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STRATASTER DEVONICUS, A NEW BRITTLE-STAR WITH UNUSUAL PRESERVATION FROM THE MIDDLE DEVONIAN SILICA FORMATION OF OHIO

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VOLUME 24

1. A new species of *Porocrinus* from the Middle Ordovician Kimmswick Limestone of Missouri, by Robert V. Kesling. Pages 1–7, with 2 plates and 8 text-figures.

STRATASTER DEVONICUS, A NEW BRITTLE-STAR WITH UNUSUAL PRESERVATION FROM THE MIDDLE DEVONIAN SILICA FORMATION OF OHIO

ROBERT V. KESLING

ABSTRACT—A new brittle-star from the Middle Devonian Silica Formation of northwestern Ohio has large alternating ambulacral plates which feature an admedian articulation instead of a "dorsal" nose and "dorsal" groove. Ambulacral musculature was extensively developed, and probably was responsible for pulling each arm in two after the death of the animal. Each lateral plate is thick, with a large "nose" articulating with the ambulacral; it was probably provided with wide scapula-shaped oral spines of exceptional size, nearly as long as the lateral plate itself, as well as robust distal spines. Mouth-angle plates, known only from their impressions through the disk integument and from X-ray photographs, were large and strongly constructed. The characteristics of this species are best accommodated in the genus *Strataster,* so that this becomes the first known Devonian occurrence of the genus.

INTRODUCTION

BRITTLE-STARS may still be regarded as rare fossils, even though washings for micropaleontological material reveal that their record in the Michigan Basin region during Middle Devonian time was rather extensive. With our present knowledge of these animals and our current classification, isolated plates are inadequate for identification. Each discovery of a relatively complete specimen, therefore, has special significance; it provides evidence for the potential extension of brittle-star history—taxonomically, geologically, and geographically.

Two brittle-stars collected in 1966 by Millard E. Widener from the Middle Devonian Silica Formation in northwestern Ohio are particularly interesting. Not only are they new species, but they are fossilized in a condition which I believe is unique.

Each specimen lies on a bedding plane of gray shale with its oral surface concealed. One has an arm turned back over the disk and partly disarticulated to show, in part, the nature of the oral side. The distal ends of all arms are missing. The remarkable feature is the preserved proximal parts of the arms: each arm is split in half beginning at the edge of the disk, and each half is curved away from the other. When I first saw the specimens I thought this brittle-star might have each ray subdivided to form two arms. On closer examination, I noted that the inward-facing surface of each "arm" appeared to be composed of ambulacral plates.

I explained the problem to Professor Albert G. Richards of The University of Michigan School of Dentistry. Prof. Richards was as kind to me as he has been to a multitude of other colleagues at the University who have research in need of his wizardry with X rays; he promptly X-rayed the specimens. The films show definitely that each branch is actually half an arm; they also indicate that the concealed mouth-angle plates are very large.

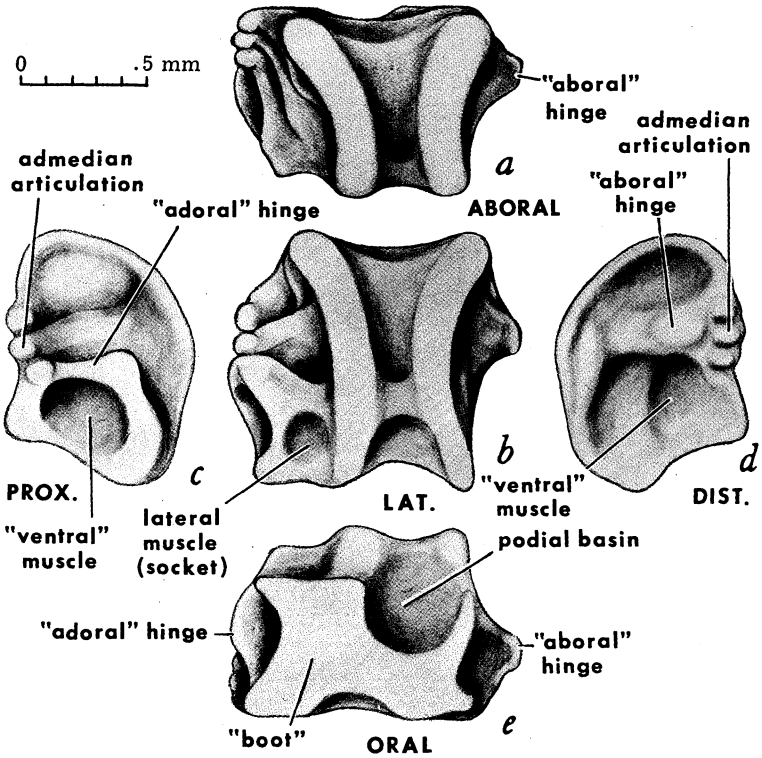
Although the brittle-stars are not unique in their basic arm structure, they constitute a new species, which I assign to my genus *Strataster.* At the present state of taxonomy, this seems the best generic fit for their characters. The unusual splitting of the arms prior to burial elicits some speculative comments on the postmortem history of these brittle-stars.

Many persons helped make this paper possible. In particular, I am grateful to Mr. Widener for his gift of the specimen, to Prof. Richards for his X-raying, to Karoly Kutasi for his assistance in photography, to Mrs. Helen Mysyk for her typing, and, last but not least, to Mrs. Gladys Newton for her careful proofreading. All deserve lasting credit.

The specimens are catalogued and deposited in the Museum of Paleontology at The University of Michigan.

LOCALITY

Middle Devonian Silica Formation, Unit 18. North Quarry of the Medusa Portland Cement Company, Lucas County, northwestern Ohio; west wall of the quarry as it existed in September, 1966. Specimens found associated with the crinoid *Eutaxocrinus wideneri* Kesling & Strimple.



TEXT-FIG. *1*—*Strataster devonicus* n. sp. Restorations of Ambb in various views, labeled with significant terms. *a,* aboral (top) view. *b,* lateral view. *c,* proximal ("adoral") view. *d,* distal ("aboral") view. *e,* oral view. Based on numerous camera lucida sketches of the holotype.

TERMINOLOGY

Some of the old established terms convey a confused orientation, particularly those dealing with details of ambulacral plates. The term *oral* has been used with two distinctly different meanings: (1) the side opposite the disk, on which the mouth is central; the side of the arm containing the ambulacral groove; in most brittle-stars, the side on which the animal rests, the underside; and (2) the side of a plate which is nearest to the center of the animal, the side away from the arm tip. The second usage is equivalent to *proximal.* In referring to an Amb, the terms *adoral hinge* and *aboral hinge* also involve this meaning; they might more accurately be called the *proximal hinge* and *distal hinge* of the plate. Nevertheless, the old terms are used in the descriptions below, with the confused terms in quotation marks—*"adoral" hinge* and *"aboral" hinge*—so that direct comparison can be made with previous literature.

The terms *dorsal* and *ventral* have also been used to mean *aboral* and *oral,* particularly in connection with musculature. Thus, the muscle connecting adjacent Ambb in their oral parts has been termed the *dorsal muscle,* and that connecting Ambb in their aboral parts has been termed the *ventral muscle.* As above, the old terms are retained here, but the inappropriate adjectives are put into quotation marks: *"dorsal" muscle* and *"ventral" muscle.*

SYSTEMATIC DESCRIPTION

Subclass OPHIUROIDEA Gray
Order OEGOPHIURIDA Matsumoto
Suborder LYSOPHIURINA Gregory
Family PROTASTERIDAE Miller

Genus STRATASTER Kesling & Le Vasseur

Type species.—*Strataster ohioensis* Kesling & Le Vasseur, 1971, p. 317–330, pls. 1–13.

Remarks.—*Strataster* was created by Kesling & Le Vasseur for Mississippian brittle-stars of the family Protasteridae which differ from *Protasterina* in having longer Ambb (trapezoidal instead of subtriangular), larger MAPP, larger and longer "nose" on LL plates, and uniform taper of the arms.

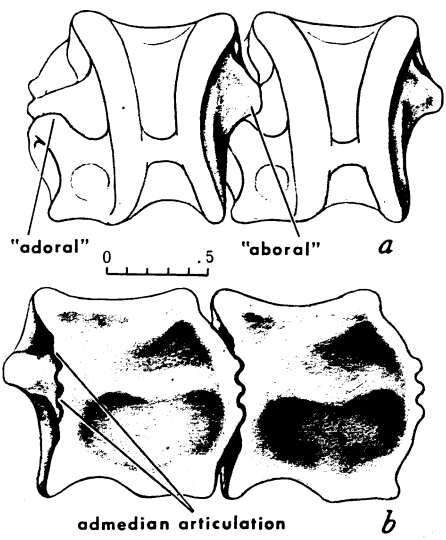
The brittle-stars described here from the Middle Devonian agree with the type species of *Strataster* in most respects. However, the articulating "nose" of L is much smaller than that in *S. ohioensis,* although it seems to be proportionally larger than that known in *Protasterina.* Because the arms are incomplete, the extent and degree of taper are not known in the new species.

STRATASTER DEVONICUS n. sp.
Pls. 1, 2; text-figs. 1–3

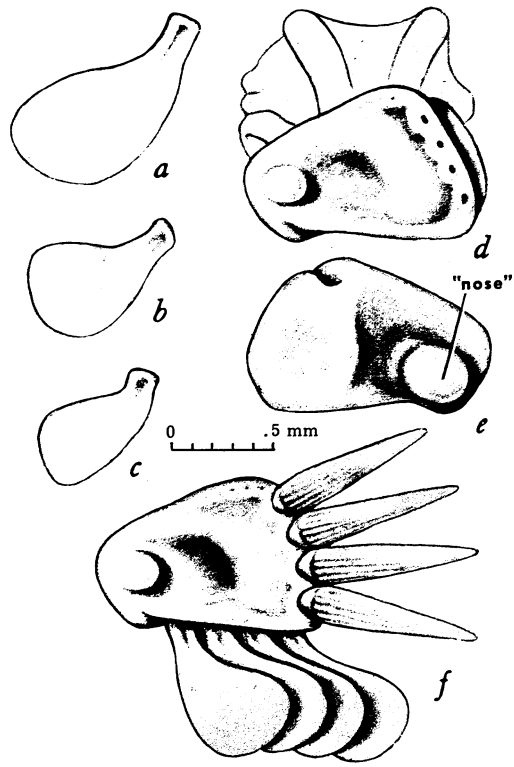
Disk.—Subround to subpentagonal, about 11 mm in diameter. Aboral surface, as preserved, pressed down to show general form of concealed MAPP. Integument with no discernible plates (pl. 2, fig. 1), thickly studded with small grains, probably marking positions of papillae. Tiny dislocated spines here and there on surface of paratype (pl. 2, fig. 1), each subconical and about 0.3 mm long.

Arm plates.—Ambb and LL in paratype exposed mostly in aboral view (pl. 2, fig. 1); those in holotype exposed in oral and other views (pl. 1, figs. 1, 2; pl. 2, figs. 2–4).

Ambb alternating (pl. 1, fig. 2; pl. 2, fig. 3), with sharp relief and sculpturing. As reconstructed from numerous camera lucida sketches (text-figs. 1, 2), each Amb higher than wide, with two prominent ridges curved around aboral (text-fig. 1a) and lateral (text-fig. 1b) surfaces. These ridges converging toward the side, but separated by a channel throughout their extent; about one-third the distance from the oral surface, a saddle-shaped process linking the two ridges. Proximal face of Amb with a deep subcircular depression near its oral edge to accommodate the "ventral" muscle (text-fig. 1c), surrounded by a flattened ridge or flange. Aboral edge of flange serving as the "adoral" hinge; outer edge also bordering the socket for the lateral muscle on the side of the Amb (text-fig. 1b). No distinct "dorsal nose" on proximal face; instead, three toothlike nodes along the inner edge of the face, forming an admedian articulation with the adjoining plate (pl. 1, fig. 2).



TEXT-FIG. 2—*Strataster devonicus* n. sp. Restoration of two adjacent Ambb from right side of arm. *a,* lateral view with distal ends shaded, showing two hinges. *b,* inner view. Based on numerous camera lucida sketches of the holotype.



TEXT-FIG. 3—*Strataster devonicus* n. sp. *a–c,* three flat spines found on the same bedding plane and in close proximity to the holotype, presumed to be oral ("groove") spines of LL. *d,* lateral view of L (shaded) in association with Amb. *e,* inner view of L, showing articulating "nose." *f,* lateral view of L, with distal ("vertical") spines and with the supposed oral spines in position. Based on numerous camera lucida sketches of the holotype.

Distal face of Amb with a large aboral cavity for the "ventral" muscle (text-fig. 1d), just below a prominent "aboral" hinge. No "dorsal groove" developed. Admedian articulation developed as three nodes to alternate with those on the proximal face of the next Amb. In adjacent Ambb (text-fig. 2a), "aboral" hinge fitting above "adoral" hinge of next plate in the arm series. Inner face of Amb (text-fig. 2b) concave, with a central horizontal ridge, the part of the face below the ridge deeper than that above.

Oral surface of Amb (text-fig. 1e) featuring a "boot"-shaped ridge very similar to that in *Strataster ohioensis,* of which Kesling & Le Vasseur stated (1971, p. 326): "Actually, the

shape of the Amb ridges in these specimens strongly resembles a jackboot with the foot directed distally, complete with heel and toe, the opposite orientation from that normally used." Embayments at the ends of the "boots" at the edges of the concavities for "ventral" muscles. Podial basins very large and distinct, forming subcircular sharp-edged embayments in the "boots."

LL large, thick, about as long as the Ambb to which they attach. Each L appreciably longer than high, subtrapezoidal with oral and aboral edges converging proximally and with distal and proximal edges subparallel (text-fig. 3d). Lateral surface with a small knob near the proximal end, just opposite to the inner articulating "nose" of the plate; proximocentral part of plate concave; distal end of plate with a distinct ridge, bearing the articulations of the four distal spines and extending along the aboral and oral edges of the plate to form a C-shaped structure.

Distal end of L divided into an outer and inner part by a deep smooth groove (text-figs. 3d, 3e), the distal spines being attached to the outer part. Inner surface of L with a large "nose" articulating with the Amb, more than one-fourth as long as the plate (text-fig. 3e), lying in front of a median depression.

Distal spines of L about three-fourths as long as the plate to which they attach, each robust, subconical, and longitudinally grooved or fluted. Spines abruptly tapering to their articulation with the plate, but evidently (from their size) nearly touching one another. In close proximity to the holotype (pl. 1, fig. 1), flat scapula-shaped plates (text-figs. 3a, 3b, 3c), probably the oral spines of LL; if so interpreted (text-fig. 3f), exceptionally large, some longer than observed distal spines.

Remarks.—Presumably, in life *Strataster devonicus* had a rotund disk, bristly with short erect little spines. X-ray films of the specimens show the MAPP to be very large. The shape and extent of the arms are unknown, but the size of the Ambb and LL indicate that the arms were robust, at least in their proximal parts.

Spencer (1925, p. 254) described a shallow groove across the Amb "boot" to accommodate the short branch from the radial nerve and pseudohaemal canal to the tube foot. Hotchkiss (1970, p. 71) found a similar groove in *Taeniaster,* and Kesling & Le Vasseur (1971, p. 326) reported a groove in *Strataster ohioensis.* The "boots" in *Strataster devonicus* are somewhat worn, probably abraded in their exposed position atop the disk (pl. 1, fig. 2), and only one "boot" displays any kind of groove crossing its narrow part. The evidence is not very convincing, therefore, although I suspect that the groove in the one "boot" is actually for the branch to the tube foot and that the grooves of the other Ambb plates were obliterated.

Fossilization.—The remarkable feature of the two types, as indicated above, is the splitting of the arms into oppositely curved halves. The only conceivable force which could tear the arms asunder in such fashion is the contraction of the muscles linking the Ambb together in each series, the left and the right, in each arm. Inasmuch as the arm halves were turned outward, so that their oral surfaces remained in the same plane as before the rupture, it must be assumed that the pull of the muscles was distributed equally in oral and aboral regions of the Ambb—for otherwise the arms would have been twisted under the disk by "ventral" muscles or back over the disk by "dorsal" muscles. Hence, we have evidence that there were strong "dorsal" muscles linking the Ambb, even though the proximal and distal faces of the plates do not show well-developed cavities for their attachment. It may be seen (pl. 2, fig. 2) that the configuration of the Ambb plates permitted each half arm to twist away from the opposite half without disrupting the admedian articulations; it seems possible that the strength of these hinges kept each series of plates together and may have helped keep the series in the original plane of the arms. If this was a significant factor, then the pull of "dorsal" muscles may have been somewhat weaker than that of "ventral" muscles, with the hinge being responsible for distributing the total pull equally into the regions above and below it.

EXPLANATION OF PLATE 1

Stereograms; specimen lightly coated with sublimated ammonium chloride

Strataster devonicus n. sp. Holotype UMMP 58376 (other views of the specimen in plate 2, figures 2–4). *1,* entire specimen, showing split arms; × 4. *2,* details of plates of arm recurved over the disk; a few Ambb and associated LL are only slightly disarranged (center and below); a pair of Ambb (central left) is turned to show the admedian articulation above the basins for the "ventral" muscle; one L (just above center) is seen laterally, showing the ornamental knob and the articulations for the distal spines; other LL (bottom left) are exposed in distal view, showing the groove between inner and outer edges; the outlines of the Ambb "boots" are sharply delineated in this carefully prepared and unabraded surface; × 15.

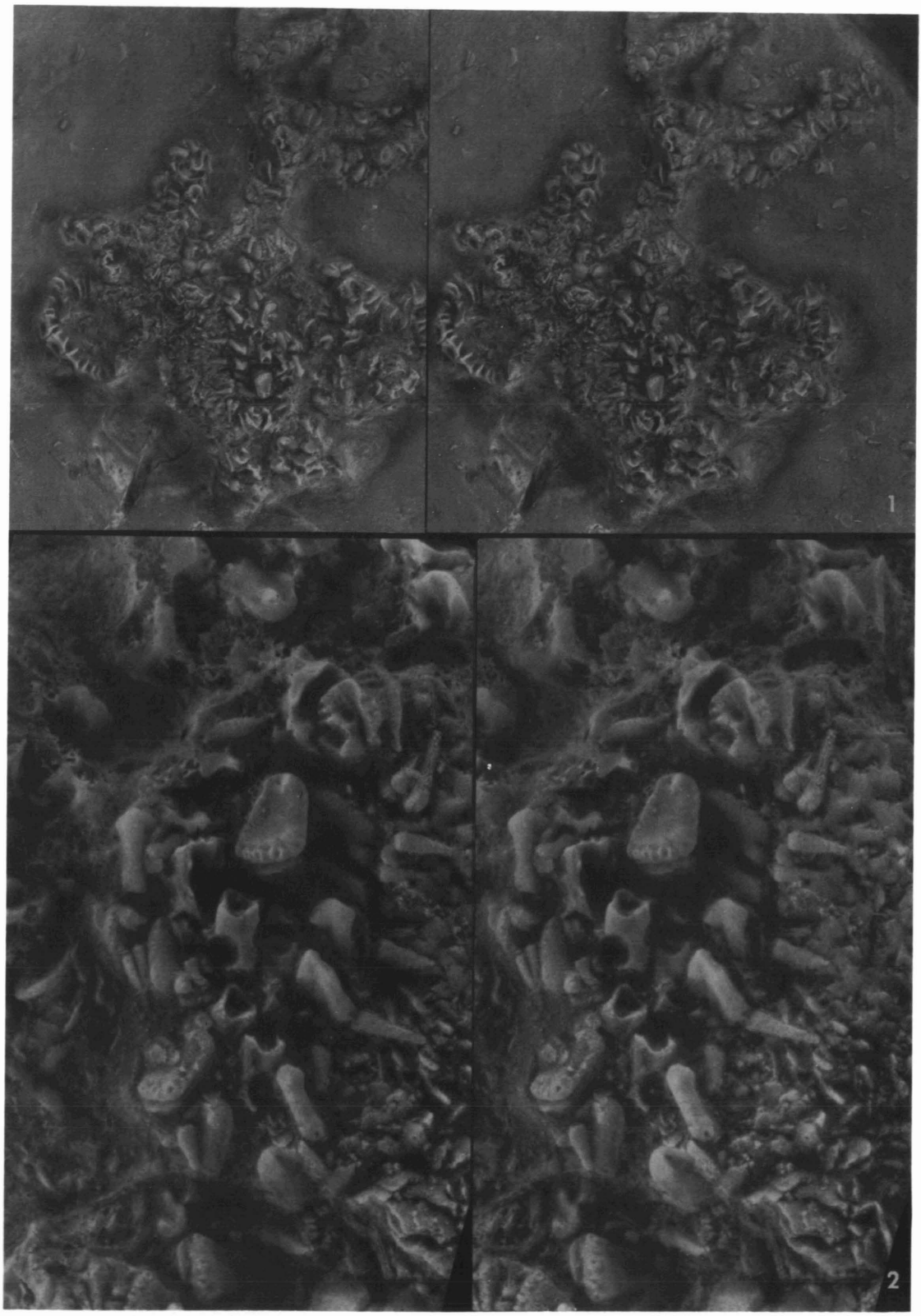


PLATE 1

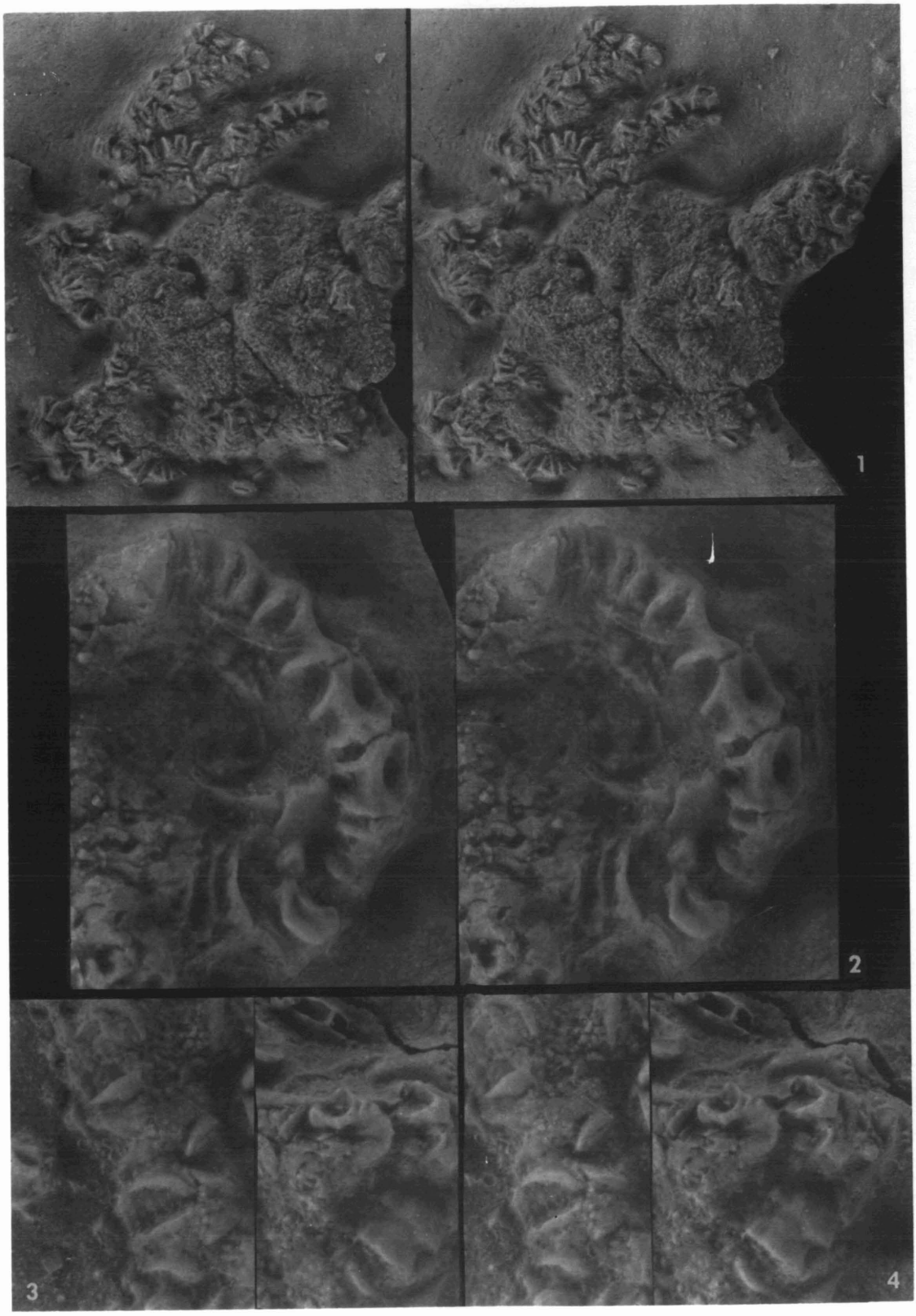


PLATE 2

The main problem is why the musculature in these particular specimens was powerful enough to pull the arms apart, whereas that in all other known specimens of fossil brittle-stars was insufficient. Two explanations are logical. First, rigor mortis may have caused the muscles to contract in *Strataster devonicus* more than in other species, and the arm integument in this species may have been somewhat weaker than that in other brittle-stars; the combination of strong muscular contraction and soft integument, perhaps assisted by early bacterial decay, may have been responsible for the arms splitting apart. A second explanation involves subaerial exposure just after death; drying action on the muscles could have produced abnormally strong contraction.

Of the two logical explanations, the first seems to accord with other circumstances of the fossils' occurrence. No mud cracks, irregular bedding, or other evidence of exposure can be found in the matrix around the two type specimens. Nevertheless, the splitting of the arms remains a unique feature in brittle-star preservation.

MANUSCRIPT SUBMITTED SEPTEMBER 15, 1971.

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EXPLANATION OF PLATE 2

Stereograms; specimen lightly coated with sublimated ammonium chloride

Strataster devonicus n. sp. *1,* paratype, UMMP 58377; aboral surface of entire specimen, showing split arms and outlines of large MAPP impressed through integument of the disk; × 4. *2–4,* holotype, UMMP 58376 (other views in pl. 1, figs. 1, 2); all × 15; *2,* aboral view of Ambb series in left half of split arm (see pl. 1, fig. 1, left edge); *3,* alternating Ambb in unsplit distal part of arm (see pl. 1, fig. 1, upper right); *4,* inclined view of proximal end of Amb, showing deep pit for "ventral" muscle and admedian articulation (see pl. 1, fig. 1, upper middle).