. Spencer (1927) recognized *Lepidasterella* as a valid genus, basing most of his information on previous reports by Schuchert and Ruedemann, although he mentioned having a plaster cast of the specimens described by Ruedemann as "*Lepidasterella gyalum*." He put the genus in his new family Taeniactinidae and new subfamily Taeniactininae. The family was characterized (1927, p. 367) by ambulacrals of the "flooring-plate" type, opposite or slightly alternate, with an open ambulacral channel; no inframarginals; adambulacrals thin and shielding sides of arms; madreporite oral; interbrachial areas "frequently occupied by downgrowths separating the base of the arms." The family was divided into three subfamilies by the number of adambulacral spines: the Protactininae with no prominent spines, the Taeniactininae with one large spine on each adambulacral, and the Calyptactininae with many spines in a row on each plate.

In 1951, Spencer assigned the family Taeniactinidae to the subclass Asteroidea, order Hemizonida Spencer 1951, and suborder Gnathasterina Spencer 1951. He typically selected names for suprageneric taxa without consideration of priority. Thus, he put *Helianthaster* in his family Taeniactinidae despite the facts that this genus had been made the type of the subfamily Helianthasterinae by Gregory in 1900 (p. 258) and that the family Helianthasteridae had been used by Stürtz in 1900 (p. 204).

Briefly, Clarke (1908) correctly analysed the plate relationships of the arms and understood the orientation and nature of the fossil material; Schuchert (1915), Ruedemann (1916), and Spencer (1927) confused oral and aboral sides and regarded the mold as the starfish itself.

SYSTEMATIC DESCRIPTION

Subphylum Eleutherozoa

Subclass Auluroidea Schöndorf 1910

In his treatment of Palaeozoic Stelleroidea, Schuchert (1915) recognized the Auluroidea, which Schöndorf had created five years previously, as a distinct subclass. In his long-continued (1914–1940) works on "The Palaeozoic Asterozoa," Spencer omitted this taxon from consideration; nor did he include it in his final system of classification (1951). The auluroids listed by Schuchert were distributed by Spencer in the subclass Ophiuroidea, being placed in the order Stenurida and part of the order Ophiurida. Recently, many workers have followed the system of Spencer. Shrock and Twenhofel (1953) and Blackwelder (1963), however, use Auluroidea in their classification of starfish.

It is my conviction that the Auluroidea is distinct from both the Asteroidea and the Ophiuroidea. Salient characteristics of the three subclasses are shown in Table IV. Auluroids resemble asteroids in having unfused ambulacrals, open ambulacral grooves, and ampullae, but differ in lacking inframarginals, regular columns of aboral plates, and extensions of the digestive caeca into the arms. Auluroids resemble ophiuroids in having irregular ossicles or scales on the aboral sides of arms and the oral position of the madreporite, but differ in having ampullae, open ambulacral grooves and distinct columns of ambulacrals. The central disk of an asteroid has regular columns of plates leading into the broad arms, with indistinct boundary; the disk of an ophiuroid is a rigid, circular structure, sharply set off from the narrow, snakelike arms; but the disk of an auluroid is intermediate, a flexible structure lacking distinct boundary with the arms, in some forms consisting of an inflated sac. Not only did the auluroids differ from the asteroids and ophiuroids in structures, but they also seem

TABLE IV

CHARACTERISTICS OF THE SUBCLASSES ASTEROIDEA, AULUROIDEA, AND OPHIUROIDEA

Character	ASTEROIDEA	AULUROIDEA	OPHIUROIDEA
Use of arms in feeding	Powerful arms and strong suctorial podia to grasp and open bivalves	Podia to sweep small particles along ambulacral groove	Arms for locomotion only, feeding directly by mouth parts
Flexibility of arms	Little	Moderate	Extreme
Central disk	Merging into thick arms, incorporating some radials and supramarginals	Flexible, no major or shield plates, typically extending into concave ambital areas between arms	Rather rigid, bearing shield plates in some, circular, set off sharply from narrow arms
Radial canal of water-vascular system	Below ambulacrals	Enclosed between opposing ambulacrals	Below vertebrae
Aboral arm plates	Regular columns of large plates, typically radials and supramarginals	Scalelike covering or small irregular ossicles embedded in integument	
Inframarginals	Present	None	
Digestive and reproductive organs	Extending into arm cavities	Never extending into arm cavities	
Madreporite	Aboral	Oral	
Ambulacrals	Distinct, columns on each side of arm		Fused into vertebrae
Ambulacral groove	Open		Covered
Ampullae	Present		None

to have occupied a different ecological position. Whereas the asteroids were adapted for grasping and pulling and the ophiuroids for direct feeding by the mouth, apparently the auluroids were "sweepers," passing small particles along the ambulacral grooves with their podia.

Order STREPTOPHIURAE Bell 1892

Diagnosis.—Auluroids with opposite ambulacra.

Remarks.—The starfish that I regard as Streptophiurae were distributed by Schuchert in the Streptophiurae of the Auluroidea and the family

Lepidasteridae (Phanerozonia) of the Asteroidea, and by Spencer in the superfamilies Eophiuricae (order Stenurida), Zeugophiuricae (suborder Oegophiurina, order Ophiurida), and Ophiuricae (suborder Myophiurina, order Ophiurida) of the Ophiuroidea and in the suborder Gnathasterina (order Hemizonida) of the Asteroidea.

Family Helianthasteridae Gregory 1899

Helianthasterinae Gregory, 1900, p. 258.
Helianthasteridae Stürtz, 1900, p. 204.
Lepidasteridae Gregory, Schuchert (*partim*), 1915, p. 157.
Taeniactinidae Spencer (*partim*), 1927, p. 367.

Diagnosis.—Streptophiurans with long, tapering arms, thin adambulacrals enveloping sides of the arms, concave ambital areas bearing interbrachial ossicles or plates, and prominent mouth frame.

Remarks.—The presence of more than five arms is considered to be a generic character, not familial.

Genus *Helianthaster* Roemer 1863

Helianthaster Roemer, 1863, p. 147.
Lepidasterella Schuchert, 1914, p. 23 (*nomen nudum*); 1915, p. 160.
Palaeosolaster Schuchert (*partim*), 1915, p. 210.

Type species.—By monotypy, *H. rhenanus* Roemer, 1863, pp. 147–48, Pl. 28.

Diagnosis.—Helianthasterids with more than five arms, spines on the adambulacrals, central disk composed of small ossicles, aboral surface of arm covered by integument containing granular ossifications, mouth frame wide and composed of rather large orals (mouth-angle plates), and very few ambulacrals involved in the oral gape.

Remarks.—The major differences between *H. rhenanus* Roemer and *Lepidasterella babcocki* Schuchert (= *H. gyalinus* Clarke), the type species, respectively, of *Helianthaster* and *Lepidasterella*, are the number of arms, the size of ossifications in the ambital areas, the number of spines on each adambulacral, and the relative width of the orals. According to Spencer, *H. rhenanus* has 14 to 16 arms, ossifications in the ambital areas consisting of "scale-like plates" (1927, p. 388) bordered by larger "marginalia" (1930, p. 392), only one large spine on each adambulacral (1927, p. 367; 1930, p. 391), and broad orals "distinct from the long narrow deeply grooved mouth-angle plates shown by *Lepidasterella*" (1930, p. 392.) In contrast, "*L. babcocki*" has 24 arms, prominent plates throughout the ambital areas, several large spines on each adambulacral, and rather narrow orals, although not, apparently, as narrow as indicated by Ruedemann (1916) in his text-figures 17–18, from which Spencer drew his comparison. Until more species are known, these differences may be regarded as specific rather than generic.

Helianthaster gyalinus Clarke

(Fig. 1; Plates I–IV)

Helianthaster sp nov. Clarke, 1906, pp. 36–37, pl. opp. p. 36.
Helianthaster gyalum Clarke, 1908, pp. 61–64, Pls. 12–13.
Lepidasterella babcocki Schuchert, 1914, p. 23 (*nomen nudum*); 1915, pp. 160–61, Pl. 25, Fig. 2. Ruedemann, 1916, pp. 38–39, text-fig. 14. Spencer, 1927, pp. 383–84.
Palaeosolaster (?) *gyalum* Schuchert, 1915, p. 210, Pl. 34.
Lepidasterella gyalum Ruedemann, 1916, pp. 39–42, Pl. 10, Fig. 5, text-figs. 15–18. Spencer, 1927, pp. 383–84.

Arms.—Twenty-four equal arms radiating from the oval mouth area. Each arm approximately 30 mm long (as shown by casts attaining nearly the distal tips of certain arms) and 3 mm wide at the proximal end (Pl. I, Fig. 2), tapering beyond ambital areas. Greatest diameter (from tip to tip of arms) calculated to be 75 mm, least diameter (through ambital areas) to be 37 mm.

Ambulacrals and adambulacrals the only major plates composing the arms. Ambulacrals in the two sides of each arm arranged opposite (Pl. III, Figs. 1–2), about 34 in each column (plates average 1 mm long in the proximal 10 mm of each arm). As seen orally (Pl. I, Fig. 2), each ambulacral broad, its width about four-fifths its length. Each bearing a T-shaped ridge; crossbars of ridges on opposing plates outlining the ambulacral groove along middle of the arm, and normal ridges directed laterally (Pl. III, Fig. 2). Ampullar cups or depressions apparently shared by adjacent ambulacrals. As seen aborally (Pl. IV, Fig. 1), ambulacrals forming two parallel series of narrow rounded ridges, slightly constricted at their junctions.

Adambulacrals relatively thin, curved around sides of arms, offset from corresponding ambulacrals (Fig. 1). As seen orally (Pl. III, Figs. 1–2), each plate with prominent lobular oral edge; in its proximal one-third, a narrow ridge directed inward to become confluent with the normal ridge of the ambulacral. Several proximal adambulacrals apparently without spines; those along ambital areas with one spine each, from the distal end of the oral edge, the size of the spines increasing distally (Pl. III, Figs. 1–2); and beyond ambital areas, each adambulacral bearing at least four, perhaps five, stout close-set spines along its distal edge (Fig. 1; Pl. III, Fig. 1; Pl. IV, Fig. 2). As seen aborally (Fig. 1; Pl. IV, Fig. 1), adambulacrals extending far up on sides of arms, restricting ambulacrals to narrow zones along middle of the arm.

Of the casts made of distal parts of arms, some exhibiting aboral areas with granular texture much coarser than that of other surfaces, apparently due to ossifications in the integument covering aboral sides of the arms.

Mouth frame.—Prominent, composed of oral plates and only a few plates of the arms. Oral plates relatively narrow and elongate, each abutting against a modified ambulacral. The two modified ambulacrals of each arm forming a V where spread apart by distortion, in other parts of the ophiuroid forming a very narrow angle or in contract. No syngnaths observed.

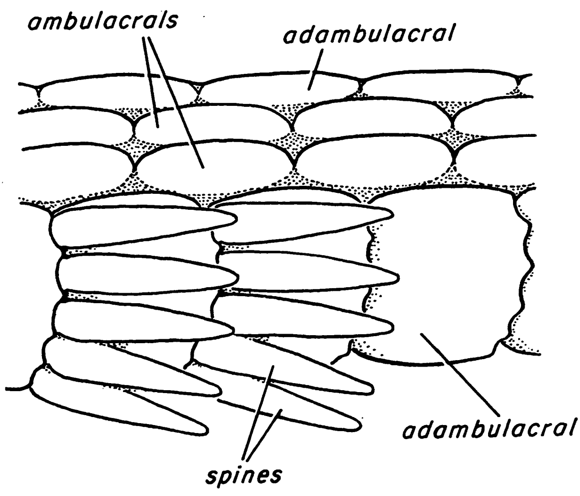

FIG. 1. *Helianthaster gyalinus* Clarke. Inclined aboral view of distal part of an arm. Spines shown only on the two proximal adambulacrals. Compare with photograph shown as Plate IV, Fig. 1.

Ambital areas.—Narrow ambital areas between arms, with concave outer borders, bearing rounded distinct interbrachial plates. In all but one ambital area, plates alternating and biserial (Pl. III, Figs. 1–2); in the ambital area containing the madreporite, a third row of plates intercalated, making the area noticeably wider than the others (Pl. I, Fig. 2; Pl. II, Fig. 2). Madreporite a disklike plate, flatter and larger than surrounding interbrachial plates (Pl. II, Fig. 2). Distal plates of ambital areas not differentiated as marginals.

Remarks.—The weblike ambital areas extend outward for about half the diameter of the auluroid. The animal was not nearly as much of a wriggling form as earlier interpretations implied. Although the central disk is not preserved on any of the fossils yet discovered, it probably was a saclike structure which sloped into the aboral surface of the ambital areas.

The observations and descriptions given above show the following published remarks to be in error:

(1) The arms are "very long compared to the size of the disk which is much suppressed" (Clarke, 1908, p. 63).

(2) "The rays have slender radial columns, the ossicles of which are disposed alternatingly with the larger and more prominent supramarginals" (Schuchert, 1915, p. 160); the aboral sides of arms "exhibit now a composition of three columns of plates" (Ruedemann, 1916, p. 40); the aboral covering of the arm is "reduced to a triple row of ossicles" (Spencer, 1927, p. 372).

(3) "Margining the rays may be seen a little of the inframarginalia" (Schuchert, 1915, p. 161).

(4) "The Earl's Quarry slab carries three individuals ... all casts" (Clarke, 1908, p. 62); "two of the specimens show their abactinal side, and only the third the actinal side" (Ruedemann, 1916, p. 39).

(5) The arms of "*Lepidasterella babcocki*" are "only known abactinally, from a natural mold in fine sandstone" (Schuchert, 1915, p. 160); "*Lepidasterella*" is known "only from its abactinal side" (Ruedemann, 1916, p. 40).

(6) "There appear to be no ambital areas" (Schuchert, 1915, p. 160).

(7) The margin of ambital areas is "strengthened by marginal ambital plates" (Ruedemann, 1916, p. 39; quoted by Spencer, 1927, p. 384).

(8) Each adambulacral bears "one large prominent adambulacral spine" (Spencer, 1927, p. 367).

(9) The madreporite "overlaps two adjoining interbrachial angles and the mouth parts pertaining thereto" (Clarke, 1908, p. 63); the madreporite "lies completely covering one proximal ambulacral furrow and across parts of two adjacent rays" (Schuchert, 1915, p. 211).

(10) The madreporite lay "on the abactinal side of the creature" (Ruedemann, 1916, p. 40); the madreporite is "marginal and apical" (Spencer, 1927, p. 384).

These and minor differences of interpretation combined to give a very misleading portrayal of the starfish. As described herein, this species cannot be an asteroid nor an ophiuroid. *Helianthaster gyalinus* Clarke is a twenty-four-armed auluroid.

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Submitted for Publication June 30, 1964

PLATES

EXPLANATION OF PLATE I

(Both figures × 1½)

Helianthaster gyalinus Clarke 126

FIG. 1. Specimen, UMMP 30527, preserved as an external mold of the oral surface. Ambital area containing the madreporite lies to the right of the vertical arm in the upper half of the figure.

FIG. 2. Latex cast prepared from the specimen, reproducing the oral side of the auluroid. Interbrachial plates can be seen in many ambital areas. The madreporite lies to the left of the uppermost ambital area. At the right, one of the arms is turned so that the aboral side is also cast.

PLATE I

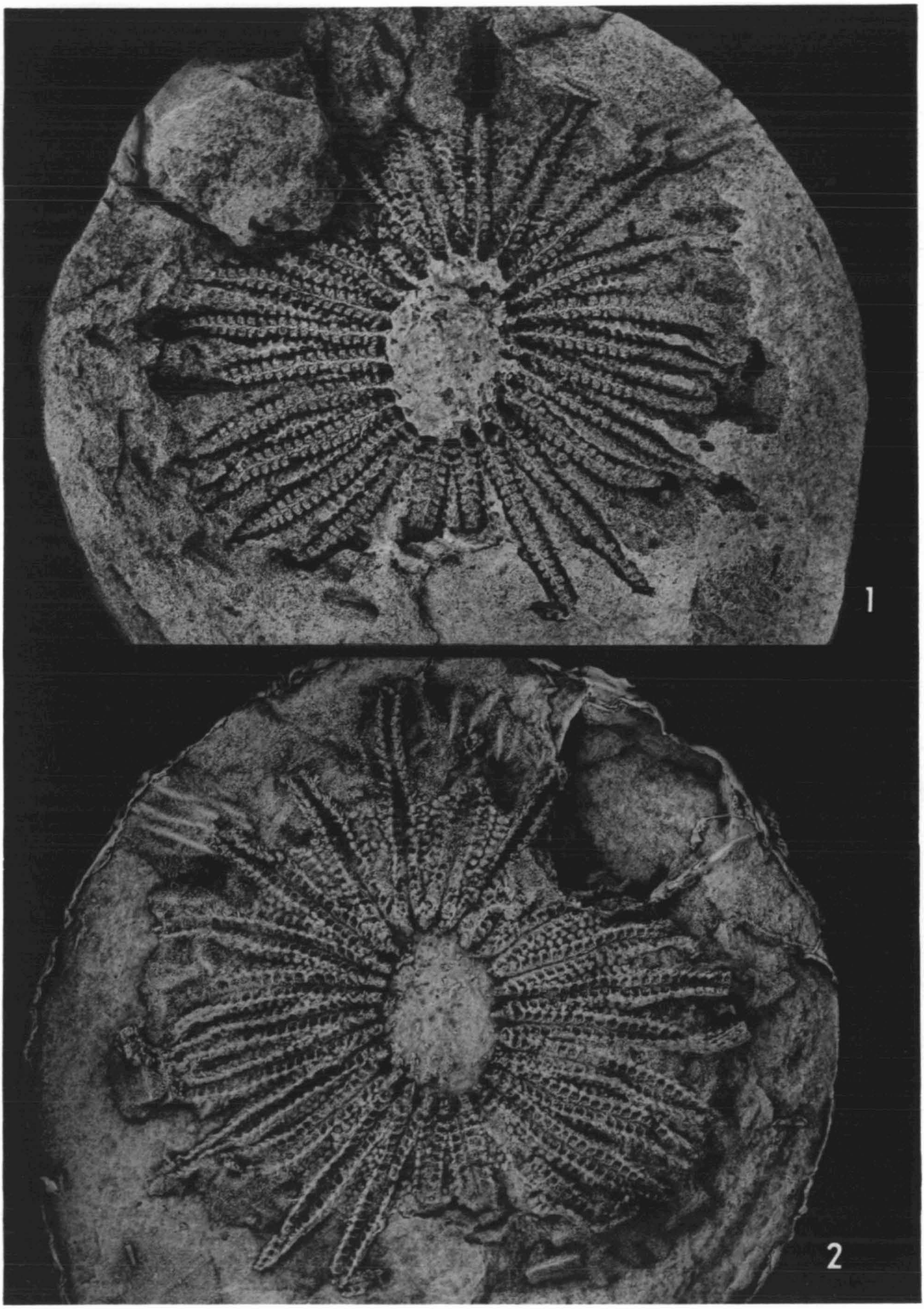
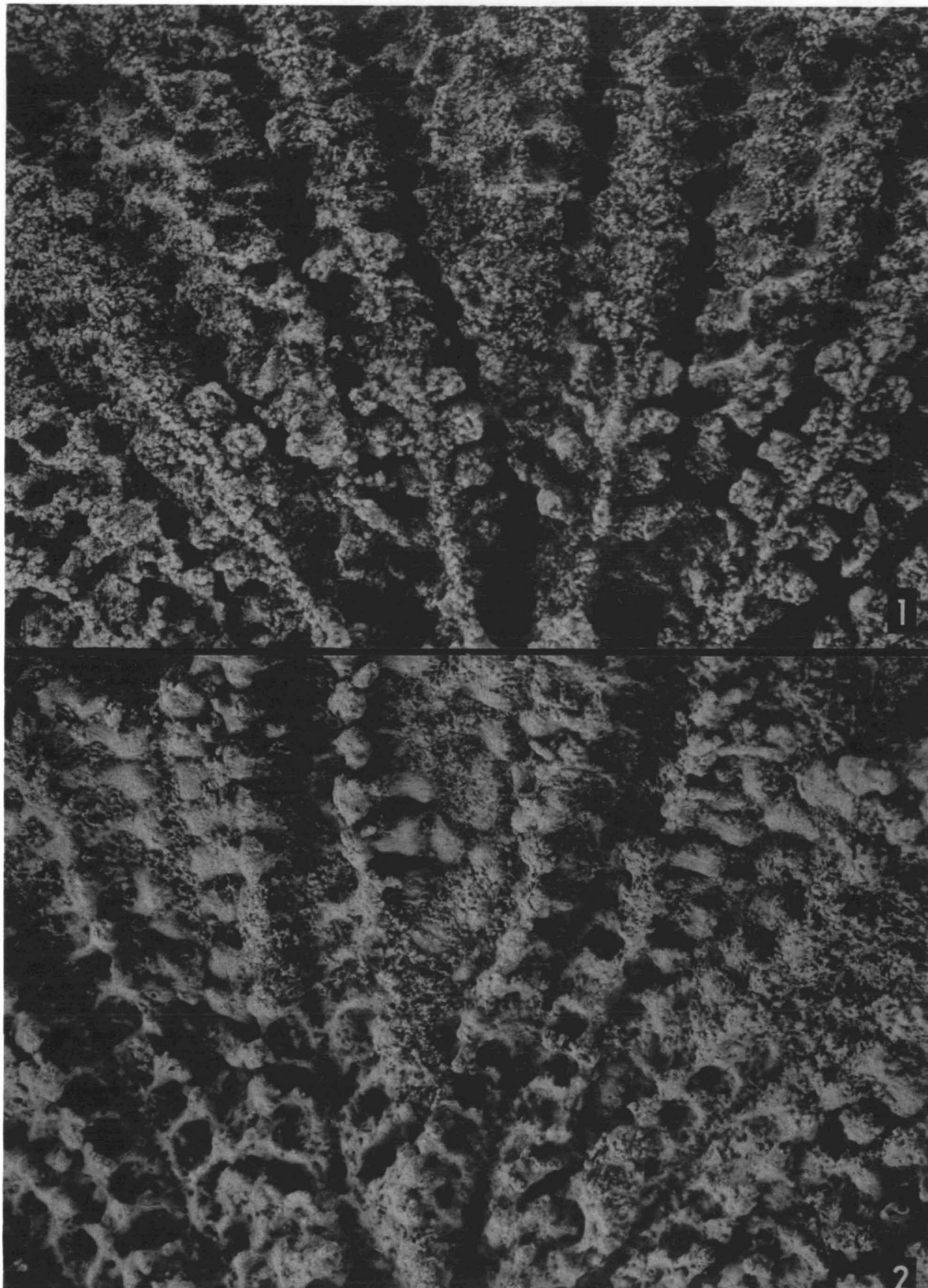


PLATE II



EXPLANATION OF PLATE II

(Both figures × 7½)

Helianthaster gyalinus Clarke 126

FIG. 1. Enlargement of part of the specimen, a mold of the oral surface, UMMP 30527. The madreporite lies in the upper central part of the figure.

FIG. 2. Enlargement of latex cast made of the same area shown in Figure 1 above. The madreporite lies in the upper central part of the figure.

EXPLANATION OF PLATE III

(Both figures × 7½)

Helianthaster gyalinus Clarke 126

FIGS. 1–2. Enlargements of parts of latex cast of oral surface, UMMP 30527. Area shown in Figure 1 lies on the left side in Figure 2 of Plate I; area shown in Figure 2 lies on the right side in Figure 2 of Plate I. Both figures show ambulacral and adambulacral plates of the arms and interbrachial plates of the ambital areas. The upper right corner of Figure 1 also shows prominent spines along distal edges of the adambulacrals that lie beyond the ambital areas.

PLATE III

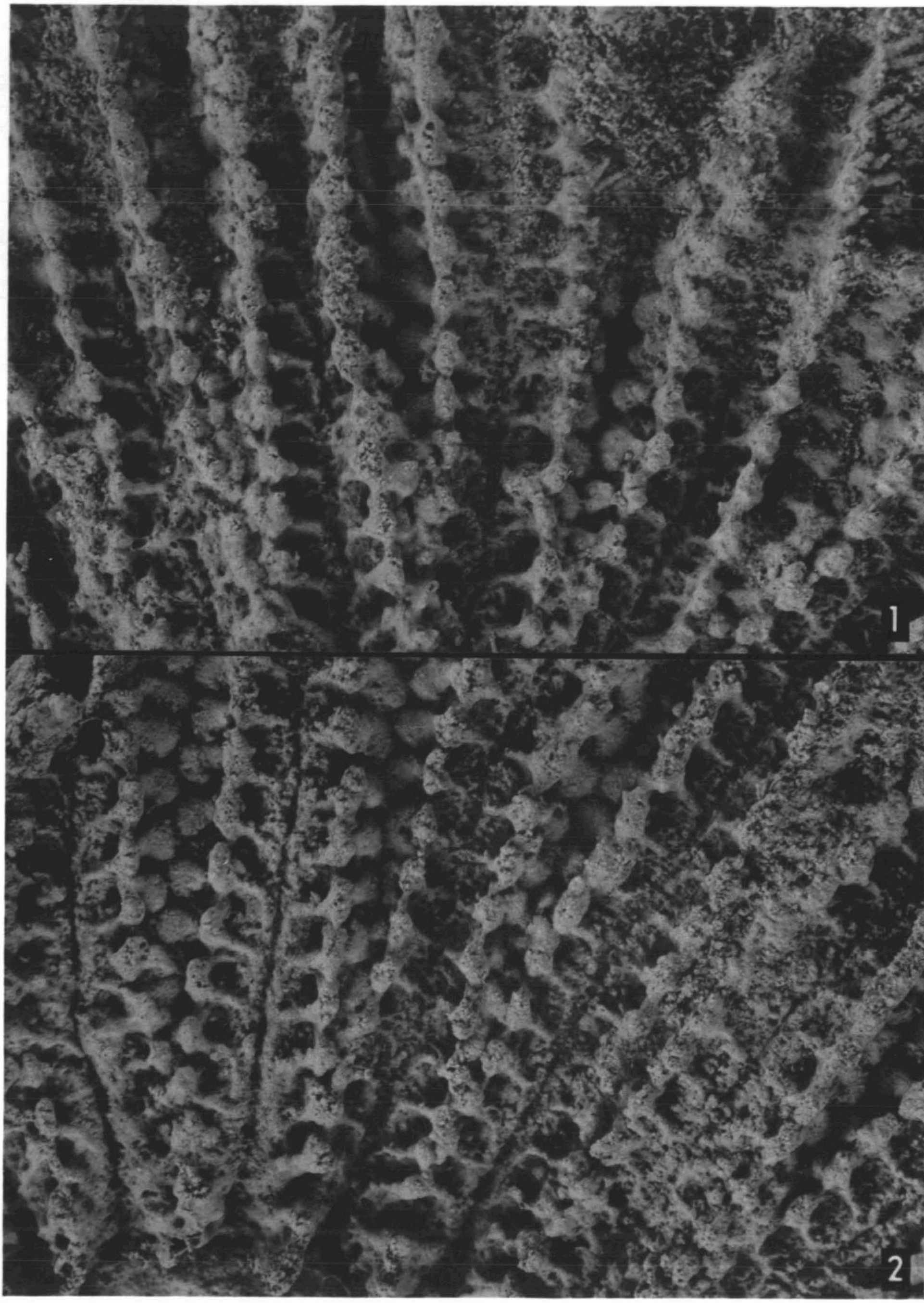
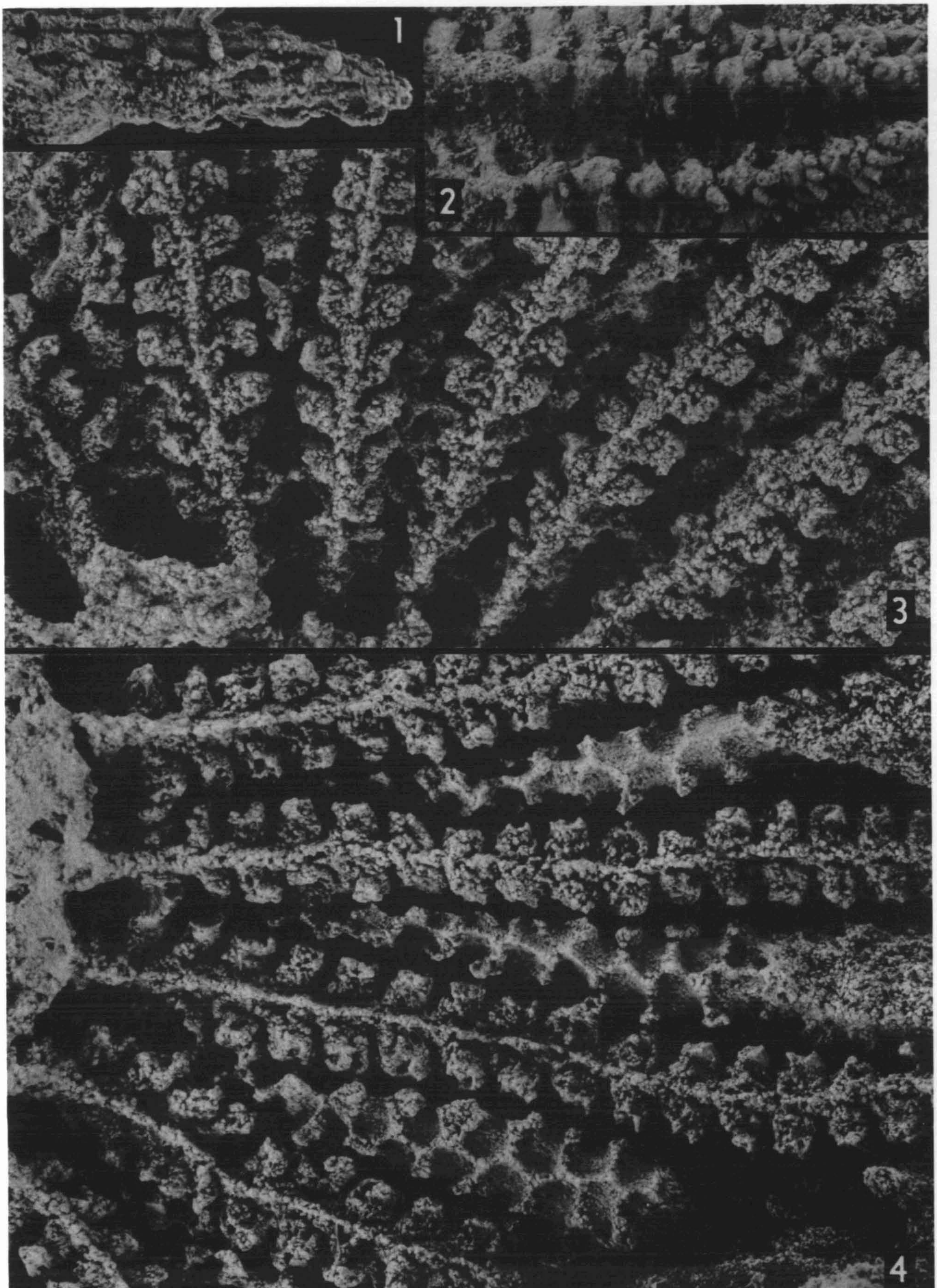


PLATE IV



EXPLANATION OF PLATE IV

(All figures × 7½)

Helianthaster gyalinus Clarke 126

FIG. 1. Inclined aboral view of latex cast of distal part of an arm, UMMP 30527. Ambulacral plates appear as paired longitudinal ridges. Only a few remnants of spines on the adambulacrals.

FIG. 2. Part of latex cast of oral side of arm, showing only one spine on each adambulacral within the ambital area and several on each adambulacral beyond the area. This arm lies at the upper left in Figure 2 of Plate I, just to the left of the ambital area containing the madreporite.

FIGS. 3–4. Enlargements of parts of the specimen, an external mold of the oral surface. Area shown in Figure 3 lies in the upper right sector in Figure 1 of Plate I; area shown in Figure 4 lies on the left side in Figure 1 of Plate I. Thin radial ridges are fillings of ambulacral grooves; they are bordered by quadrate elevations, which are molds of ambulacrals. Deep, scalloped grooves are molds of adambulacrals. Between the arms, alternating subcircular depressions are molds of interbrachial plates in the ambital areas.