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GROWTH CHANGES IN *AMPHILIMNA OLIVACEA* (LYMAN) AND THE SYSTEMATIC STATUS OF *AMPHITARSUS SPINIFER* SCHOENER[1]

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ABSTRACT. Analysis of the developmental sequence in the brittlestar *Amphilimna olivacea* (Lyman) has revealed the similarity between its young stages and those of adult *Amphitarsus spinifer* Schoener. Evidence is provided to justify synonymizing the latter species with the former.

INTRODUCTION

Two recent papers published almost simultaneously have dealt with the enigmatic brittlestar genus *Amphitarsus*. Schoener (1967a) described two new species of this previously monotypic genus and discussed its possible family affinities, while Thomas (1967: 126) pointed out the similarities between *Amphitarsus mirabilis* H. L. Clark 1941 and *Amphilimna olivacea* (Lyman, 1869). The information contained in these two papers has prompted a re-examination of *Amphitarsus spinifer* and a study of the growth stages of *Amphilimna olivacea*. As a result of our studies we synonymize *A. spinifer* as a junior synonym of *Amphilimna olivacea* and discuss changes that take place during the growth of this species.

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Amphilimna olivacea (Lyman, 1869)

Ophiocnida olivacea Lyman, 1869, Bull. Mus. Comp. Zool., 1(10): 340 (off Alligator Reef, Caribbean, 79 fms.).

Amphitarsus spinifer Schoener, 1967a, Breviora No. 267: 6, fig. 2 (NW Atlantic, 200 m). See Thomas (1967) for complete synonymy of *A. olivacea.*

Diagnosis. Adult specimens (see below for discussion of young animals). Jaws with two, occasionally three, infradental papillae at apex, two or three slender oral papillae bordering each adoral plate; two oral tentacle scales, resembling papillae, in each oral slit. Arms slender, six times disc diameter; tentacle pores large; eight to ten proximal ventral arm plates with two tentacle scales on each side, innermost attenuated; beyond tenth ventral arm plate a single tentacle scale on each side; seven to nine slender arm spines, ventralmost largest; arm spines of arm segments under disc greatly flattened, fused together to form peculiar flanges occupying genital slits; dorsal arm plates slightly wider than long. Disc scales studded with slender spines; primary plates present, often inconspicuous. Radial shields narrow, joined proximally, slightly separated distally; disc deeply notched at each pair of radial shields. Color variable, disc gray, tan, or brown, arms pink or orange.

SYSTEMATIC DISCUSSION

Although this species has been known for over a century, it has been only in the last nine years that the peculiar fused arm spines under the disc have been described. Early references to *A. olivacea,* in addition to omitting mention of this important character, are generally brief and often unillustrated. Lyman's only figures (1871, pl. 1, figs. 7, 8) show primitive plates, although only indistinctly, and a view of the ventral arm and disc surfaces, omitting the fused arm spines. The only other illustrations prior to 1962 are Verrill's (1899; pl. 42, figs. 1, 1a) stylized figures of the ventral disc surface and one row of arm spines. Again, the fused arm spines are omitted. Finally, Cherbonnier (1962) described and illustrated the fused arm spines, erroneously referring to them as "écailles genitales." They were described and properly identified by Thomas (1967), who also considered the similar "winglike flanges" of *Amphitarsus mirabilis* to be fused arm spines. If the latter observation is correct, it is almost certain, in view of

the other similarities discussed by Schoener (1967a) and Thomas *(ibid.),* that *Amphitarsus mirabilis* and *Amphilimna olivacea* are congeneric. External features and dissection of oral and dental plates indicate that *Amphilimna olivacea* belongs in the family Ophiacanthidae, but material of *Amphitarsus mirabilis* is not available for dissection.

GROWTH CHANGES

In the following section small (presumably young) and large (presumably adult) specimens of *Amphilimna olivacea* are figured in dorsal and ventral aspect (Figs. 1A, B & 2A, B). Synopses of the growth changes are given, purposely written so as to trace the growth sequence in reverse, going from the larger to the smaller individual. This was done so that specimens of the even smaller species, *Amphitarsus spinifer* (Figs. 1C, D & 2C, D), could be viewed as initial stages of a growth series terminating with large specimens of *A. olivacea.*

Growth changes on the dorsal surface

Amphilimna olivacea. In the larger specimen (9.7 mm disc diameter) important systematic characters of the dorsal surface (Figure 1A) appear as follows: (1) Only the central plate of the six primary plates is conspicuous. (2) The radial shields are contiguous for much of their length and are greatly attenuated. (3) Most of the disc is covered by fine overlapping scales, each of which frequently bears a spine. (4) The dorsal arm plates are rectangular or with a convex outer edge.

In a smaller specimen (4.5 mm disc diameter): (1) All six of the primary plates are conspicuous and occupy a greater proportion of the disk than in the larger specimen. (2) The radial shields, which are less attenuated, are not always contiguous. (3) The fine scale covering of the disc is comprised of fewer scales than in the larger specimen, and the scales less frequently bear spines. (4) The dorsal arm plates have convex distal edges and are concave laterally.

Amphitarsus spinifer. The holotype of this species (Fig. 1C) has a disc 3.8 mm in diameter, and is therefore comparable to the specimen of *A. olivacea* illustrated in Figure 1B. Here: (1) The six primary plates are conspicuous, although in this case they are

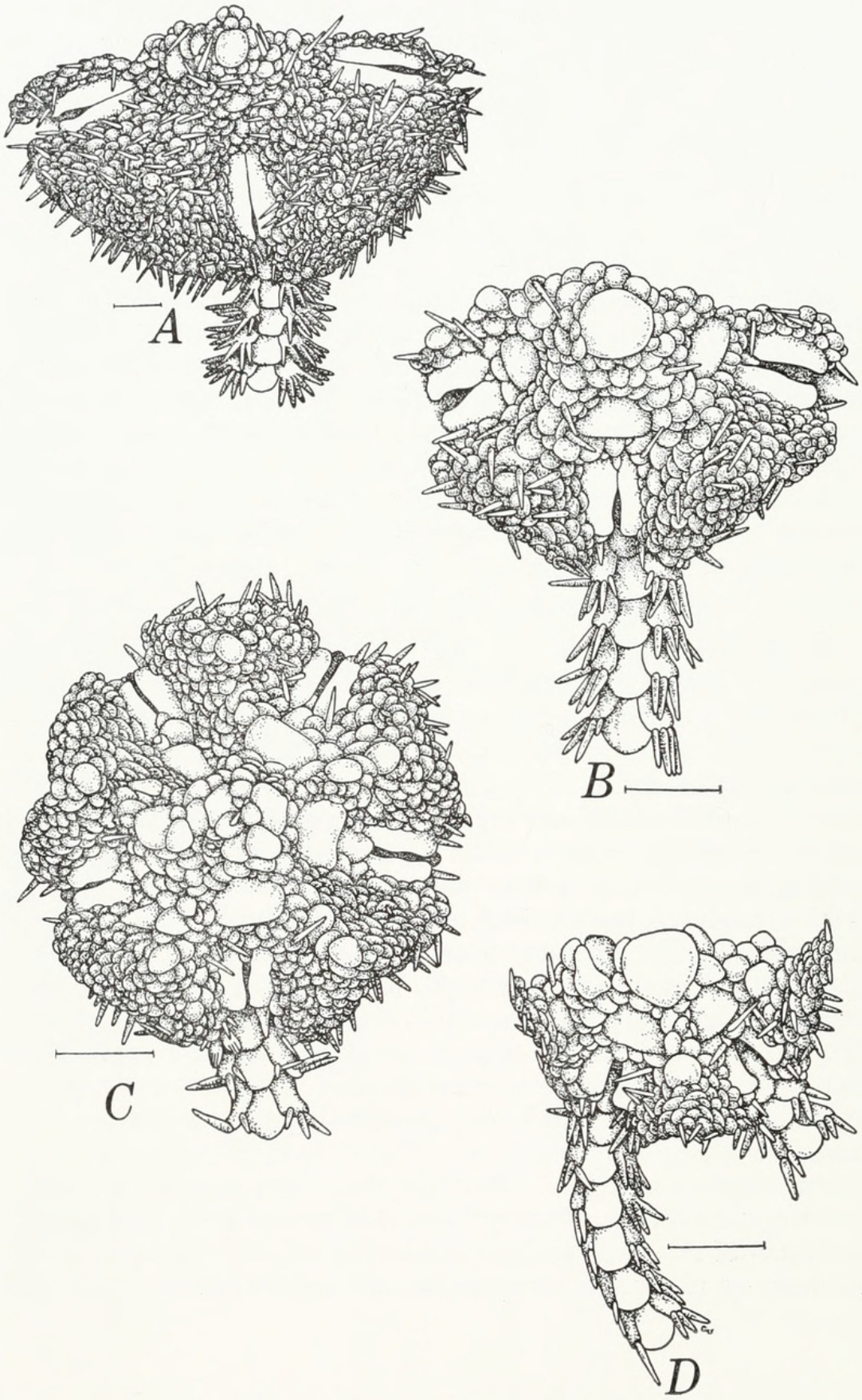

Figure 1. Dorsal views of specimens arranged in order of decreasing size. A. *Amphilimna olivacea* (9.7 mm); B. *A. olivacea* (4.5 mm); C. *Amphitarsus spinifer* (3.8 mm); D. *A. spinifer* (ca. 3 mm).

less perfectly arranged and other large irregular scales are present on the disc. (2) The radial shields are separated for their entire length and, although longer than wide, do not appear greatly attenuated. (3) The fine disc scales bear spines only occasionally. (4) The dorsal arm plates are nearly identical to those figured for *A. olivacea* of this size (Fig. 1B).

Figure 1D illustrates a paratype of *A. spinifer* whose disc diameter is smaller (ca. 3 mm) than that of the holotype. Here: (1) The primary plates, of which one central and three radial are figured, are large relative to the size of the disc, occupying a sizable fraction of the dorsal surface. (2) The radial shields are much shorter, relative to their width, and are not contiguous. (3) The scalation of the disc consists of even fewer fine overlapping scales, which bear scale spines only occasionally. Here again, several larger scales, particularly one in each interradial area, are quite noticeable, although other large scales are present around the central disc area. (4) The dorsal arm plates, which are basically rectangular, show some convexity at the distal edge and slight indentations laterally.

Growth changes on the ventral surface

Amphilimna olivacea. In the specimen with a disc 9.7 mm in diameter: (1) Seven sets of flanges of fused arm spines are borne by those arm segments overlain by the disc. (2) The oral shield is basically triangular with a distal edge that forms a slight outward bulge toward the middle. (3) On the arm plates overlain by the disk two tentacle scales are usually present. (4) Eight or nine arm spines are present on each side arm plate at the point where the arm becomes free of the disc. (5) The ventral surface of the disc is covered by many small overlapping scales bearing spines.

Figure 2B shows the smaller specimen of this species: (1) There are only three sets of flanges per arm. (2) The oral shield, with an even more convex distal side, almost forms a rhombus. (3) Two tentacle scales are often present on the arm plates overlain by the disc. (4) The arm bases have fewer arm spines (five or six) than in the above specimen. (5) The ventral surface of the disc is covered by fewer overlapping scales than in the above specimen. Some of these bear single scale spines.

Amphitarsus spinifer. The specimen illustrated in Figure 2C (the holotype) is almost the same size as the *A. olivacea* shown

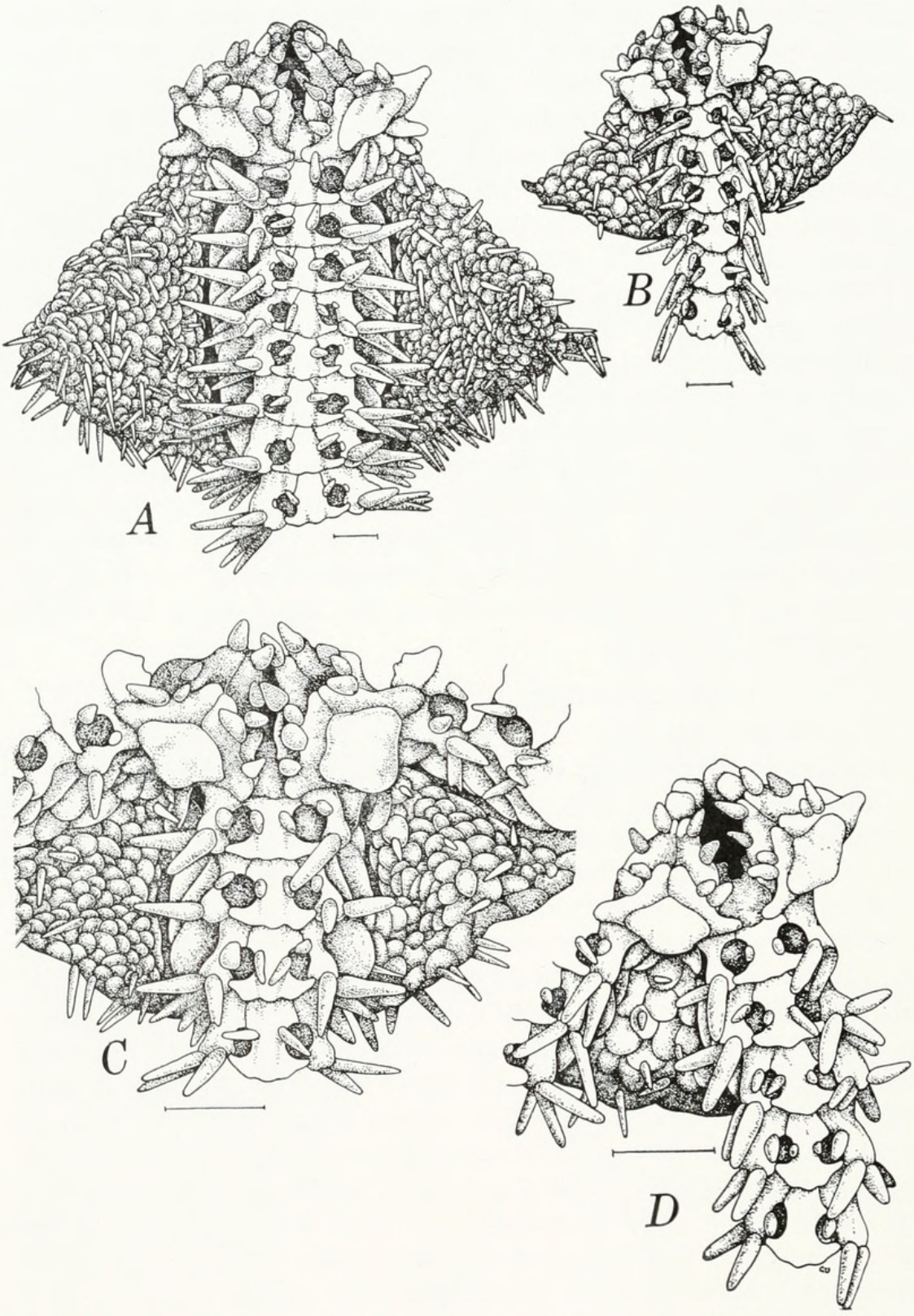

Figure 2. Ventral views of specimens arranged in order of decreasing size. A. *Amphilimna olivacea* (9.7 mm); B. *A. olivacea* (4.5 mm); C. *Amphitarsus spinifer* (3.8 mm); D. *A. spinifer* (ca. 3 mm).

in Figure 2B. In the characters considered, except perhaps for the length of the disc scale spines, it scarcely differs from *A. olivacea.*

Figure 2D shows the ventral aspect of the smaller specimen of *A. spinifer:* (1) The number of flanges in the genital area is reduced still further to two sets per arm. (2) The distal side of the oral shield is more rounded. (3) Two tentacle scales usually are present on the arm plates overlain by the disc. (4) The number of arm spines near the arm base (four or five) is less than that in the larger *A. spinifer* (above). (5) The ventral surface of the disc is covered by still fewer scales, which overlap less, and only a few of which bear spines.

CONCLUSION

In order to conclude on the basis of evidence from growth sequences that two supposed species, the larger *Amphilimna olivacea* and the smaller *Amphitarsus spinifer,* are in reality only one species, two criteria must be satisfied. First, for specimens of each species that overlap in size, one must show that the variation in important characteristics is negligible. Second, one must be able to offer a logical progression of growth stages from one to the other.

The first point is readily satisfied upon examination of specimens of the same size range. This has been done (see Figs. 1B, C & 2B, C) and the specimens are found to be very similar.

The second point, that growth sequences should generally agree within reasonable bounds with those of other species investigated, is also satisfied. Superficially the following sequences are consistent with knowledge of developmental series for other ophiuroid species (Schoener, 1967b, 1969). These points include the following: (1) The six primary plates of the dorsal disc surface may become less conspicuous as the specimens in a series increase in size. (2) The radial shields are initially small and may elongate with an increase in the size of the specimen. (3) More arm spines are added as the adult condition is approached. (4) There may be an increase in the number of specialized elements (e.g., flanges in the genital area) as the adult condition is reached. (5) There will be an increase in the number of scales covering the disc if

their absolute size remains constant while the size of the specimen increases.

Several other characters remained fairly constant in this series. These were the deep notching of the disc at the distal ends of the radial shields, the shape of the dorsal and ventral arm plates, and the number of infradental papillae at the jaw apex.

Points on which no judgment is presently made concern the variation in the shape of the oral shield, which in any case seems slight, and the fact that there is no documented sequence of development in which radial shields in the smallest specimens are initially separated but later become contiguous. However, since our knowledge in this area is just being expanded, this may indeed occur in other species.

Based on the above evidence, it is concluded that the smaller species *Amphitarsus spinifer* Schoener is part of the developmental series of *Amphilimna olivacea* (Lyman), the latter name having priority.

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