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ANTIQUASTER MAGRUMI, A NEW UNUSUAL BRITTLE-STAR FROM THE MIDDLE DEVONIAN SILICA FORMATION OF NORTHWESTERN OHIO

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VOLUME 23

1. The rodents from the Hagerman local fauna, Upper Pliocene of Idaho, by Richard J. Zakrzewski. Pages 1–36, with 13 text-figures.
2. A new brittle-star from the Middle Devonian Arkona Shale of Ontario, by Robert V. Kesling. Pages 37–51, with 6 plates and 2 text-figures.
3. Phyllocarid crustaceans from the Middle Devonian Silica Shale of northwestern Ohio and southeastern Michigan, by Erwin C. Stumm and Ruth B. Chilman. Pages 53–71, with 7 plates and 4 text-figures.
4. *Drepanaster wrighti,* a new species of brittle-star from the Middle Devonian Arkona Shale of Ontario, by Robert V. Kesling. Pages 73–79, with 2 plates.
5. Corals of the Traverse Group of Michigan. Part 13, *Hexagonaria,* by Erwin C. Stumm. Pages 81–91, with 4 plates.
6. The Pliocene rodent *Microtoscoptes disjunctus* (Wilson) from Idaho and Wyoming, by Claude W. Hibbard. Pages 95–98, with 2 text-figures.
7. A new microtine rodent from the Upper Pliocene of Kansas, by Claude W. Hibbard. Pages 99–103, with 1 plate and 1 text-figure.
8. Evolution of the fern family Osmundaceae based on anatomical studies, by Charles N. Miller, Jr. Pages 105–169, with 2 plates and 10 text-figures.
9. The insectivores of the Hagerman local fauna, Upper Pliocene of Idaho, by Claude W. Hibbard and Philip R. Bjork. Pages 171–180, with 4 text-figures.

ANTIQUASTER MAGRUMI, A NEW UNUSUAL BRITTLE-STAR FROM THE MIDDLE DEVONIAN SILICA FORMATION OF NORTHWESTERN OHIO

ROBERT V. KESLING

ABSTRACT—A brittle-star from the Silica Formation is classified as a new genus and species of the order Stenurida. Transverse arm elements, interpreted as ambulacrals, sublaterals, and laterals, show elongation reminiscent of the somasteroids. On the other hand, the juxtaposition of ambulacrals and the form of the mouth frame are very similar to those in the order Oegophiurida. The unique combination of primitive and advanced characters provides the basis for a new family, the Antiquasteridae.

INTRODUCTION

A REMARKABLE RETENTION of ancestral arm structure was combined with advanced ambulacral arrangement in a new Middle Devonian species of the order Stenurida. Were it not for details of ambulacral development, this brittle-star might easily be mistaken for a somasteroid with a reduced number of virgals. In particular, the rodlike laterals give the arms a strong metapinnular aspect, the very small disk is hidden in oral view, the interradii have pronounced indentations, and the whole body is flattened.

Even taking its fragile construction into account, one must regard *Antiquaster magrumi* as a rare member of the prolific and diverse Silica fauna. The only two specimens known occur on one side of a little slab of shale. As I have said before (1968, 1969), the Silica Formation in this area has been scoured almost daily by a multitude of collectors for over forty years. These include professional paleontologists and knowledgeable amateurs. Hence, the discovery of the type specimens is a tribute to the ability of Mr. Jeff Aubrey, who joins the select group of collectors who have recently come up with new rare echinoderms from this much searched-over area. Mr. Larry Magrum, of Toledo, Ohio, purchased the brittle-stars and donated them, with other unusual specimens, to our Museum of Paleontology. I take pleasure in naming the species *magrumi*.

Several persons helped in preparation of this paper. I am very grateful to Mr. Karoly Kutasi for photography, Prof. Chester A. Arnold for review of manuscript, Mrs. Helen Mysyk for typing, and Mrs. Gladys Newton for proofreading. The types are catalogued in the Museum of Paleontology of The University of Michigan.

LOCALITY

Found loose in the North Quarry of the Medusa Portland Cement Company at Silica, near Sylvania, Lucas County, Ohio, the small piece of shale bearing the two brittle-stars appears to have come from Unit 11 of Ehlers, Stumm, & Kesling (1951, p. 19) in the Middle Devonian Silica Formation.

ABBREVIATIONS

To simplify the plate designations, the following standard abbreviations are used herein:

Amb(b)—ambulacral(s).

L(L)—lateral(s); correspond to adambulacrals in other starfish taxa.

MAP(P)—mouth-angle plate(s).

SubL(L)—sublateral(s).

In addition, the publication by W. K. Spencer & C. W. Wright (1966) in the *Treatise on Invertebrate Paleontology* is referred to as T.I.P.

SYSTEMATIC DESCRIPTION

Class STELLEROIDEA Lamarck 1816

The divisions of the class have been firmly established only in the last decade. The Asteroidea and Ophiuroidea have been known for a

long time, although the boundaries have been shifted from time to time to absorb the amorphous Auluroidea. In 1951 Spencer established the Somasteroidea for certain primitive starfish. At that time and for several years afterward, these forms were thought to have died out in the Ordovician. However, somasteroids were not extinct after all. In 1962 Fell discovered that the living *Platasterias latiradiata* Gray 1871 was actually a somasteroid rather than, as previously believed, an aberrant asteroid. With information available on the soft tissues, a clearer picture of the somasteroids emerged and was incorporated in the *Treatise on Invertebrate Paleontology* (1966).

The three subclasses of stelleroids are compared in table 1. Obviously, with the whole animal available for examination, the assignment to subclass should prove extremely easy. With fossil material seen only in oral view, as in the case of the specimens described here, assignment is a different matter.

In *Antiquaster magrumi,* the arms are neither broadly confluent with a large disk (as in typical asteroids) nor distinct from a well-developed small disk (as in typical ophiuroids). The interradii are incised at the arm bases and no part of the disk can be seen projecting into these areas. The proximal parts of the arms are subpetaloid, although somewhat narrower than those in *Platasterias*. The arms have no ventral (epineural) plates, which eliminates the advanced ophiuroids. The ambulacral groove is shallow, as it is in somasteroids and primitive ophiuroids. The Ambb plates are invariably opposite; such a condition is not typical of somasteroids nor of certain groups of ophiuroids. At the ends of the broken arms, the vertical extent of the Ambb can be seen; they are rather substantial thick plates, not at all like the arched plates of asteroids and with much stronger aboral development than the capitula of somasteroids. No trace can be seen of dorsal plates over the Ambb, and the overturned tip of one arm shows irregularly distributed small ossicles (pl. 4).

Adradial elements are limited, insofar as can be seen in oral view, to two kinds of plates. The terminal or bordering plates of the arm are somewhat elongate and tapering, much like the marginal radioles (terminal virgalia) in *Platasterias*. On the other hand, these ossicles bear spines, like the LL of ophiuroids; they do not, however, have the curved plate or shield form commonly associated with ophiuroid arms. The intervening series of plates have transverse rod-

TABLE 1—COMPARISON OF SUBCLASSES OF STELLEROIDEA.

Character	Somasteroidea	Asteroidea	Ophiuroidea
Ambulacral groove	Open, Ambb capable of forming shallow groove	Invariably open	In primitive forms open; in advanced forms enclosed by ventral plates
Ambb	Recumbent, adductors can raise Ambb to form groove; alternating, rarely opposite	Erect, forming permanent groove; invariably opposite	Erect, thick, forming some kind of vertebrae; alternating or opposite
Adaxial skeleton	Typically with transverse series of ossicles (metapinnules), some rodlike (virgals)	Typically reduced to adambulacrals and marginals, no virgals	Reduced to SubLL and LL or to LL (= Adambb) only; in advanced forms fused with Ambb
Disk	Aboral surface covered by integument studded (at most) with spicules	Generally with well-developed, regularly disposed plates	Primitive forms unplated, advanced forms with plates tending to fuse into large shields
Body	Arms joined at base, interradii deeply incised	Arms broadly confluent with disk	Arms generally distinct from disk
Madreporite	Oral or aboral, may be at edge of disk	Typically aboral	Typically oral
Caeca of stomach	Extending into arms	Extending into arms	Primitively into arms, later confined to disk
Tube-feet (podia)	Small internal ampullae in living forms; feet retractable into broad basins	Ampullae present; feet well developed in rows along ambulacral groove, may have suckers	No ampullae; feet projecting to exterior by 2 ranges of pores in each arm
Pedicellaria	Absent	Present in advanced forms	Always absent

like oral elements, which give them the appearance of somasteroid virgals; yet similar plates, known as SubLL, occur in such stenurid ophiuroids as *Rhopalocoma, Stuertzaster,* and *Eophiura.*

Two kinds of adradial plates of this shape and arrangement might occur in either the Somasteroidea or in the stenurid Ophiuroidea. The placement of *Antiquaster* in the ophiuroids can be made with some assurance by the development of the MAPP (pl. 3), which appear to be far advanced beyond the three-metapinnule stage exhibited by *Platasterias.* Hence, the new genus is here regarded as an ophiuroid retaining several archaic characters from its somasteroid ancestry.

Subclass OPHIUROIDEA Gray 1840

The following key to the orders of Ophiuroidea is based on Fell (1960, p. 3,4) and on Spencer & Wright (T.I.P., 1966, p. 78–103):

1. Open ambulacral groove traversing oral surface of arm 2
   Ambulacral groove closed over and internal, forming the epineural canal; Ambb invariably fused in pairs to form articulating vertebrae 3
2. Ambb persisting as discrete plates in adult stage, not fusing together; arm capable of only limited movements ..... STENURIDA
   Ambb fused in pairs to form vertebrae; arm capable of snake-like movements ..... OEGOPHIURIDA
3. Dorsal arm plates rudimentary or absent; LL ventral or subventral; disk covered with skin bearing granules or (at most) scales; zygophiuroid intervertebral arm joint, if present, with reduced ventral peg-and-socket; arms adapted for climbing .. PHRYNOPHIURIDA
   Dorsal arm plates well developed in all except the most primitive forms; disk plated, the plates in advanced forms fused to form large shields; zygophiuroid joint generally well developed, the ventral peg-and-socket permitting the arm to swing down rapidly; arms adapted for active movement along the sea floor ..... OPHIURIDA

In Paleozoic brittle-stars, preservation does not always provide a clear-cut set of characters. Ventral arm plates, which cover the ambulacral groove in Ophiurida, may not be preserved, in which case the oral surface of the arms would have the essential features of certain of the Oegophiurida; only from an examination of the articulations in disarticulated vertebrae could one arrive at the correct classification.

In *Antiquaster magrumi,* the ambulacral groove is open, even though it is very shallow. It has no ventral plates. The critical character hence becomes the condition of the Ambb. Are they fused or unfused? The Ambb are not in the compact form normally occurring in vertebrae. At the broken end of an arm, the Ambb can be seen (text-fig. 1) to be fairly flat, provided with lateral projections to articulate with the SubLL. The pairs do not, insofar as can be detected, display any kind of zygophiuroid articulation. *Antiquaster* is therefore assigned to the order Stenurida.

The mouth frame in *Antiquaster magrumi,* however, is strongly atypical of the stenurids. Behind each MAP, only one Amb plate appears to be modified as a radial component. The frame, in this respect, is more like that of the oegophiurids; the movements of the MAPP cannot be determined, so that their overlapping and overriding of Ambb are neither established nor disproved. The buccal slit is reduced to an insignificant notch.

Ubaghs (1953, p. 794,795), writing after the establishment of the somasteroids by Spencer in 1951, stated:

> Les pièces ambulacraires des Ophiuroïdes les plus archaïques ou Sténurides rappellent beaucoup celles de *Villebrunaster* et résultent, comme celles-ci, de la calcification des tissus entourant le vaisseau radial ambulacraire. Leurs transformations en vertèbres typiques—transformations précoces au point d'être réalisées des l'Ordovicien moyen dans certaines lignées (*Hallaster*)—impliquent des modifications profondes, mais dont il est possible de retracer les étapes.

Whereas it is possible to select genera which do indeed show progressive change from free Ambb into vertebrae, leading from somasteroids to ophiurids, all alterations did not follow an even chronological series. It seems to me that of all ophiuroids, *Antiquaster* shows the arm structure most like the ancestral somasteroids. In it, neither Ambb nor adaxial elements have reached the evolutionary development shown by the Ordovician *Stenaster* and *Eophiura.*

Order STENURIDA Spencer 1951
Suborder PAROPHIURINA Jaekel 1923

According to Spencer & Wright (T.I.P., p. 78–82) the differences between the two suborders of the Stenurida may be summarized as shown in table 2.

Without destroying parts of the type specimens, the radial channel cannot be precisely located. The ends of the broken arms, by neces-

sity viewed obliquely, seem to show a thin internal tube (text-fig. 1). Furthermore, where preservation is best, the pairs of Ambb show low ridges arranged on two longitudinal series, straddling the midline of the arm. These "inner ridges" of the Ambb suggest a submarginal thickening of the plates, like that known in *Stenaster obtusus* (Forbes) and illustrated many years ago by Spencer (1927, text-fig. 226). I see no marks of muscle attachment associated with these ridges or the grooves which border them; nevertheless, the attitude and configuration of the ambulacrum suggest that the Ambb may have been flattened during fossilization, that in life they may have been slightly arched, and that the arching may have been accomplished by contraction of interambulacral muscles along the oral margins of the Ambb.

As for the proximal Ambb, only one in each half-arm shows detectable modification, the remainder being notably alike.

Basins for retraction of tube-feet are rather conspicuous round depressions alongside the Ambb (pl. 2), abradially without confining walls and more or less confluent with the spaces between SubLL ridges.

In general, *Antiquaster* resembles *Stenaster* in the arrangement of Ambb and the reduction of the buccal slit; it resembles *Eophiura* in having SubLL plates. Even these common characters show differences, for the Ambb of *Antiquaster* are much lower and less "vertebralized" than those of *Stenaster*, and its SubLL are transversely more elongate than those of *Eophiura*.

Family ANTIQUASTERIDAE n. fam.

Type genus.—Antiquaster n. gen.

Diagnosis.—Ophiuroids with arms composed of well-developed rows of Ambb, SubLL, and LL plates. No ventral plates. Ambulacrum more of a surface than a groove. Ambb opposite, pairs forming low, weakly articulated series of vertebrae. LL far removed from Ambb, incapable of forming a deep narrow channel upon contraction of muscles. Cups for tube-feet distinct but without aboral confining wall. Buccal slit reduced to small notch. Interradii deeply incised between arms. MAPP strongly developed. Disk small, no interbrachial extensions.

TABLE 2—COMPARISON OF SUBORDERS OF STENURIDA.

Character	Proturina	Parophiurina
Adradial edges of Ambb	Not strengthened, radial channel open	Strengthened by ridges, radial channel completely enclosed
Ambb adjoining buccal slits	Strongly modified as elements of mouth frame	Undifferentiated, all Ambb nearly alike
Basins for tube-feet	Shallow	Fairly deep but distally open, not completely enclosed by Ambb

Remarks.—As shown in table 3, the new family has distinct differences from the three families previously assigned to the suborder. As stressed above, the wide SubLL are atypical of all ophiuroids.

ANTIQUASTER n. gen.

Type species.—Antiquaster magrumi n. sp.

Diagnosis.—Same as for family Antiquasteridae above.

Remarks.—The precise limits of genera, families, and suborders in the Stenurida cannot be determined at this time. The T.I.P. (p. 80–82) presented seven stenurid families—three with two genera each and four with only one genus each! To even a casual student, this would appear to be a taxonomic imbalance in which the brittle-stars were poorly constructed for preservation, collectors have been listless, and/or starfish workers are prone to authorship

EXPLANATION OF PLATE 1

Specimens lightly coated with ammonium chloride. Figures × 4 except as noted

FIGS. 1–4—*Antiquaster magrumi* n. gen. & n. sp. *1, 2,* holotype UMMP 57863a; *1,* very low-angle lighting to emphasize ambulacra; *2,* high-angle lighting to emphasize metapinnular aspect of arm ossicles. *3, 4,* paratype, UMMP 57863b; *4,* part of arm in oral aspect, × 20.

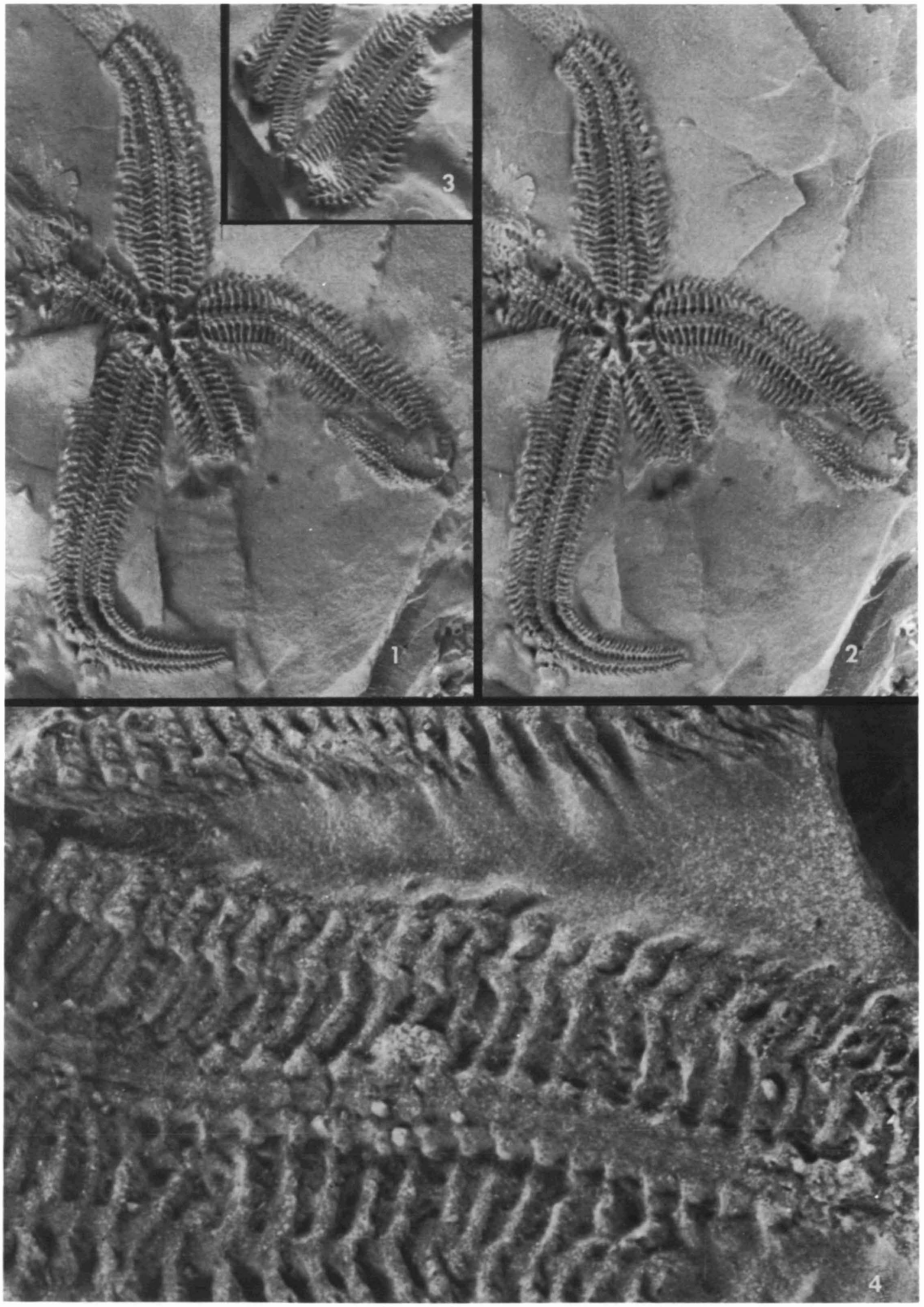


PLATE 1

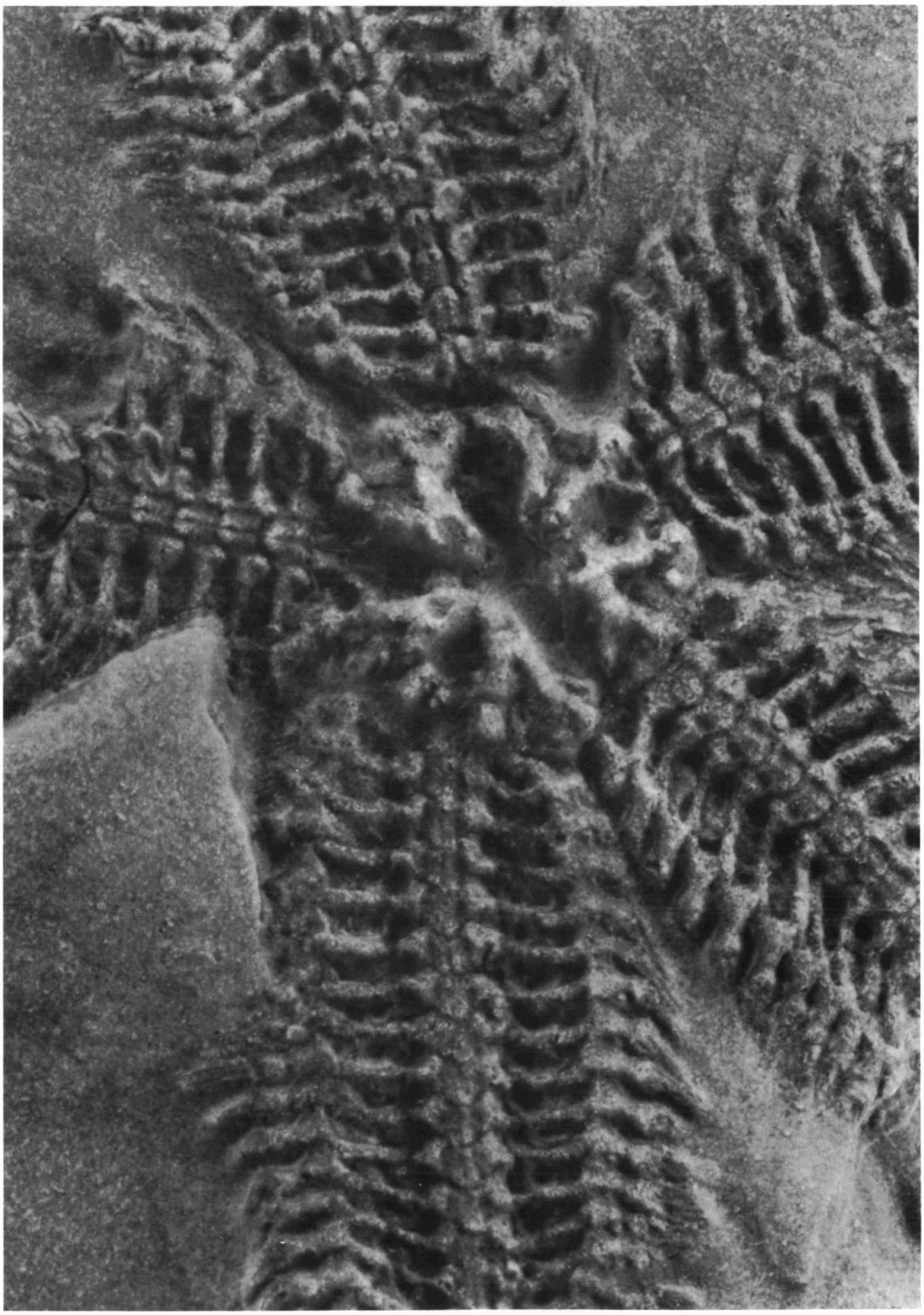
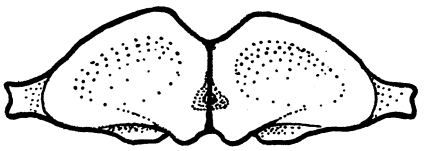


PLATE 2

TABLE 3—COMPARISON OF FAMILIES OF SUBORDER PAROPHIURINA.

Character	Eophiuridae	Palaeuridae	Stenasteridae	Antiquasteridae
Ambb	Alternating	Alternating	Opposite	Opposite
Ambb ridges	T-shaped	Boot-shaped	T-shaped	T-shaped
SubLL	Small	None	None	Large
LL	Large plates	Medium plates	Extremely large blocks	Narrow rods
Buccal slits	Very deep	Very deep	Shallow	Very shallow
Arms	Short	Long	Short	Long
Arm ends	Blunt	Tapering	Tapering	Tapering
Interbrachial areas (oral interrays)	Present	Present	Reduced	None



TEXT-FIG. 1—Sketch of distal surface of vertebra of *Antiquaster magrumi*. Approximately × 70.

of families. In this case, I feel certain that the explanation lies in the ease with which the creatures became disarticulated. The diversity attributed to stenurids at the family level is a justified attempt to interpret an inadequate fossil record. The number of genera known is so small and represented by so few specimens that any attempt at phylogeny or cladistic analysis would be inconclusive.

The name of the genus is derived from the Latin *antiquus* ("ancient, archaic") and *aster* ("star"), referring to the retention of features which were antiquated at the time when this brittle-star lived.

ANTIQUASTER MAGRUMI n. sp.

Types.—Holotype UMMP 57863a; paratype UMMP 57863b. Both types embedded on small slab of shale.

Preservation.—Fragile and readily disarticulated. Cores of ossicles and some spines irregularly pyritized. Holotype (pl. 1, figs. 1,2; pls. 2–4) displaying oral surface; its mouth area entire, two arms complete, and three arms broken off (one near the tip, leaving external mold of aboral surface of missing piece; see pl. 1, figs. 1,2); tip of one arm (pl. 4, figs. 1,2) turned to show its aboral surface. Paratype (pl. 1, figs. 3,4) preserving only proximal parts of three arms (two adjoined, one broken away), all with oral surface exposed; no MAPP.

General shape.—Interradii deeply incised between arm bases, giving proximal parts of arms a subpetaloid appearance. Arms long and gradually tapering, very flat. No part of disk visible in oral view, evidently too small to project into interrays even with compression. Madrepore plate unknown.

Arms.—Each arm composed orally of graduated series of Ambb, SubLL, and LL on each side, over 60 plates in each series. Plates near tip of arm very small. Ambb aligned with transversely elongate SubLL and LL at the side, giving the arm a strong metapinnular aspect in oral view. Rodlike LL emphasize the transverse gradients. No ambulacral groove shown by specimen; middle of Ambb forming a relatively flat surface.

Aboral surface seen directly at turned tip of one arm (pl. 4, figs. 1,2) and indicated by external molds where arms broken off (pl. 1, fig. 2); integument studded distally by small rather closely spaced ossicles, proximally by larger ossicles becoming aligned in longitudinal rows.

EXPLANATION OF PLATE 2

Specimen lightly coated with ammonium chloride. Figure × 20

Antiquaster magrumi n. gen. & n. sp. Oral surface, including mouth area and parts of arms.

Ambb.—Pairs firmly adjoined but not fused, forming primitive vertebrae (text-fig. 1). As viewed orally (p. 1, figs. 1,2), Ambb occupying narrow median strip through arm. On worn surface (pl. 2, upper right) each vertebra seen to be twice as wide as long, with a strongly convex junction with its distal neighbor. On well-preserved surface (pl. 2, top) each Amb seen to have two conspicuous elevations on its oral surface: an adradial marginal ridge and an abradial T-shaped ridge. Marginal ridge set close to that of opposite Amb, leaving little more than a fissure between; ridge extending the full exposed longitudinal extent of the Amb, with a distal prominence; no muscle scars observed. T-shaped ridge with cross-piece longitudinal and stem transverse, its end adjoining the SubLL ridge (pl. 4, fig. 1); proximally in arm, this ridge more tumid, approaching a triangle, with the stem somewhat offset in distal direction to give suggestion of boot-shape to the ridge (pl. 2, top and left). Prominent grooves alongside marginal ridges, separating them from T-shaped ridges, the grooves continuous from mouth area to tip of arm; grooves deeper at midlengths of Ambb than elsewhere (pl. 2; pl. 3, fig. 2).

As seen at end of broken arm (text-fig. 1), each vertebra about three times as wide as high. Articulating surface of vertebra with low relief, with a subtriangular depression on the midline just below the center, possibly including the radial water vessel. No suggestion of a vertical hinge; horizontal hinge (for vertical movement) consisting of shallow depression on distal end of each Amb (probably accommodating gentle even protuberance on proximal end of distally adjacent Amb). Aboral extent of vertebra forming an obtuse median V-shaped notch, undoubtedly for attachment of dorsal muscles to further widen the Ambb orally by their contraction, but no muscle scars observed.

Cups for tube-feet.—Cups shallow, subspherical, aligned alongside Ambb (pl. 1, figs. 1,2; pl. 2). Each cup bounded on three sides by T-shaped ridges of adjacent Ambb, abradially without confining wall and merging into space between ridges of SubLL. On one part of an arm (pl. 2, at left; pl. 3, fig. 2, at lower left), pyritized elongate cupule-shaped structures fill these spaces, by their shape and position suggesting remains of suckers on tube-feet.

SubLL.—Transversely elongate plates, each consisting of a thin flat aboral sheet and a sharply elevated transverse oral ridge; hence, each SubL T-shaped in cross section. Transverse ridge rodlike, emphasizing its resemblance to a virgalium of the somasteroids; its adradial end joined to the T-shaped ridge of the adjacent Amb, rather firmly in some sections of arms (pl. 2) and dislodged in only a few places; its abradial end joined off-center to adradial end of L plate. Aboral sheet of SubL apparently overlapping that of adjacent SubL; hence the series of SubLL in each half-arm imbricate, facilitating oral enrollment of arm.

LL.—Transversely elongate ossicles, each somewhat rodlike but slightly constricted in the middle, about the same width as the adjoining SubL. Adradial end of L expanded, sub-triangular, its distal corner articulated with SubL (pl. 1, fig. 4, bottom; pl. 2, top arm, left side); hence, LL apparently intercalated with ends of SubLL, each L swung slightly ahead of the adjoining SubL. Abradial end of L expanded, its slightly convex outer face provided with several tapering spines; spines as long as L plate is wide (transversely), the series of spines fringing each arm to its tip.

Presence of additional oral spines questionable; in well-preserved distal part of one arm (pl. 4, fig. 2), structures which may be small papillae present on T-shaped ridges of Ambb and on transverse ridges of SubLL, but no attached spines seen. Pyritization making interpretation difficult in this region.

Mouth frame.—MAPP large, robust plates. Each interradial pair with an orad concavity, but no torus preserved. Each MAP about as long radially as the combined transverse width of nearby Amb and SubL. First pair of Ambb in each arm modified as part of mouth frame, narrower than next Amb and apparently lacking adjoining SubLL and LL; cup for first tube-foot adjacent to distal end of MAP. Buccal slit scarcely more than a notch between the first Ambb.

Remarks.—The broad flat arms with no apparent vertical hinge structure indicate a

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EXPLANATION OF PLATE 3

Both figures × 20

FIGS. *1, 2*—*Antiquaster magrumi* n. gen. & n. sp. Oral surface of holotype. *1*, photographed without coating, showing lateral spines particularly well. *2*, photographed with coating of ammonium chloride, showing the mouth frame and the proximal arm areas, which lack buccal slits.

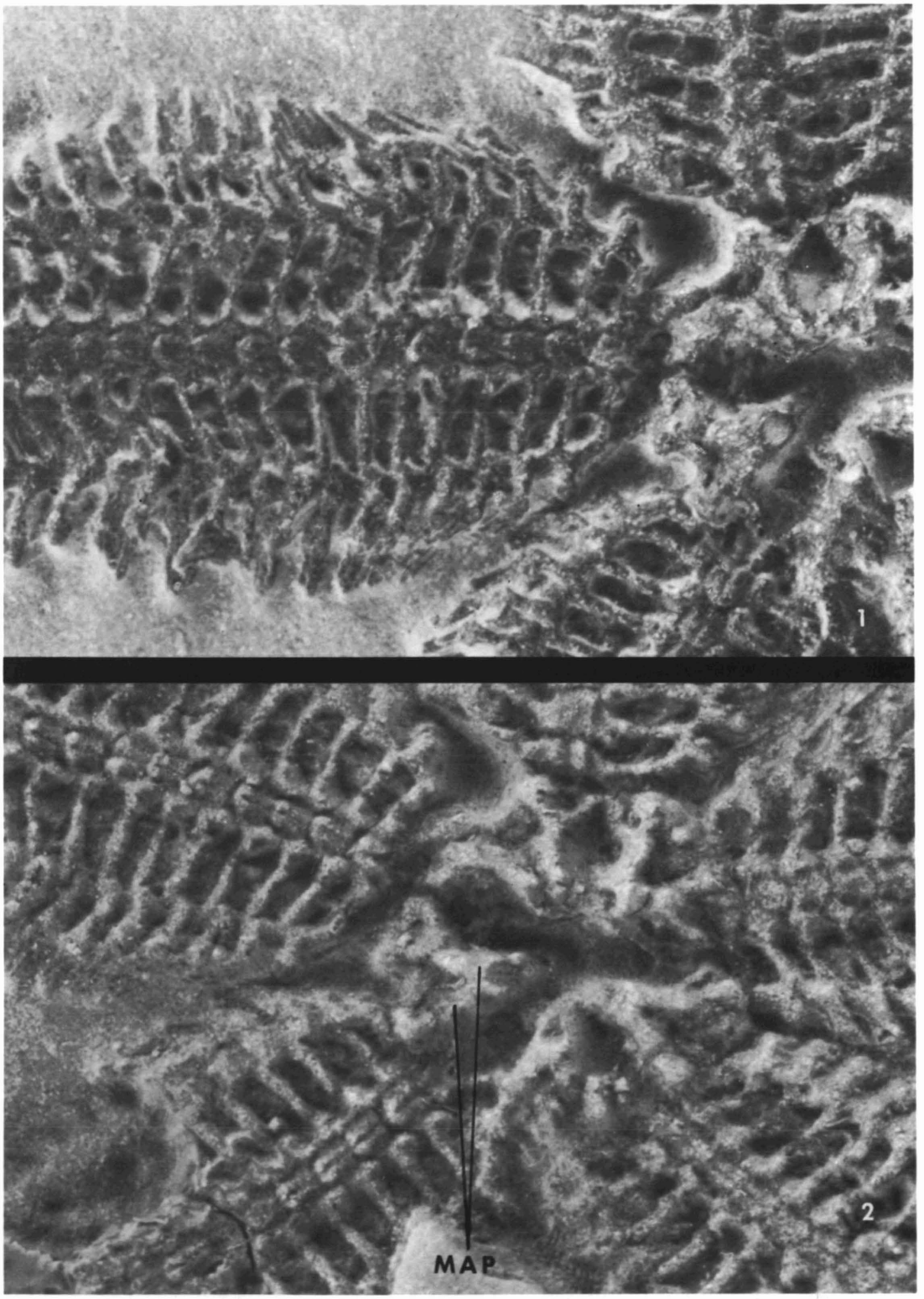

PLATE 3

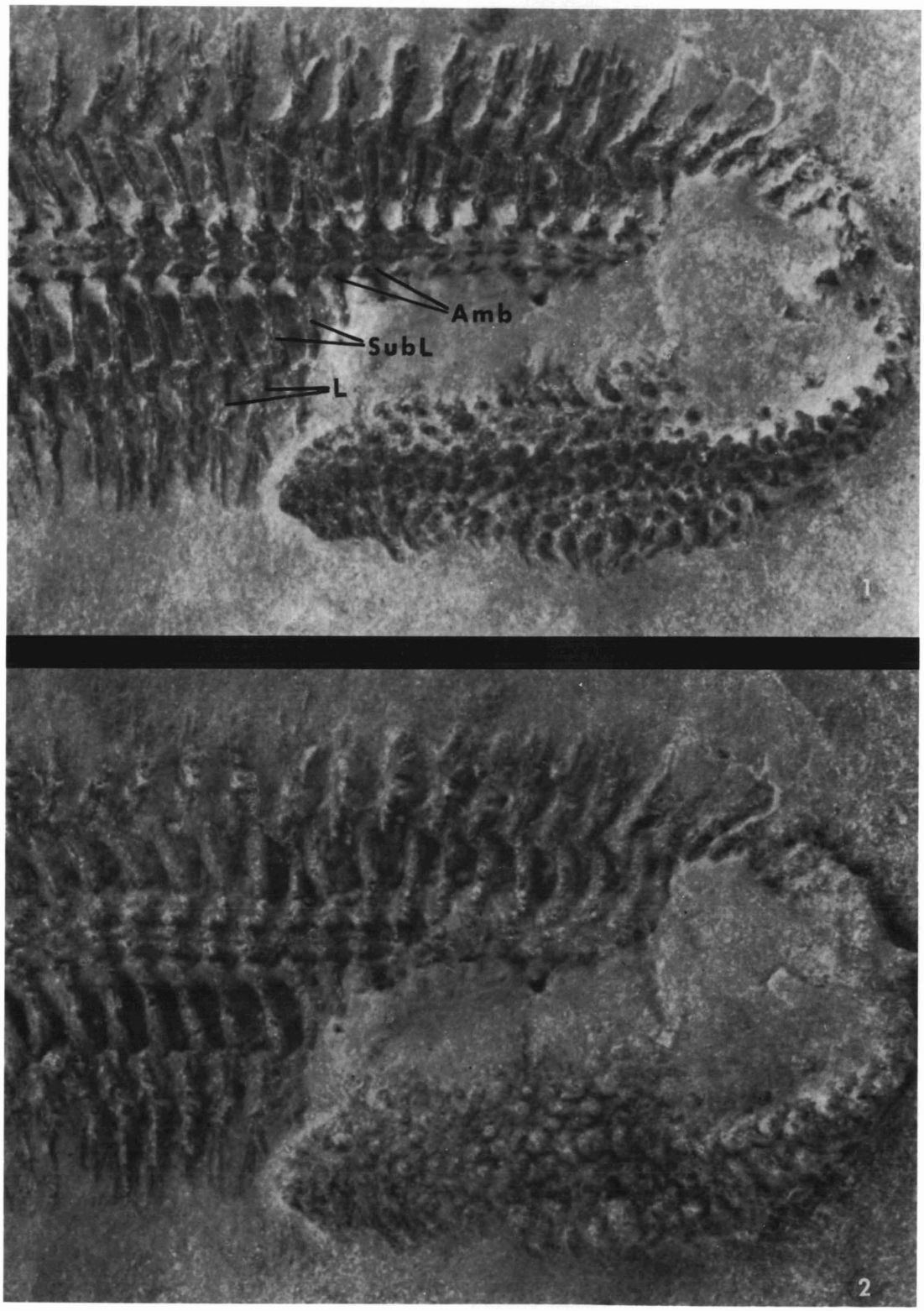

PLATE 4

brittle-star with restricted lateral flexure of its arms; the inward enrollment of arms was also probably limited, and *Antiquaster magrumi* is poorly constructed for predation. The marginal spines appear adapted for raking through bottom debris, but the poorly developed ambulacral groove indicates that only small particles could be handled. The exceptional development of the SubLL is not a direct equivalent of the metapinnular development in somasteroids, although the superficial resemblance is striking. However, the transversely elongate grooves may have been involved in ciliary concentration of small particles.

The structure of the mouth frame seems developed for strong action of small amplitude; ingestion of large prey or masses of detrital material appears impossible. Evidence points to scavenging and/or suspension feeding. The exceptionally flat arms and small unarmored disk argue against the burrowing habit. *Antiquaster magrumi* probably moved rather slowly along the bottom, feeding for extended intervals wherever organic debris was concentrated.

The species is named in honor of Mr. Larry Magrum, who presented the specimens to the Museum of Paleontology.

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EXPLANATION OF PLATE 4

Both figures × 20

FIGS. *1, 2*—*Antiquaster magrumi* n. gen. & n. sp. Oral surface of arm of holotype with end turned under to show its aboral side. *1,* photographed without coating, showing distribution of arm ossicles and spines. *2,* photographed with light coating of ammonium chloride, showing configuration of arm ossicles.