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## LYTECHINUS WILLIAMSII, A NEW SEA URCHIN FROM PANAMA

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### ABSTRACT

A fourth species of *Lytechinus* from the Atlantic, *L. williamsii*, is described as a Panama endemic. It differs from the other shallow-water species, *L. variegatus*, in having fewer than 15 wedges per primary spine and fewer than 14 interambulacral plates per series in adults. Variation in several taxonomic features of *L. variegatus* is examined.

### INTRODUCTION

During an underwater survey of the Atlantic coral reefs of Panama in September of 1967, a new species of sea urchin was discovered living in beds of leaf coral (*Agaricia agaricites* (Linnaeus)). The specimens, which were collected at Buena Ventura in depths of 5 to 10 meters, belong to *Lytechinus*, primarily an American genus, which now has four Atlantic and four Pacific species (see key, below). Two of the Pacific species are sympatric: *L. pictus* (Newport Bay, California, to Gulf of California) and *L. anamensis* (St. Barbara to Cedros Island, California). Mayr (1954) omitted *L. pictus* (Verrill 1867) in his zoogeographic discussion of the genus *Lytechinus* as a possible synonym of *L. anamensis* Clark 1912. Examination of specimens in the Museum of Comparative Zoology substantiates Mortensen's (1943) view that the two forms represent valid species. In the Atlantic, *L. callipeplus* (Caribbean and Gulf of Guinea) is sympatric with *L. euerces* (Caribbean) in depths of 100 to 500 meters. *L. williamsii* (Panama) inhabits a very small portion of the geographic range of the shallow-water species *L. variegatus* (Brazil to

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Bermuda in the Western Atlantic and Cape Verde Islands in the Eastern Atlantic). Mortensen (1943) separated *L. variegatus* into several allopatric subspecies (see key, below), which were cited by Mayr (1954) as evidence for geographic speciation. The distribution of species indicates that tropical America has been the major center of speciation for this genus and that recent migrations, possibly through the Equatorial Undercurrent, are responsible for the presence of *L. callipeplus* and *L. variegatus* in the Eastern Atlantic (Chesher 1966).

To provide statistical data for comparison of the new species with *L. variegatus*, specimens of the latter were measured from localities ranging from Brazil to Bermuda (Table 3). The subspecific taxa were ignored, and it was found that the characters that were measured showed very little variation over the entire geographic range (Table 2, Fig. 5). Swan (1952, 1958) found considerable variation in the number of wedges seen in cross-sections of spines from *Strongylocentrotus* spp., but primary spines taken from the interambulacral areas above the ambitus of *L. variegatus* showed very little variability throughout the geographic range of the species. The number of wedges per spine may thus be considered a valid taxonomic character for this genus, providing that only primary interambulacral spines from above the ambitus are used and the wedges are counted in the proximal half of the spine. The spines afford a field character for separation of specimens of *L. variegatus* and *L. williamsi*; spines of the former appear smooth and glistening and of the latter distinctly ridged.

#### ABBREVIATIONS

The following abbreviations are used in this paper: HD, horizontal diameter of the test; IA, interambulacrum; Ln, the natural logarithm; S.D., standard deviation; C.V., coefficient of variation;  $r$ , coefficient of correlation;  $S_{Y \cdot X}$  standard error of Y on the X axis (Croxtan 1959). In the formulas,  $X = \text{HD}$  in mm and  $Y =$  the taxonomic features of the test. M.C.Z., Museum of Comparative Zoology; U.S.N.M., United States National Museum.

#### ACKNOWLEDGMENTS

The species is named after L. T. Williams, who provided his boat and hospitality for the investigation of the echinoid fauna of the Atlantic reefs of Panama and later found additional specimens for examination. I would like to thank him and his wife for their help. R. Waterhouse deserves special thanks for his assistance

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LYTECHINUS WILLIAMSI new species

Figures 1, 2, 3a, c-i, 4, 5; Table 1

*Types.* The holotype (19mm HD, preserved in alcohol) is deposited in the U.S.N.M. (No. E10855), as are 14 paratypes (U.S.N.M. No. E10856). Eight paratypes are deposited in the M.C.Z. (Nos. 8194 and 8195).

*Type locality.* Buena Ventura, Panama, on top of a living coral reef 5 to 10 meters deep, 9°32'N, 79°42'W.

*Material examined.* Six specimens, 15.7 to 22 mm HD, seaward side of coral reef at Buena Ventura cove, Panama, 9°32'N, 79°42'W, 5 to 10 meters, Sept. 4, 1967, Chesher Coll. Seventeen specimens, 16 to 27.9 mm HD, same locality, Dec. 1967, Williams Coll.

*Diagnosis.* Number of wedges per primary IA spine from above the ambitus less than 15, milled ring of spines poorly developed; naked median areas near apical system in ambulacra and IA; globiferous pedicellariae purple; adults with less than 14 IA plates per series.

*Description.* Generic characters conform to those given by Mortensen (1943). All specimens have well-developed genital pores and are less than 30 mm HD.

*Apical system.* Each genital plate has one large primary tubercle and spine; secondary tuberculation poorly developed; all oculars exsert. The relative size of the apical system measured from the outer edge of ocular V to the outer edge of genital plate 2 is given in Table 1.

*Ambulacra.* Primary tubercles form a regular series just medial of the pore-pairs from the peristome to the oculars. Secondary tuberculation is poorly developed above the ambitus, resulting in a naked median zone from this point to the oculars. The number of

ambulacral plates per plate-series is indicated in Table 1 and Figure 5. Tube-feet end with a well-developed, calcitic sucking disc, as is normal for species of *Lytechinus*. Spicules of the tube-feet are C-shaped (Fig. 3h).

*Interambulacra.* Primary tubercles form a regular series from the peristome to the apical system in each row of plates, and primary spines are well developed up to and including the genital plates. Secondary tubercles are poorly developed above the ambitus, resulting in a naked median area (Fig. 1). The number of IA plates is given in Table 1 and Figure 5.

*Spines.* The sharply pointed primary spines are about 40 to 50 per cent of the HD in length, with the exception of the small spines adjacent to the peristome. The milled ring is poorly developed and the base straight sided (Fig. 3i). The number of wedges seen in a cross-section of the proximal portion of primary IA spines is about 12 (Fig. 3a). Near the peristome, the number may decrease and the small oral spines may have as few as 9 wedges. The number of wedges was counted from 250 IA primary spines taken from between the ambitus and the apical system and broken in half about 2 mm from the milled ring. About 10 spines were taken from each specimen. The number of wedges varied from 11 to 15, with a mean of 12.34 wedges (S.D. 0.7683, C.V. 6.21).

*Pedicellariae.* Globiferous, tridentate, ophicephalous, and triphyllous pedicellariae are present but not diagnostic (Fig. 3c-f). The pedicellariae are purple, and the color is retained after cleaning with bleach. Spicules of the globiferous pedicellariae are dumbbell-shaped (Fig. 3g). Large, white stalk glands are present on many globiferous pedicellariae.

*Coloration.* The spines are usually deep, rich green, although two of the specimens have white spines. The pedicellariae are purple, and the test is beige with a purple-brown stripe covering the median longitudinal suture of the ambulacra and interambulacra. After cleaning with bleach, the test is mottled green-grey.

*Habitat.* The specimens were found living in niches on the top of a living, shallow coral reef at Buena Ventura, Panama. Most of the specimens were associated with the leaf coral *Agaricia agaricites* (Fig. 4). The gut of one specimen was filled with small grey-green spheres, most of which were of unrecognizable origin. These urchins probably graze on algae and encrusting organisms of the reef. There was no evidence that they were feeding on coral. Unlike *L. variegatus* (and most other toxopneustid echinoids), *L. williamsi* does not cover itself with bottom debris.

The specimens collected in December began to spawn when placed in alcohol, which might indicate a winter spawning season. Moore *et al.* (1963), however, found that *L. variegatus* may spawn to some degree during the entire year.

*Relationships.* *L. williamsi* lives in the same depth range as *L. variegatus* and in a portion of its geographic distribution. Specimens of *L. variegatus* can be found in the grass areas at Buena Ventura. Although occasionally found on rocky areas or on soft sediments, *L. variegatus* normally occurs in grass areas (Moore *et al.* 1963; personal observations), while *L. williamsi* appears to be distributed only on living reef areas.

The new species differs from *L. variegatus* in several features, the most obvious of which is the number of wedges per primary interambulacral spine, which averages 12.34 in the former and 24.14 in the latter (Fig. 3b, Tables 1 and 2). The relative size of the apical system and peristome is greater in the new species than in *L. variegatus*. The number of plates per ambulacral or IA series is much greater in *L. variegatus* than in *L. williamsi* (Fig. 5). Jackson (1912, 1914), after examining 1,443 specimens of *L. variegatus*, found none with all oculars exsert, whereas all of the specimens of the new species have every ocular exsert.

*L. williamsi* can be separated from the two remaining, relatively deep-water, Atlantic species on the basis of the number of plates per series, the tuberculation, the coloring, and the spicules of the globiferous pedicellariae. *L. euerces* and *L. callipeplus* do not have naked areas in the median ambulacral and interambulacral area; the secondary tubercles are irregularly scattered on the test and are almost the same size as the poorly-developed primary tubercles. Whereas the spicules of the globiferous pedicellariae are dumbbell-shaped in *L. williamsi* and *L. callipeplus*, they are C-shaped in *L. euerces*. The naked test of *L. callipeplus* has red blotches on the dorsal side, which the new species lacks.

*L. williamsi* is most closely allied to *L. panamensis* of the Bay of Panama. It differs from that species, however, in having fewer IA and ambulacral plates (Fig. 5). In addition, the pedicellariae of *L. panamensis* are brown, whereas they are purple in *L. williamsi*. Ocular I is normally insert in *L. panamensis* and exsert in the new species, and the milled ring of the primary spines is well developed in *L. panamensis* and almost absent in the new species. The other Pacific species are separated from the new species in the following key.

## KEY TO THE SPECIES OF THE GENUS

*LYTECHINUS*

1. Secondary tuberculation poorly developed, leaving a naked median area in the aboral portion of the ambulacra and interambulacra; primary tubercles large .....3  
 Secondary tuberculation scattered irregularly over the test, no naked areas, primary tubercles small ..... 2
2. Large, red blotches dorsally on the cleaned test, spicules of globiferous pedicellariae dumbbell shaped (Caribbean, Gulf of Guinea, deep water) .....*L. callipeplus*  
 Test and spines white, spicules C-shaped (Caribbean, deep water) ....  
 .....*L. euerces*
3. Spicules of globiferous pedicellariae C-shaped (California) ...*L. pictus*  
 Spicules dumbbell-shaped .....4
4. Primary IA spines from above ambitus with less than 16 wedges ....5  
 Spines with more than 16 wedges .....6
5. Adults with less than 14 IA plates per series, pedicellariae purple (Atlantic coast of Panama) .....*L. williamsi*  
 Adults with more than 14 IA plates per series, pedicellariae brown (Bay of Panama) .....*L. panameensis*
6. Ambital spines much longer than other primaries, producing a fringe; test low, mottled with purple (California) .....*L. auamensis*  
 Spines more or less uniform in size .....7
7. Naked IA area granular, with a row of small tubercles along the horizontal sutures, pedicellariae purple, covering naked area (Galapagos, N.W. coast of South America) .....*L. semituberculatus*  
 Naked IA area not pronounced, smooth, pedicellariae white, confined to tuberculated areas .....8
8. Test green, mottled with white, spines green or tinged with purple (Brazil, West Indies) .....*L. variegatus typicus*  
 Test not greenish or whitish .....9
9. Buccal membrane not densely plated outside buccal plates (Cape Verde Islands, Africa) .....*L. variegatus pallidus*  
 Membrane heavily plated .....10
10. Spines slender, dark purple (Bermuda) .....*L. variegatus atlanticus*  
 Spines reddish, stout (U.S. east coast) .....*L. variegatus carolinus*

TABLE 1

*L. williamsi*: equations for regression lines from plots of taxonomic features of the test.

Apical system (V-2 ax's, in mm):

$$\text{LnY} = 0.8162\text{LnX} - 0.7688 \quad S_{Y.X} = 0.056 \quad r = 0.89243$$

Peristome (V-2 axis, in mm):

$$\text{LnY} = 0.7306\text{LnX} + 0.0646 \quad S_{Y.X} = 0.025 \quad r = 0.97049$$

Interambulacral plates per series:

$$\text{LnY} = 0.3832\text{LnX} + 1.3117 \quad S_{Y.X} = 0.039 \quad r = 0.80026$$

Ambulacral plates per series:

$$\text{LnY} = 0.7321\text{LnX} + 0.5368 \quad S_{Y.X} = 0.038 \quad r = 0.93362$$

Number of wedges per IA spine from above the ambitus (N = 250):

$$\text{Mean} = 12.34, \text{S.D.} = 0.7683, \text{C.V.} = 6.21$$

TABLE 2

*L. variegatus*: equations for regression lines from plots of taxonomic features of the test.

Apical system (V-2 axis, in mm):

$$\text{LnY} = 0.7245\text{LnX} - 0.7219 \quad S_{Y.X} = 0.081 \quad r = 0.97798$$

Peristome (V-2 axis, in mm):

$$\text{LnY} = 0.8247\text{LnX} - 0.3291 \quad S_{Y.X} = 0.043 \quad r = 0.99107$$

Interambulacral plates per series:

$$\text{LnY} = 0.3916\text{LnX} + 1.6275 \quad S_{Y.X} = 0.042 \quad r = 0.97057$$

Ambulacral plates per series:

$$\text{LnY} = 0.5397\text{LnX} + 1.4525 \quad S_{Y.X} = 0.037 \quad r = 0.99248$$

Number of wedges per IA spine from above the ambitus (N = 500):

$$\text{Mean} = 24.14, \text{S.D.} = 1.7924, \text{C.V.} = 7.4$$

TABLE 3

Material of *L. variegatus* examined.

<i>M.C.Z. No.</i>	<i>Locality</i>	<i>Size (HD in mm)</i>	<i>Number</i>
8179	Near Canal, Panama	21 to 39.6	3
—	Buena Ventura, Panama	22 to 27	2
1252	Bahia, Brazil	10 to 41.5	5
3346	Bahia, Brazil	41.5	1
7412	Pigeon Pt., Tobago	30	1
8042	Banes Bay, Cuba	15 to 33	2
5070	Jamaica	26.5	1
—	Santa Marta, Columbia	34.3	1
7939	Cedar Key, N.W. Florida	16 to 30.2	3
4444	Tortugas, Florida	5.5 to 63	5
1281	Beaufort, North Carolina	21.5	1
3340	Bermuda	26	1

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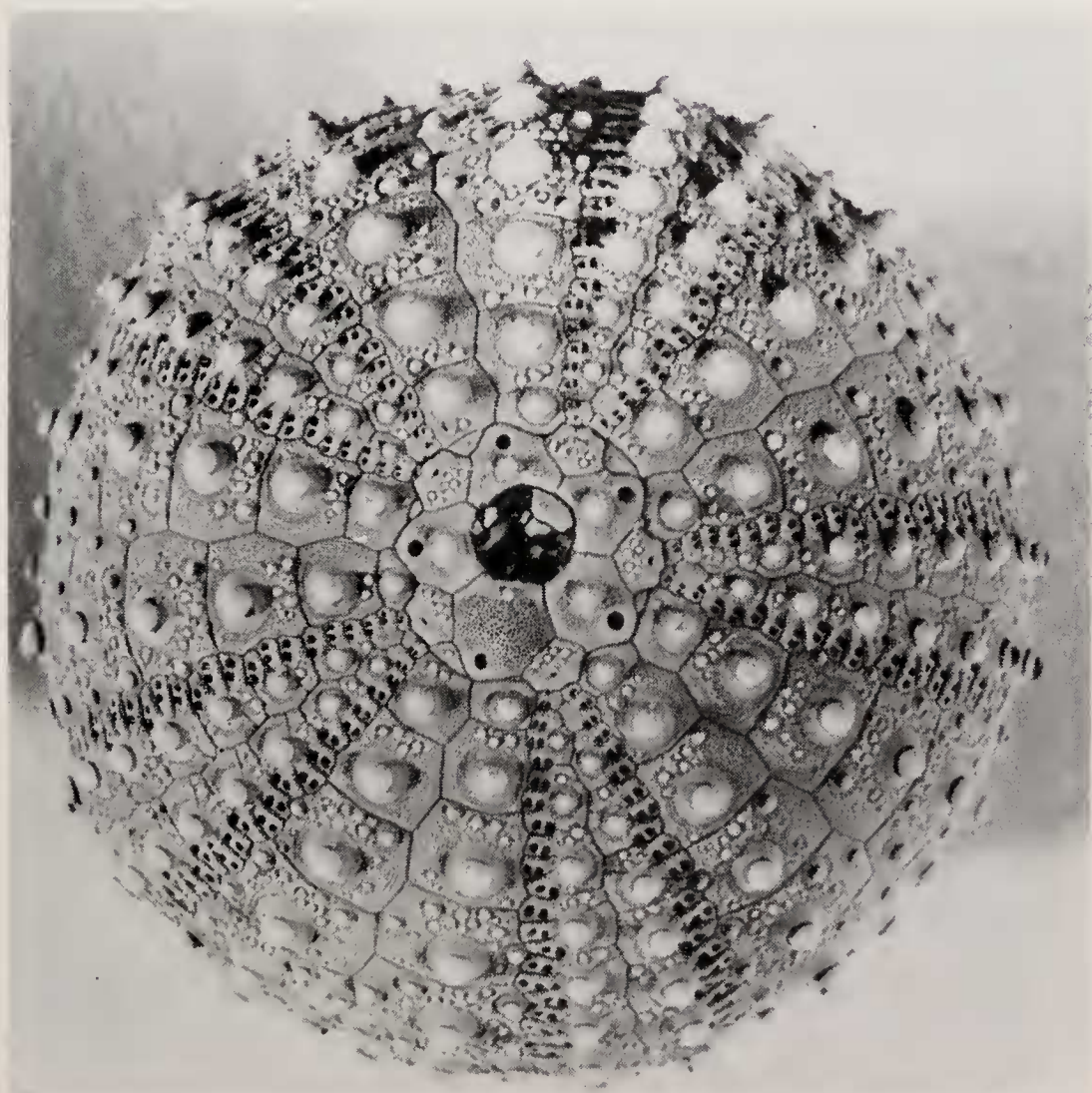


Figure 1. Dorsal view of *L. williamsi* (Paratype, 23 mm HD).

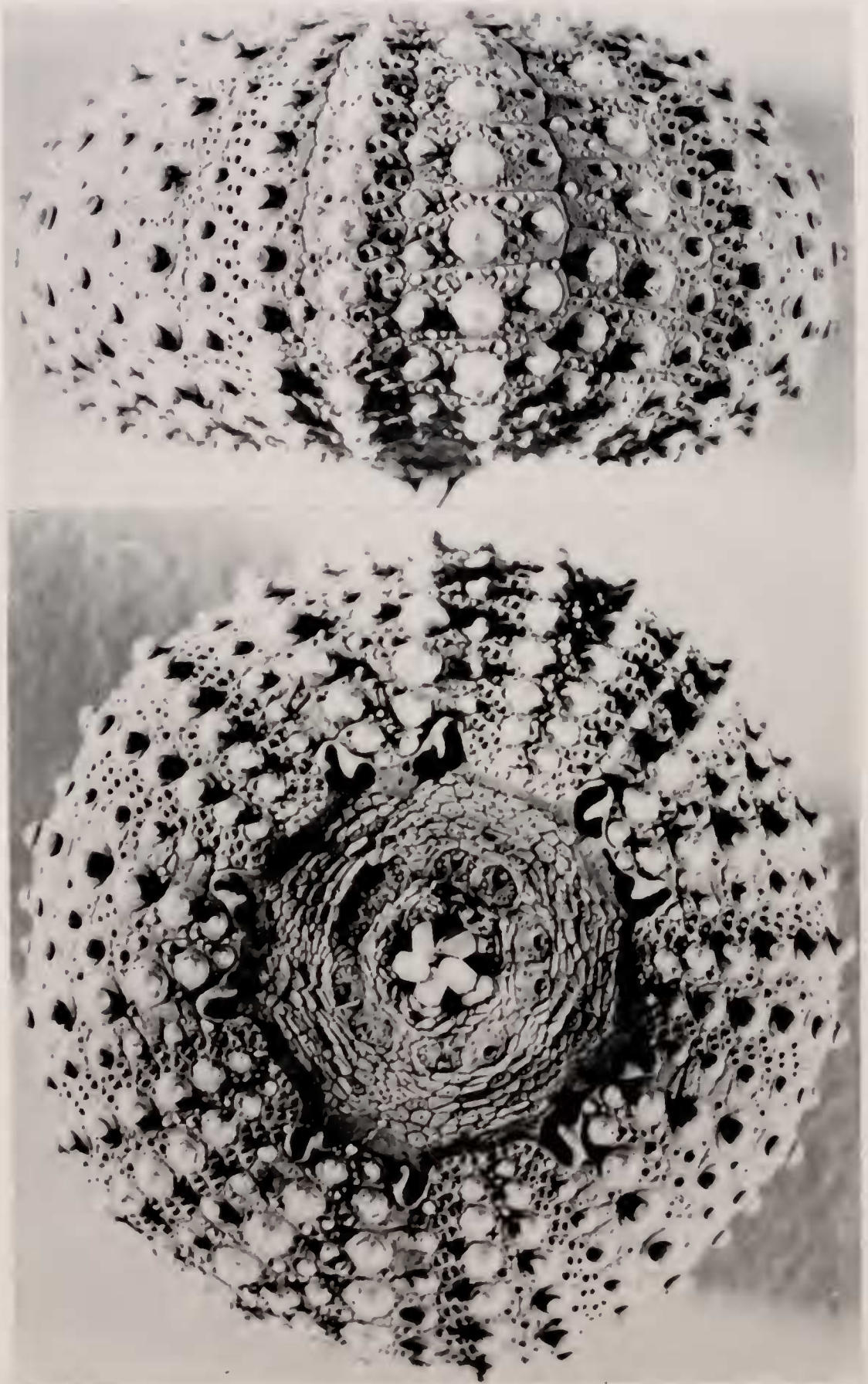


Figure 2. Lateral and ventral view of *L. williamsi* (Paratype, 23 mm HD).

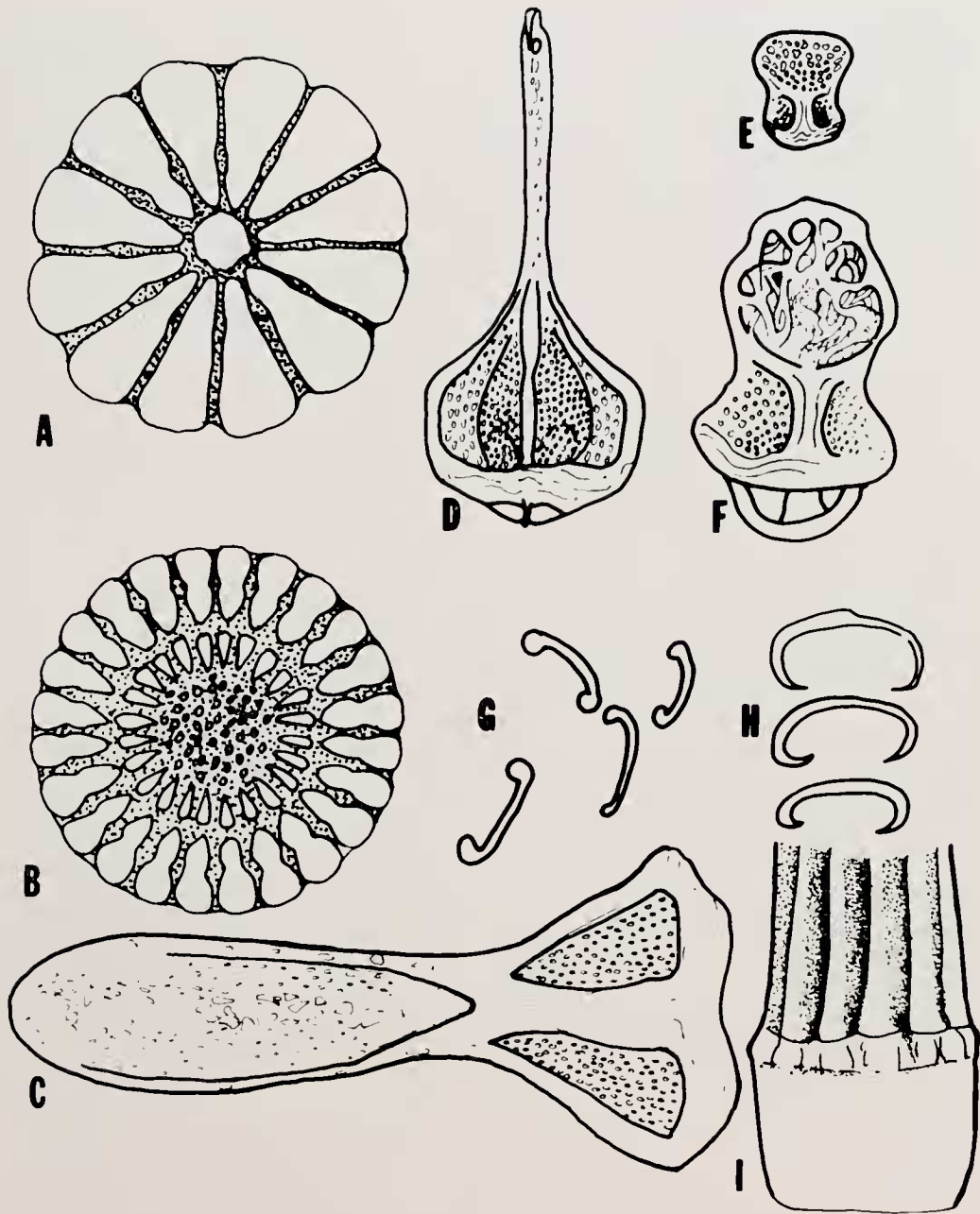


Figure 3. Spines, spicules, and pedicellariae of *L. williamsii*: A, cross-section of a primary interambulacral spine 0.7 mm in diameter; B, the same, from *L. variegatus* 0.65 mm in diameter; C, valve of a tridentate pedicellaria 1.09 mm long; D, valve of globiferous pedicellaria 0.8 mm long; E, valve of triphylous pedicellaria 0.155 mm long; F, valve of ophicephalous pedicellaria 0.55 mm long; G, spicules of globiferous pedicellaria 0.04 mm long; H, spicules of the tube feet 0.04 to 0.047 mm long; I, base of a primary spine, 0.8 mm in diameter.



Figure 4. Underwater photograph of *L. williamsi* at the base of some leaf coral (*Agaricia agaricites*).

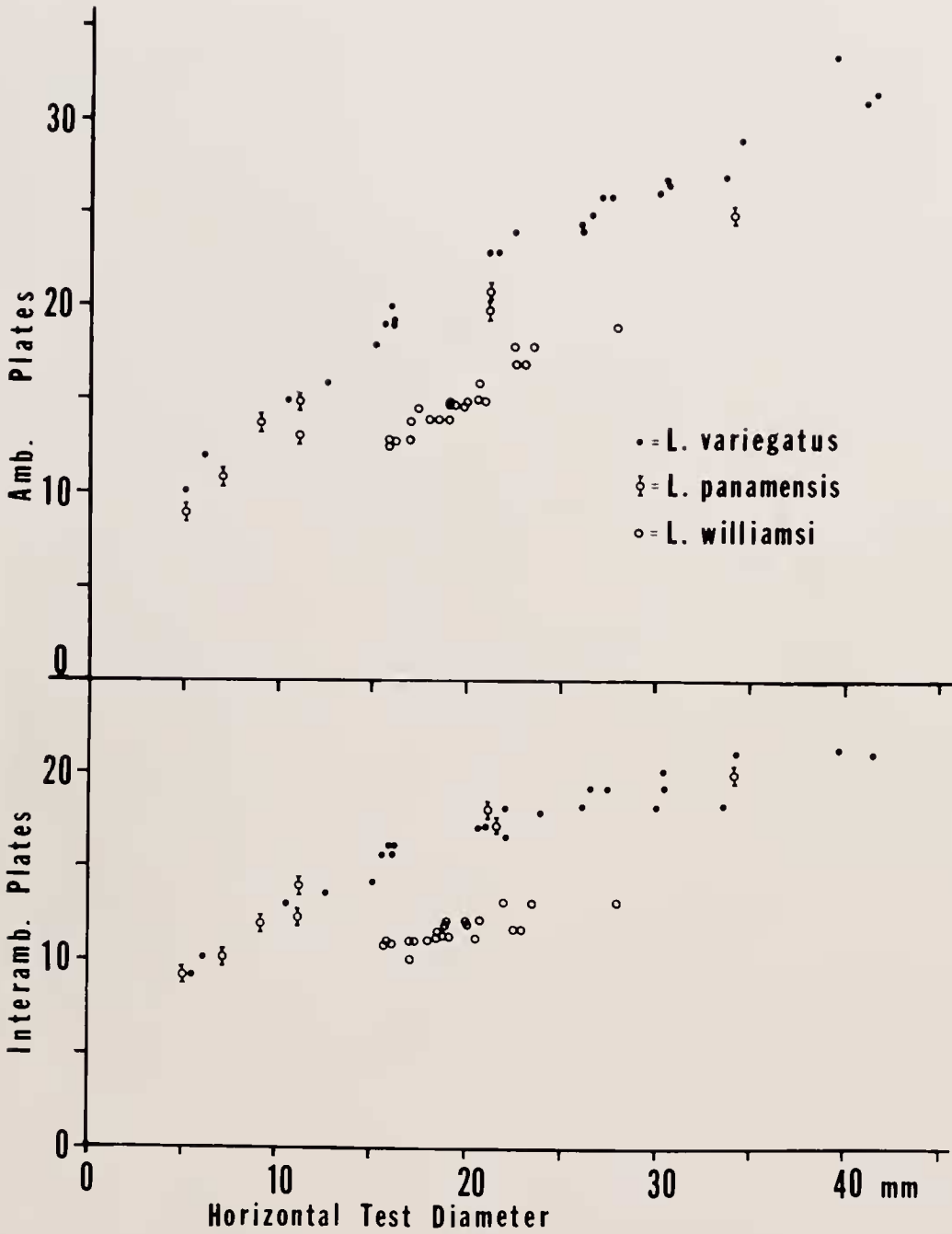


Figure 5. The number of plates in an ambulacral plate-series and an interambulacral plate-series for *L. williamsi*, *L. variegatus*, and *L. panamensis*.