

A REVIEW OF CARIBBEAN ACANTHOCHITONIDAE (MOLLUSCA: POLYPLACOPHORA) WITH DESCRIPTIONS OF SIX NEW SPECIES OF ACANTHOCHITONA GRAY, 1821

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ABSTRACT

Nine previously described species of Acanthochitonidae are recognized in the region between Bermuda and the Caribbean coast of South America: *Acanthochitona andersoni* Watters, 1981; *A. astrigera* (Reeve, 1847); *A. balesae* Abbott, 1954 (+ *A. elongata* and *A. interfissa*, both Kaas, 1972); *A. bonairensis* Kaas, 1972; *A. hemphilli* (Pilsbry, 1893); *A. pygmaea* (Pilsbry, 1893); *A. rhodea* (Pilsbry, 1893); *Choneplax lata* (Guilding, 1829); *Cryptoconchus floridanus* (Dall, 1889). Four new species (*Acanthochitona lineata*, *A. roseojugum*, *A. worsfoldi*, and *A. zebra*) are described from Florida, the Bahama Islands and the northern Caribbean; *Acanthochitona venezuelana* sp. nov. is described from Margarita Id., Venezuela; *Acanthochitona ferreirai* sp. nov. is described from Pacific coasts of Panama and Costa Rica. No subsequently collected specimens were seen of *Acanthochitona spiculosa* (Reeve, 1847), originally described from the West Indies; *A. spiculosa* is considered a *species inquirenda*.

Until recently, seven species of Acanthochitonidae generally were recognized in the Caribbean region (Bermuda, Florida, and the Bahama Islands to the north coast of South America): *Acanthochitona spiculosa* (Reeve, 1847) [+ *A. astriger* (Reeve, 1847)]; *A. hemphilli* (Pilsbry, 1893); *A. pygmaea* (Pilsbry, 1893); *A. rhodea* (Pilsbry, 1893); *A. balesae* 'Pilsbry' Abbott, 1954; *Choneplax lata* (Guilding, 1829); *Cryptoconchus floridanus* (Dall, 1889). In 1972, P. Kaas published a monograph on the Polyplacophora of the Caribbean region. In his treatment of Cryptoplacidae (= Acanthochitonidae), Kaas (1972) proposed *A. elongata* to replace *A. balesae* 'Pilsbry', recognized as valid the other six species, and described two new species, *A. bonairensis* and *A. interfissa*, increasing to nine the number recognized from the region. Kaas was followed by G. T. Watters' (1981) review of New World *Acanthochitona*, in which he declared *A. astriger* to be separate from *A. spiculosa*, assigned *A. pygmaea* to the synonymy of *A. spiculosa*, assigned *A. rhodea* to the synonymy of *A. hemphilli*, resurrected *A. balesae* Abbott, with synonyms *A. elongata* and *A. interfissa*, declared *A. bonairensis* to be a synonym of the European *A. communis* (Risso, 1826), and described a new species, *A. andersoni*. As a result, the number of recognized Caribbean species of Acanthochitonidae was reduced to eight.

In a report on the Polyplacophora of Barbados published four years later, A. J. Ferreira (1985) proposed addi-

tional changes in the classification of Caribbean Acanthochitonidae. Ferreira recognized *Acanthochitona astrigera*, *A. spiculosa*, *A. bonairensis*, and *Cryptoconchus floridanus*, reversed Watters' action by assigning *A. hemphilli* to the synonymy of *A. rhodea*, and declared *A. andersoni*, *A. balesae*, and *A. interfissa* to be juveniles, and thus synonyms, of *Choneplax lata*. Six recognized species of Caribbean Acanthochitonidae remained.

In this report, I present new conclusions based upon examination of type specimens of *Acanthochitona andersoni*, *A. astrigera*, *A. bonairensis*, *A. hemphilli*, *A. interfissa*, *A. pygmaea*, *A. rhodea*, and *A. spiculosa*. I have relied extensively on specimens in the collection of the Florida Department of Natural Resources (FDNR) and in the research collection of Dr. R. C. Bullock, University of Rhode Island. I also re-examined many museum specimens utilized previously by Kaas (1972), Watters (1981), and Ferreira (1985). After Dr. Ferreira's death in 1986, his collection was transferred to the California Academy of Sciences. Unfortunately, only the dry collection could be inspected during 1987.

Nine previously named species and five new species of Acanthochitonidae that occur in the Caribbean region are described and illustrated. Relationships between Caribbean species and their eastern Pacific cognate species are discussed, and one eastern Pacific cognate species is described as new.

METHODS

Complete species treatments should provide full descriptions and illustrations of valves, spicules and radulae. Examinations of spicules and radulae of taxa treated here are still in progress and so cannot be presented. Instead, this report presents conclusions derived principally from characters of the valves, with less emphasis on girdle spicules and no information on radulae. Descriptions, illustrations, and differential diagnostic comments are provided for all of the species. Characters described include general dimensions, color, shape of the jugum, tegmentum, sutural laminae, and insertion plates, tegmental pustule morphology, and counts and measurements of girdle spicules. Species are illustrated with SEM photographs of valves and tegmental pustules as well as with photographs of intact specimens.

Tegmental pustules are illustrated in near-perpendicular aspect from anterolateral portions of left or right sides of intermediate valves, depending upon specimen condition. As shown in illustrations of entire valves, pustules usually are arranged in rows parallel to the jugum, but individual pustules are aligned anterolaterally, so pustular apices point posterolaterally toward the jugum.

Longitudinal lines or incisions on the jugum are mentioned often in descriptions of *Acanthochitona*. In fact, lines are visible within the jugum of nearly all species examined, but lines at the surface are uncommon. Careful examination in most instances reveals that such lines are internal and do not interrupt the jugal surface. Whether the surface is smooth or incised can be ascertained by using scanning electron microscopy or, with light microscopy, by using high magnification with light directed obliquely at a low angle across the short axis of the jugum.

Measurements of small intact specimens, individual valves, and girdle spicules were made using a Zeiss IV-B dissecting microscope with ocular micrometer. Dimensions of tegmental pustules were measured from scanning electron micrographs of known magnification. Large intact specimens were measured with vernier calipers. Most specimens were flat when preserved, so measurements are accurate to 0.1 mm. Lengths of slightly curled specimens were determined by making several incremental linear measurements along the longitudinal curve; those lengths are accurate to about 0.5 mm. Extremely curled specimens were not measured. Data presented for individual species lots include number of specimens, size range (total length), location, depth, date of collection, and museum catalogue number.

Specimens were examined from or deposited in the following institutional collections: Academy of Natural Sciences of Philadelphia, Pennsylvania (ANSP); British Museum (Natural History), London [BM(NH)]; California Academy of Sciences, San Francisco (CAS); Delaware Museum of Natural History, Wilmington (DMNH); Florida Department of Natural Resources, Bureau of Marine Research, St. Petersburg (FSBC I); Indian River Coastal Zone Museum, Harbor Branch Oceanographic Institution, Ft. Pierce, Florida (IRCZM); Rijksmuseum van Natuurlijke Historie, Leiden (RMNH); Tulane University Department of

Geology, New Orleans (TUDG); and the National Museum of Natural History, Smithsonian Institution, Washington, D. C. (USNM).

SYSTEMATIC ACCOUNTS

Family Acanthochitonidae Pilsbry, 1893

Genus *Acanthochitona* Gray, 1821

Acanthochitona hemphilli (Pilsbry, 1893)

Figs. 1-9

Acanthochites (*Notoplax*) *hemphilli* Pilsbry, 1893: 34, 35, pl. 13, figs. 65-67.

Acanthochitona hemphilli, Kaas, 1972: 38-41, figs. 58-64, pl. 2, figs. 1, 2 (pars). Watters, 1981: 173 (pars).

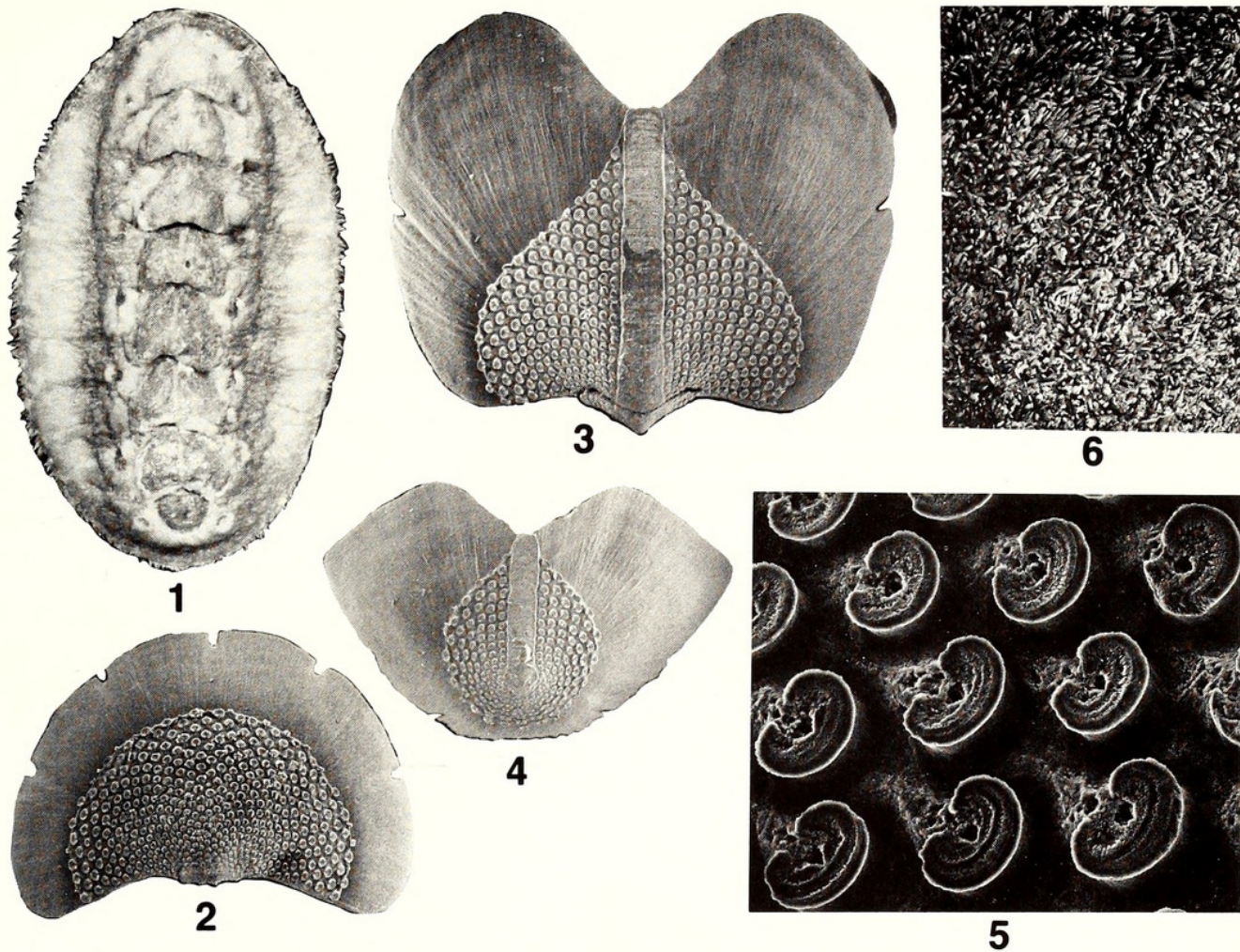
Acanthochitona rhodea, Ferreira, 1985: 207, 208 (pars) [*non* *A. rhodea* (Pilsbry, 1893)].

TYPE MATERIAL: LECTOTYPE: $\approx$ 24 mm, partially disarticulated; Key West; ANSP 35803 (herein designated).

OTHER MATERIAL EXAMINED: FLORIDA: 3 spec., 33.4-34.5 mm, Long Key Reef, Dry Tortugas, intertidal, 11-12 May 1979, FSBC I 32042. —1 spec., 13.0 mm, patch reef near Long Key Reef, 1.5-2.5 m, 11 May 1979, FSBC I 32428. —2 spec., 33.5, 38.4 mm, Bird Key Reef, Dry Tortugas, 0.5-1.0 m, 4 Oct 1979, FSBC I 32044. —8 spec., 23.8-44.2 mm, Garden Key, Dry Tortugas, 1-2 m, 13 May 1979, FSBC I 32043. —6 spec., 15.2-44.1 mm, Garden Key, 0-2 m, 5 Oct 1979, FSBC I 32045. —1 spec., 29.3 mm, Sand Key off Key West, 0.5-2.0 m, 3 Aug 1980, FSBC I 32046. —2 spec., 30.0-36.2 mm, Western Sambo Reef off Key West, 4.2-7.3 m, 12-21 Mar 1973, FSBC I 9397. —1 spec., 50.9 mm, off Pompano Beach, southeast Florida, 18.3 m, 1981, FSBC I 32429. BAHAMAS: 27 spec., 10.0-51.3 mm, Bahama Beach Canal, West End, Grand Bahama, intertidal, 29 Aug 1984, FSBC I 32049. —5 valves, Gold Rock, Grand Bahama, bottom sediments, 24.4 m, May-July 1981, FSBC I 32519. —14 spec., 8.0-37.5 mm, McLeanstown, east end Grand Bahama, 1-2 m, 24 May 1981, FSBC I 32047. —19 spec., 4.5-47.0 mm, McLeanstown, 1 m, 27 Aug 1984, FSBC I 32048. —8 valves, Grand Bahama, bottom sediments, May 1981, R. Quigley collection. —11 spec., 30.5-47.6 mm, Harbour Id., Eleuthera, 0-3 m, 24 Aug 1978, FSBC I 32041. —3 spec., 23.8-41.9 mm, Fernandez Bay, Cat Island, 3 m, 10-16 July 1976, FSBC I 15804. —1 spec., curled, Georgetown, Great Exuma, 0-1 m, 21 June 1974, FSBC I 32518. TURKS AND CAICOS ISLANDS: 8 spec., 11.1-51.3 mm, Providenciales, 0-2 m, 22 Sept 1986, FSBC I 32430. PUERTO RICO: 2 spec., 38.8, 41.6 mm, Cayo Enrique, La Parguera, 0-1 m, 19 Aug 1985, FSBC I 32050. —8 spec., 15.2-32.1 mm, Magueyes Id., La Parguera, 20 Apr 1966, Bullock collection. JAMAICA: 1 spec., 30.8 mm, 3 km west of Runaway Bay, 0-1.5 m, 3 Nov 1983, Bullock collection. CAYMAN ISLANDS: 1 spec., 35.8 mm, Grand Cayman, 1965, FSBC I 5549. BELIZE: 2 spec., curled, Carrie Bow Cay, 8 m, 21-24 Oct 1973, FSBC I 10765. —8 spec., curled, Carrie Bow Cay, 23 Mar 1981, IRCZM 61:050. HONDURAS: 2 spec., 22.6, 34.5 mm, Anthonys Key, Roatan, 4-10 July 1971, Bullock collection. —13 spec., all curled, Oak Ridge, Roatan, intertidal, Mar 1987, FSBC I 32431. —5 spec., 24.0-32.1 mm, Roatan, 1981, FSBC I 32520.

TYPE LOCALITY: Key West, Florida (original designation).

DISTRIBUTION: South Florida and Grand Bahama Island to Puerto Rico, Jamaica, and Honduras; intertidal to 18 m.



Figs. 1-6. *Acanthochitona hemphilli* (Pilsbry, 1893). **Fig. 1.** Whole specimen, 42.6 mm; Harbour Id., Eleuthera, Bahamas; FSBC I 32041. **Fig. 2.** Valve i ex 15.2 mm specimen; Dry Tortugas, Florida; FSBC I 32045. **Fig. 3.** Valve iv, same specimen. **Fig. 4.** Valve viii, same specimen. **Fig. 5.** Tegmental pustules, valve v, 16.7 mm specimen; same lot (field width = 330 μ m). **Fig. 6.** Spicules of dorsal girdle mat, specimen from McLeanstown, Grand Bahama; FSBC I 32047 (field width = 500 μ m).

DESCRIPTION: Largest specimen 51.3 mm long, 28.0 mm wide including girdle; valves occupying about 30% of total specimen width (Fig. 1). Exposed parts of valves dark red with white maculations, small relative to total specimen size; unexposed valve parts greenish white. Girdle broad, fleshy, appearing smooth, dark brown, with few brown or reddish brown spicules in dorsal tufts; color of girdle and tufts sometimes faded in preserved material.

Valve i semilunate (Fig. 2), wider than long, beaked, sinuous posteriorly, with anterior insertion plate bearing 5 slits; tegmentum occupying about 65% total valve length. Valves ii-vii strongly beaked (Fig. 3); tegmentum spade-shaped, about as long as wide, strongly constricted anteriorly, with broadly sinuous anterolateral margins; sutural laminae broad, expanded anteriorly, with subparallel lateral margins rendering overall valve shape nearly quadrate except for broad, shallow anterior sinus; single small narrow slits near midpoints of margins. Valve viii subtriangular (Fig. 4), rounded posteriorly, with elevated mucro posterior of center; tegmentum drop-shaped, longer than wide, constricted anteriorly; sutural laminae large, flared anterolaterally, with straight to sinuous anterior margins, separated by wide V-shaped sinus; 2 slits in posterior inser-

tion plate small, narrow, V-shaped.

Jugum smooth, narrow, with parallel sides well-separated from lateral tegmental surface. Tegmentum of all valves covered with small (35-50 μ m), round to ovate, cupped pustules with edges incised at apex to render overall appearance reniform (kidney-shaped) (Fig. 5), with single central macresthete, 2-3 micresthetes.

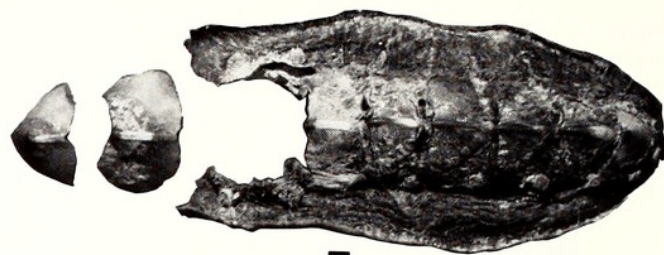
Girdle upper surface appearing smooth, actually covered with dense mat of very small (50 μ m) slender, sharp, brown spicules (Fig. 6); 18 anterior and sutural dorsal tufts with about 50 thick, reddish-brown to white, flat-sided spicules, longest 1.5-2.0 mm; slender, needle-like, sharp spicules interspersed among larger spicules of tufts; margin with dense fringe of straight, slender, brown and white spicules 1.0-1.5 mm long; underside covered with small (50 μ m) slender, sharp, white spicules directed toward periphery.

DISCUSSION: *Acanthochites hemphilli* Pilsbry, 1893, was described from a specimen collected at Key West, Florida, and the name generally has been applied to the large (> 50 mm) fleshy species that occurs in south Florida, the Bahama Islands, and the northern Caribbean Sea. *A. rhodeus*

Pilsbry, 1893, was described from a specimen bearing only the data "Panama (McNeill Expedition)", prompting subsequent question as to whether *A. rhodea* properly belonged to the Caribbean fauna, the eastern Pacific fauna, or perhaps to both. Leloup (1941) reported specimens of *Acanthochiton rhodeus* from off Cabo la Vela, Caribbean Colombia, and provided additional descriptive notes for the species. Keen (1958) listed *Acanthochitona rhodea* in her compendium of mollusks from the eastern Pacific but noted that the species might belong to the Caribbean rather than the Panamic fauna. A. G. Smith (1961) seemed to confirm the presence of *A. rhodea* in the eastern Pacific when he contrasted its characters with those of *A. tabogensis* Smith, 1961, and *A. hirundiniformis* (= *hirundiniformis*) (Sowerby, 1832), two other species from that region. The name again appeared on a list of Caribbean fauna in Houbbrick's (1968) account of species from Costa Rica. Thorpe (*In* Keen, 1971) illustrated a specimen identified as *A. rhodea* and listed its range as Mexico (Pacific Ocean) to Peru. Kaas (1972) summarized descriptions by Pilsbry and by Leloup and treated the species as a member of the Caribbean fauna. The species again was illustrated and reported from Caribbean Colombia by Götting (1973). Watters (1981) relegated *A. rhodea* to the synonymy of *A. hemphilli* without discussion of morphological characters or geographic range, only to be followed soon thereafter by Ferreira (1985) who declared *A. hemphilli* to be a synonym of *A. rhodea*, citing page priority of the original descriptions. Ferreira concluded that the complex constituted a single species ranging from Florida and the Bahamas to Brazil in the western Atlantic Ocean and from Mexico to Peru in the eastern Pacific Ocean. Examination of type-specimens of both species, as well as additional materials from Florida, the Bahama Islands, several localities in the northern Caribbean, the Caribbean coast of Central America, and the Pacific coasts of Costa Rica and Panama, indicates that the complex actually consists of three species, including one previously undescribed.

One of Pilsbry's specimens (ANSP 35803) is herein designated as lectotype of *Acanthochites hemphilli* Pilsbry, 1893. Pilsbry described a dried specimen 24 mm in length. The lectotype measures about 24 mm overall and is partially disarticulated (Fig. 7); valves i-vi remain attached to the girdle, but valves vii and viii are free. Pilsbry described the posterior valve viii as "...not bilobed behind, having the usual two slits, and between them a number (6-8) of smaller, irregular and unequal slits or nicks". That this is the specimen described by Pilsbry is confirmed by the condition of valve viii, which is aberrant. The valve has two slits in the usual positions (Fig. 8), but one slit is unusually large and wide, whereas the other is unusually small and narrow; the reported irregularities are also present.

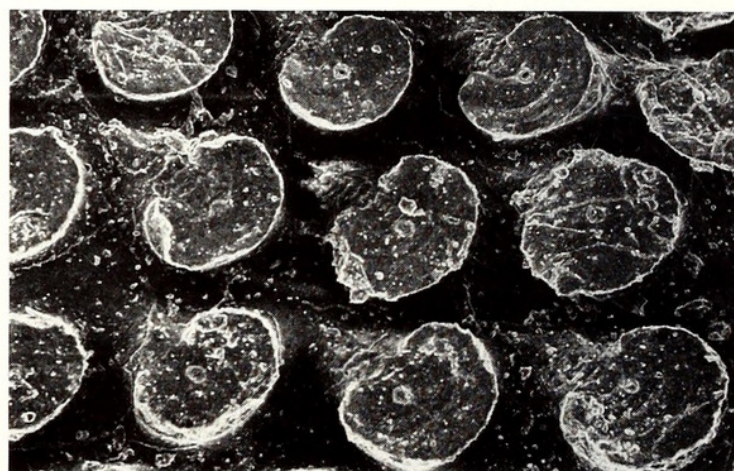
Asymmetrical tail valves are not unusual in *Acanthochitona*; several valves viii of *A. astrigera* which I examined were misshapen, some completely lacking one of the posterior slits. All other characters of the lectotype, including the reniform tegmental pustules (Fig. 9), indicate the specimen to be conspecific with material reported here as *A. hemphilli*. The reniform pustules, "smooth" girdle, greenish white sutural laminae, and subquadrate, parallel-sided intermediate valves



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Figs. 7-9. *Acanthochitona hemphilli* (Pilsbry, 1893), lectotype; Key West, Florida; ANSP 35803. Fig. 7. Whole specimen. Fig. 8. Valve viii, ventral. Fig. 9. Tegmental pustules, valve vii (field width = 345 μ m).

distinguish *A. hemphilli* from *A. rhodea* and from the new species.

Acanthochitona hemphilli now is demonstrated to occur from southeast Florida and the northern Bahama Islands southward to Puerto Rico, Jamaica, Belize, and Honduras. Specimens reported from Cuba (Jaume and Sarasúa, 1943) and Caribbean Mexico (Vokes and Vokes, 1983) are probably referable to this species, whereas those reported from Caribbean Panama (Olsson and McGinty, 1958) almost certainly are *A. rhodea* (see that species account). Specimens illustrated by Kaas (1972: pl. 2, figs. 1, 2) from Curaçao as *A. hemphilli* are *A. rhodea*. Other reports of *A. hemphilli* from Barbados, Bonaire, and Venezuela (Ferreira, 1985) and Aruba (Kaas, 1972) could also represent *A. rhodea*. Records by Righi (1971) of *A. hemphilli* in Brazil seem especially unlikely

because the specimens were collected in 47-115 m depths, far deeper than the 18 m maximum depth otherwise known for the species.

***Acanthochitona rhodea* (Pilsbry, 1893)**

Figs. 10-18

Acanthochites rhodeus Pilsbry, 1893: 26, 27, pl. 12, figs. 48-51.

Acanthochiton rhodeus, Leloup, 1941: 39-42, figs. 5-7.

Acanthochitona rhodea, Keen, 1958: 519 (pars). Kaas, 1972: 42, 43, figs. 65-71. Götting, 1973: 251-253, pl. 11, figs. 15, 16. Bullock, 1974: 164 (pars). Ferreira, 1985: 207, 208 (pars).

Acanthochitona rhodeus, Houbrick, 1968: 10, 20.

Acanthochitona hemphilli, Kaas, 1972: pl. 2, figs. 1, 2 (pars).

Watters, 1981: 173 (pars) [*non A. hemphilli* (Pilsbry)].

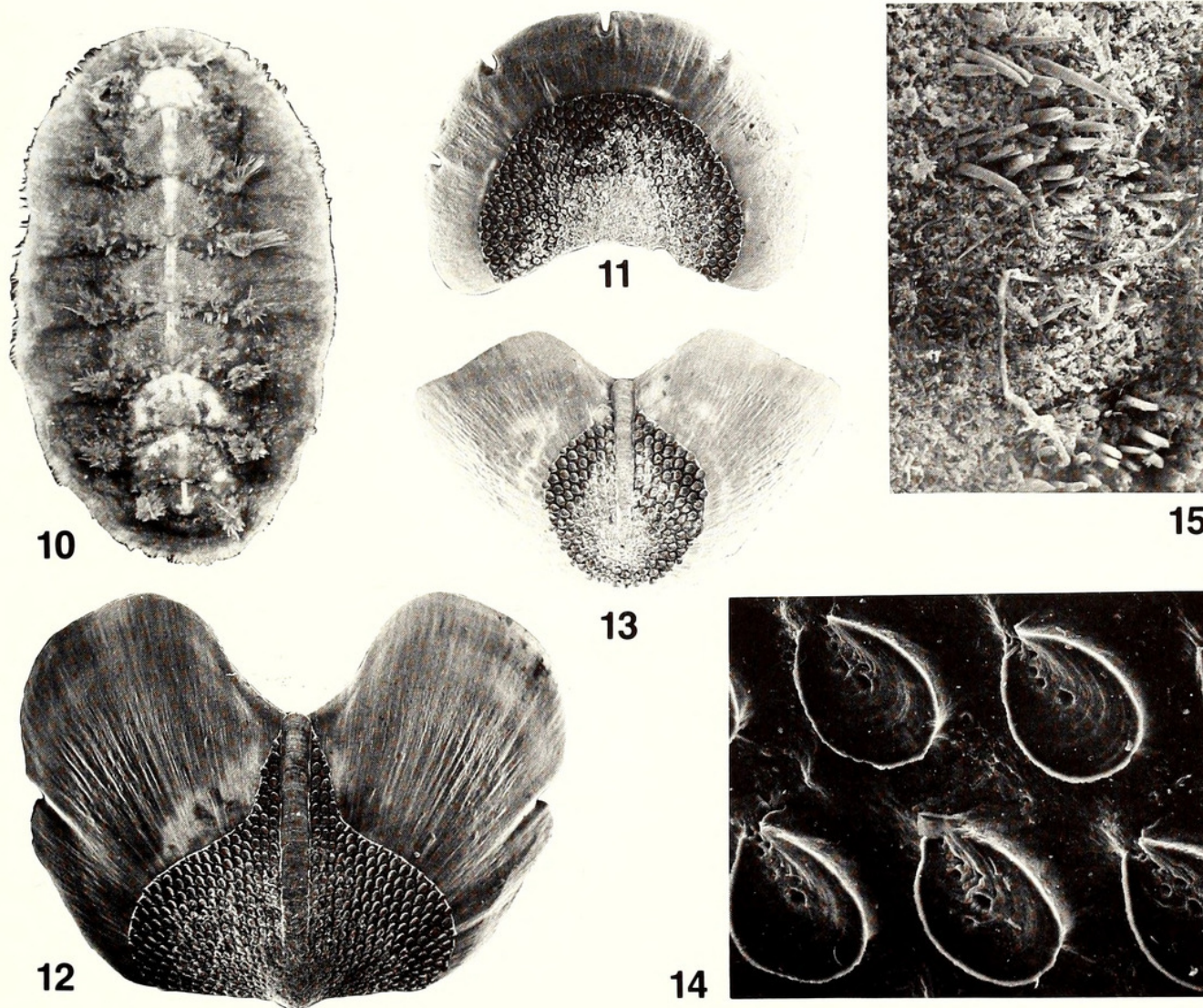
TYPE MATERIAL: HOLOTYPE: 3 disarticulated valves, "Panama; McNeill Exped.", ANSP 63429.

OTHER MATERIAL EXAMINED: COSTA RICA: 2 spec., both curled, Portete, Limon Prov., 12 June 1966, USNM 702874. PANAMA: 1 spec., curled, Toro Point, Ft. Sherman, Canal Zone, Sept 1969, Bullock collection. —4 spec., 6.5-27.0 mm, Ft. Randolph, Canal Zone, 1 m, Nov 1980, FSBC I 32530. —10 spec., 1.8-30.0 mm, Galeta Id., Canal Zone, Bullock collection. —20 spec., 19.7-32.5 mm, Galeta Id., Sept 1973, FSBC I 32562 (1), Bullock collection (19). —2 spec., 10.3, 25.1 mm, near Portobelo, 0-1 m, Nov 1980, FSBC I 32529. —2 spec., 12.0, 12.4 mm, Cocal Point, Portobelo, 13 Sept 1973, Bullock collection. —12 spec., 24.5-39.5 mm, Ironcastle Point, Portobelo, 13 Sept 1973, Bullock collection.

TYPE LOCALITY: Portobelo, Caribbean coast of Panama (by subsequent designation, Ferreira, 1985).

DISTRIBUTION: Caribbean coasts of Costa Rica, Panama, and Colombia; intertidal to 53 m.

DESCRIPTION: Largest specimen slightly curled, 39.5 mm long, 24.0 mm wide including girdle; valves occupying approximately 30% of total specimen width (Fig. 10). Exposed parts



Figs. 10-15. *Acanthochitona rhodea* (Pilsbry, 1893). **Fig. 10.** Whole specimen, 25.1 mm; Portobelo, Panama; FSBC I 32529. **Fig. 11.** Valve i ex 25.0 mm specimen; Galeta Id., Panama; FSBC I 32562. **Fig. 12.** Valve iv, same specimen. **Fig. 13.** Valve viii, same specimen. **Fig. 14.** Tegmental pustules, valve iv, same specimen (field width = 340 μ m). **Fig. 15.** Spicule clusters, dorsal girdle mat, same specimen (field width = 550 μ m).

of valves dark red with white maculations; unexposed parts dark red to plum. Girdle broad, fleshy, tan to dark reddish brown, appearing smooth but with very small clusters of short, stout, white spicules widely scattered on dorsal surface, especially where girdle intrudes between valves; long spicules in dorsal tufts reddish brown, shorter basal spicules of tufts blue-green.

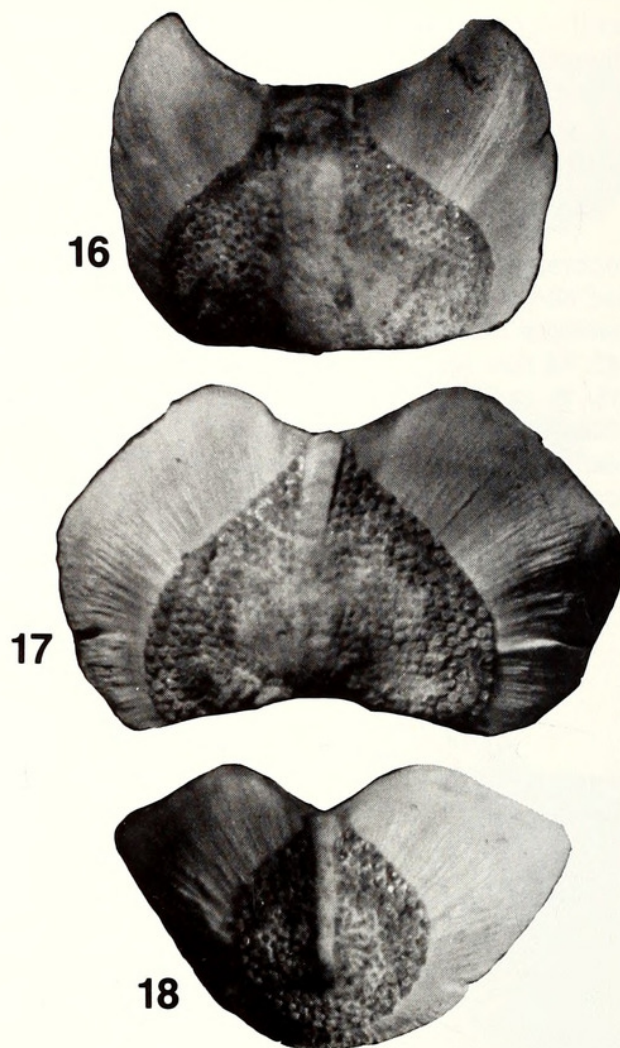
Valve i semilunate (Fig. 11), wider than long, concave posteriorly, with anterior insertion plate bearing 5 U-shaped slits; tegmentum occupying about 65% total valve length. Valves ii-vii beaked (Fig. 12); tegmentum alate (wing-shaped), little wider than long but constricted over much of anterior portion, with markedly concave anterolateral margins; sutural laminae very large, longer than wide, broad, flared anterolaterally, separated anteriorly by wide, deep, U-shaped sinus; lateral margins not parallel to each other or to jugum; single slits near midpoints of margins. Valve viii broadly triangular (Fig. 13), about twice as wide as long, rounded posteriorly, with mucro posterior of center; tegmentum drop-shaped, longer than wide, constricted anteriorly along jugum; sutural laminae very wide, flared anteriorly, separated by wide, V-shaped sinus, with straight anterior margins; 2 slits in posterior insertion plate small, narrow, V-shaped.

Jugum smooth, narrow, with parallel sides well-separated from lateral tegmental surface, extending anteriorly beyond main body of tegmentum. Tegmental pustules drop-shaped (Fig. 14), 120 μm long, 80 μm wide, with single central macrostethete, 3-6 microstethetes nearly all adapical of macrostethete.

Girdle upper surface covered with dense mat of very small (50 μm) brown spicules interrupted by clusters of stout, white, 200-400 μm long spicules (Fig. 15), clusters very sparse on main dorsal surface, dense where girdle intrudes between valves; 18 anterior and sutural tufts containing about 50 straight, stout, sharp-tipped spicules up to 2 mm long, brown along shafts, blue-green at base, with extremely fine, needle-like spicules within base; margin fringed with slender, straight or slightly curved, sharp-tipped blue or blue-green spicules up to 1.4 mm long; underside densely covered with slender, sharp-tipped spicules about 80 μm long, directed toward periphery.

DISCUSSION: Pilsbry (1983) described *Acanthochitona rhodea* from an alcoholic specimen 28 mm long, 15 mm wide, that had already "lost the cuticle and hairs from its girdle, leaving a smooth whitish surface pitted at the sutures." Thus, one important identification character, the girdle spicules, could not be described. Now all that remains of the holotype are three disarticulated valves, ii, vii(?), and viii (Figs. 16-18). Nevertheless, sufficient evidence remains in the drop-shaped pustules, well-illustrated by Pilsbry (1893: pl. 12, fig. 49), to demonstrate that *A. rhodea* is the species that inhabits the Caribbean coast of Panama. Thus, Ferreira's (1985) restriction of the type locality to Portobelo was appropriate.

Characters important in separating *Acanthochitona rhodea* from *A. hemphilli* include the drop-shaped rather than reniform pustules, the dark red rather than greenish white sutural laminae, and the small clusters of stout spicules widely scattered among the mat of shorter spicules on the dorsal



Figs. 16-18. *Acanthochitona rhodea* (Pilsbry, 1893), holotype; "Panama"; ANSP 63429. **Fig. 16.** Valve ii. **Fig. 17.** Valve vii (?). **Fig. 18.** Valve viii.

surface of the girdle. Differences between *A. rhodea* and the Pacific coast species are discussed under remarks following the description of that species.

Ferreira's (1985) distributional records of *Acanthochitona rhodea* are unreliable because he identified all three species as *A. rhodea*. Houbick's (1968) specimens from the Caribbean coast of Costa Rica, which I examined, are *A. rhodea*. Leloup's (1941) description and illustrations of drop-shaped tegmental pustules (his figs. 5, 6) and large spicules scattered in widely separated groups among the smaller spicules of the dorsal girdle surface demonstrate that his specimens from off Colombia in 28-29 fm (51-53 m) were *A. rhodea*. Scattered spicule clusters on the girdle and shapes of valves i, vii, and viii indicate that specimens illustrated as *A. hemphilli* from Curaçao by Kaas (1972) are *A. rhodea*. Likewise, Götting's (1973) illustration of scattered clusters of girdle spicules indicates that specimens he reported as *A. rhodea* from Caribbean Colombia were identified correctly. Thus, the species is known with certainty only from the southern Caribbean Sea, where it usually is collected in the shallow subtidal zone.

***Acanthochitona ferreirai* Lyons, sp. nov.**

Figs. 19-24

Acanthochitona rhodea, Keen, 1958: 519, fig. 10 (pars). A. G. Smith, 1961: 89. Thorpe *In* Keen, 1971: 867, 868, fig. 14. Bullock, 1974: 164 (pars). Ferreira, 1985: 207, 208 (pars). [*non A. rhodea* (Pilsbry, 1893)].

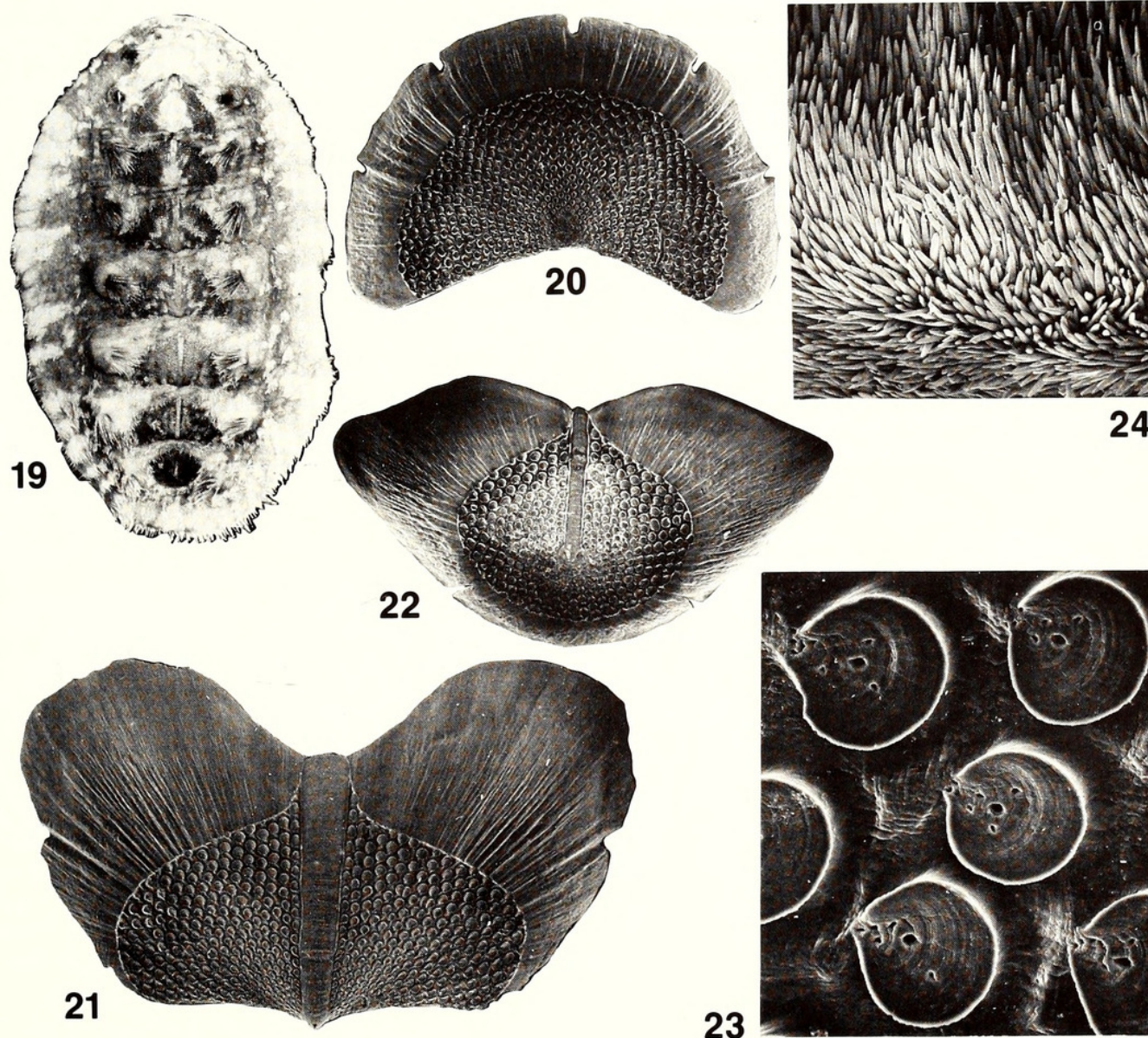
TYPE MATERIAL: HOLOTYPE: 28.2 mm, Punta Mala, Pacific coast of Panama, July 1969, R. C. Bullock, collector, USNM 859314. PARATYPES: PANAMA: 13 spec., 9.4-28.2 mm, collected with holotype, ANSP A12121 (1), CAS 064883 (1), RMNH 55985 (1), FSBC I 32563 (2), Bullock collection (8). COSTA RICA: 2 spec., 19.6, 26.5 mm, Playa de Jaco, intertidal, 25 Apr 1975, FSBC I 32564.

TYPE LOCALITY: Punta Mala, Panama.

DISTRIBUTION: Pacific coasts of Costa Rica and Panama; intertidal and shallow subtidal depths.

DESCRIPTION: Largest specimen (holotype) 28.2 mm long, 17.0 mm wide including girdle; valves occupying approximately 65% of total specimen width (Fig. 19). Exposed valves uniformly red or rose, usually with white maculations; unexposed parts rose pink. Girdle broad, orange-brown or dark red, with large white patches of spicules unevenly spread across dorsal surface; spicules of dorsal tufts green.

Valve i semilunate (Fig. 20), wider than long, concave posteriorly, with anterior insertion plate bearing 5 slits; tegmentum occupying about 65% total valve length. Valves ii-vii beaked (Fig. 21); tegmentum alate, twice as wide as long, constricted anteriorly, with anterolateral margins concave near jugum; sutural laminae broad, flared anterolaterally, separated anteriorly by wide, shallow sinus; lateral margins not parallel with each other or with jugum; single slits near midpoints of margins. Valve viii broadly triangular (Fig. 22), twice as wide as long, rounded posteriorly, with nearly central mucro;



Figs. 19-24. *Acanthochitona ferreirai* Lyons, sp. nov. Fig. 19. Holotype, 28.2 mm; Punta Mala, Panama; USNM 859314. Fig. 20. Valve i ex 24.5 mm paratype; same location; FSBC I 32563. Fig. 21. Valve iv, same specimen. Fig. 22. Valve viii, same specimen. Fig. 23. Tegmental pustules, valve iv, same specimen (field width = 280 μ m). Fig. 24. Dorsal girdle spicules, same specimen (field width = 650 μ m).

tegumentum ovate, wider than long, constricted anteriorly along jugum; sutural laminae very wide, flared anterolaterally, with straight anterior margins, separated by very shallow, broad, V-shaped sinus; 2 slits in posterior insertion plate small, narrow, V-shaped.

Jugum smooth, narrow, with parallel sides well-separated from lateral tegmental surface, extended anteriorly beyond main tegmental mass. Tegmentum of all valves covered with small (100 μm) round to slightly ovate pustules (Fig. 23), with single subcentral macresthete, 3-4 micresthetes.

Girdle upper surface covered with dense mat of very small (60 μm) spicules overlain by extensive patches of slender, straight, white spicules 400-500 μm long (Fig. 24), especially evident posteriorly and where girdle intrudes between valves; 18 anterior and sutural tufts containing 50-60 straight or slightly curved, stout, sharp-tipped green spicules up to 2.2 mm long; margin fringed with slender, sharp-tipped spicules up to 1 mm long, arranged in alternating groups of purple and white; underside densely covered with slender, sharp-tipped spicules about 80-90 μm long, directed toward periphery.

DISCUSSION: *Acanthochitona ferreirai* is related to *A. hemphilli* and, especially, to *A. rhodea* of the Caribbean region. The relatively shorter, wider valves, round to subovate tegmental pustules, and dense, clearly evident patches of longer spicules on the dorsal surface of the girdle separate *A. ferreirai* from the other two species.

This is the species reported from the eastern Pacific as *Acanthochitona rhodea* by Keen (1958), A. G. Smith (1961), Thorpe (*In* Keen, 1971), Bullock (1974), and Ferreira (1985). Together, those authors reported specimens ranging from Mexico to Peru. I examined only specimens from Costa Rica and Panama, so I cannot confirm that specimens from Mexico and Peru are conspecific with the material described here.

ETYMOLOGY: Named for the late Antonio J. Ferreira, whose work stimulated much interest in Caribbean and Panamic polyplacophorans.

***Acanthochitona spiculosa* (Reeve, 1847)**

Figs. 25-29

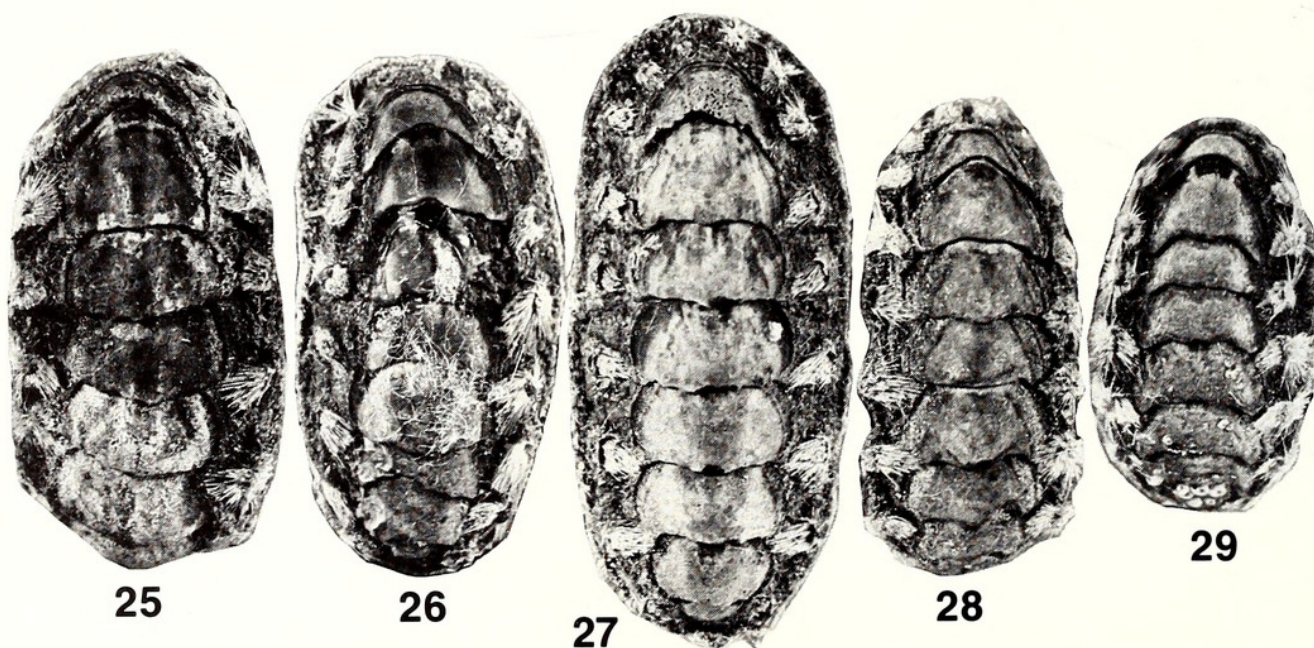
Chiton spiculosus Reeve, 1847: pl. 9, sp. and fig. 47.

Acanthochites spiculosus, Pilsbry, 1893: 22, pl. 13, figs. 60-62.

(*non Acanthochitona spiculosa* of subsequent authors).

TYPE MATERIAL: LECTOTYPE: 33.0 mm; "Loc. West Indies; Cumming collection; Acc. 1829"; BM (NH) 1981251/1 (herein designated). **PARALECTOTYPES:** 4 spec., 21.0-28.0 mm; collected with lectotype; BM (NH) 1981251/2-5.

DISCUSSION: All five types (Figs. 25-29) at one time were glued to a tablet by either the dorsal or ventral surface. Three specimens contain the dried remains of the foot and viscera, and two have been scraped clean beneath. Within one of the latter, a tag was glued but has been removed, leaving only a torn remnant upon which no information remains. This specimen [BM(NH) 1981251/1], previously labeled as the figured syntype, is the most flattened and best preserved of the specimens and most resembles Reeve's figure 47 in its proportions of length and width; it is designated herein as the lectotype. However, if this is the specimen figured by Reeve, considerable liberties were taken to enhance the illustration. Reeve's figure depicts a black, smooth, shiny surface over all valves; each intermediate valve is drawn with a distinct jugal separation extending obliquely from the posterior beak to the anterolateral corners of the exposed valve surface; a single concentric band appears near the lateral margins of each valve. Spicules of dorsal tufts are depicted as long, densely packed, and fully spread from each cluster, overlying the entire girdle and extending beyond its narrow margin. The



Figs. 25-29. *Acanthochitona spiculosa* (Reeve, 1847), type specimens, "West Indies". **Fig. 25.** Paralectotype, 27.0 mm; BM(NH) 1981251/3. **Fig. 26.** Paralectotype, 28.0 mm; BM(NH) 1981251/2. **Fig. 27.** Lectotype, 33.0 mm; BM(NH) 1981251/1. **Figs. 28, 29.** Paralectotypes, 26.0, 21.0 mm; BM(NH) 1981251/4, 5.

spicules are olive with traces of blue-green.

The actual syntypes are not nearly so attractive. Expectedly, having been dried for more than 150 years, the girdles are shrunken and hardened, and many of the spicules are broken. However, the greatest difference between the specimens and Reeve's description is in the condition of the dorsal tegmentum. The jugal tract and most of the lateropleural areas of each valve of every specimen are severely eroded, evidently as a result of surf abrasion (this condition occurs frequently among Caribbean species such as *Acanthopleura granulata*, *Chiton squamosus*, and *Ceratozona squalida* which inhabit intertidal zones of surf-swept rocks). The only remaining tegmentum occurs near lateral margins of the valves; the intersection of original tegmentum and eroded valve is evidently the concentric band depicted in Reeve's figure. On some specimens, the jugal area is marked by an eroded dark band set apart by lighter areas at each side, but the only actual remnants of jugum were found beneath the overhang of the posterior edge of the preceding valve on valve ii of the smallest curled specimen and on valve viii of the next larger curled specimen. The jugum is black, nearly smooth but microscopically pitted. No incisions are evident on the jugum of any syntype. The densely arranged pustules near lateral margins of intermediate valves are so coated with grime that their form is difficult to discern, but, where apparent, they vary from ovate to drop-shaped.

Four types of spicules occur on the girdle. Those of the 18 dorsal tufts, although frequently broken, are most evident, being long, round, sharp-pointed, and densely packed; individual lengths vary considerably, as do corresponding thicknesses; their color is now light golden brown. Aside from the tufts, the dorsal surface of the girdle is covered with short, blunt-tipped, club-shaped brown spicules. Fairly short, slender, vitreous, sharp-pointed spicules form a fringe at the outer margin of the girdle. On the underside, densely packed, very short, vitreous spicules barely break the girdle surface. Particles of quartz sand occur among debris trapped in girdle spicules of the types.

The taxonomic history of *Acanthochitona spiculosa* has been greatly confused. Much of that confusion can be traced to W. H. Dall and E. A. Smith. Dall (1889a) identified as *A. spiculosa* specimens hereafter shown to be *A. pygmaea* (Pilsbry, 1893). In the following year, E. A. Smith (1890) combined *A. spiculosa* with *A. astrigera* (Reeve, 1847). Pilsbry (1893) included *A. spiculosa* among species in the West Indian fauna, but he only attempted to reproduce Reeve's description verbally and visually and did not report any additional material. A full synonymy of correct and incorrect applications of the name *A. spiculosa*, and of its confusion with *A. astrigera*, *A. pygmaea*, and other taxa, comprises nearly five manuscript pages. Because most references cited are lists or repetitions of relatively few uncritical but far-reaching decisions, only the more important are discussed in the following species accounts.

Valve morphology and other characters of the syntypes indicate that *Acanthochitona spiculosa* is related to the group containing the Caribbean *A. astrigera*, the eastern Pacific *A. hirudiniformis* (Sowerby, 1832), and the Hawaiian *A. viridis*

(Pease, 1872). However, the syntypes are so worn that they cannot be related with certainty to any of those species. The valves are somewhat wider and the dorsal tuft spicules are shorter, more coarse, and less numerous than are those of both *A. astrigera* and another Caribbean species described hereafter. The valves and spicules of *A. spiculosa* seem to most resemble those of *A. hirudiniformis*; if they prove to be conspecific, the latter name will have priority. No other specimens of Caribbean, Brazilian, or East Pacific *Acanthochitona* resemble the syntypes of *A. spiculosa*. Until the syntypes can be related with certainty to specimens of known locality, *A. spiculosa* should be considered a *species inquirenda*.

Acanthochitona astrigera (Reeve, 1847)

Figs. 30-41

Chiton astriger Reeve, 1847: pl. 18, sp. and fig. 109.

Acanthochiton astriger, Dall, 1889a: 174, 175.

(?) *Chiton (Acanthochiton) astriger*, E. A. Smith, 1890: 496, 497.

Acanthochites spiculosus var. *astriger*, Pilsbry, 1893: 22, 23, pl. 13, figs. 55-57.

Acanthochitona spiculosa, Kaas, 1972: 46-49 (pars) non *A. spiculosa* (Reeve, 1847).

Acanthochitona astriger, Watters, 1981: 173 (pars, non pl. 2d, pl. 4h).

Acanthochitona astrigera, Lyons, 1983: 91. Ferreira, 1985: 205-207 (pars).

TYPE MATERIAL: LECTOTYPE: 19.0 mm, Barbados, BM(NH) 19809/4 (herein designated). PARALECTOTYPES: 3 spec., 19.5-22.0 mm, collected with lectotype, BM(NH) 19809/1-3.

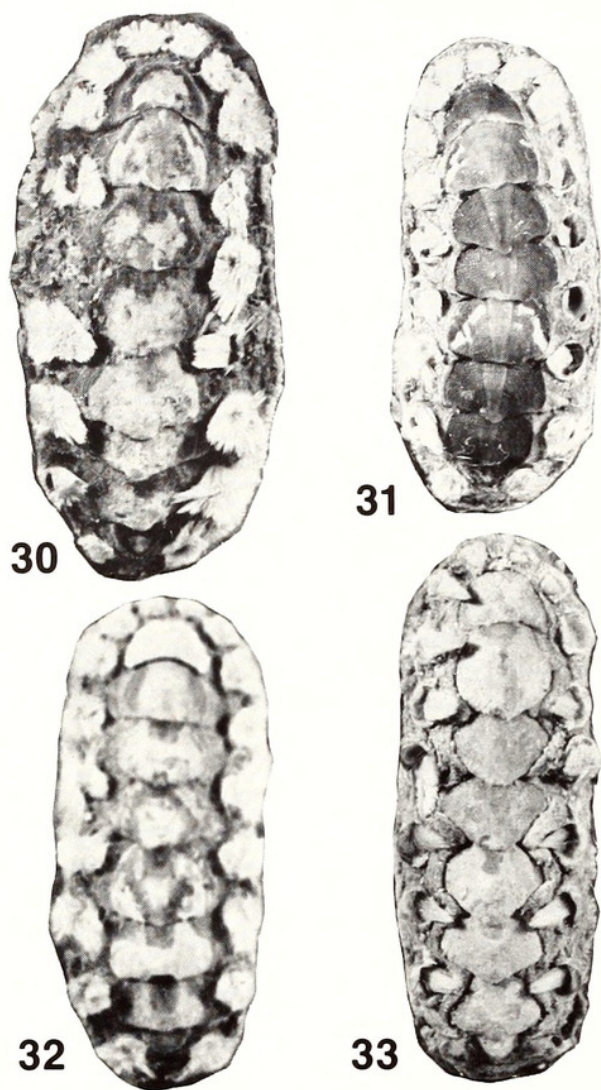
OTHER MATERIAL EXAMINED: BAHAMAS: 30 spec., 11.5-19.0 mm, Eight Mile Rock, Grand Bahama, intertidal, 21-23 May 1981, FSBC I 32527. —3 spec., 9.4-12.7 mm, Bartlett Hill, Eight Mile Rock, Grand Bahama, intertidal, 29 Aug 1984, FSBC I 32038. —28 spec., 9.9-21.5 mm, Hunters, Grand Bahama, intertidal, 29 Aug 1984, FSBC I 32037. —5 spec., Silver Cove Canal, Freeport, Grand Bahama, 0.5-1.5 m, 28 Aug 1984, FSBC I 32036. —1 spec., curled, Grand Bahama, RMNH K3730. —1 spec., Chub Cay, intertidal, M. Williams collection. DOMINICAN REPUBLIC: 3 valves, Playa Embassy, 16 km east of Boca Chica, beach drift, Bullock collection. CAYMAN ISLANDS: 2 spec., 14.0, 15.0 mm, Jackson's Point, Grand Cayman, 0-0.5 m, 9 June 1973, RMNH. ST. MAARTEN: 1 spec., 16.9 mm, W. Long Beach, RMNH K4952. BARBADOS: 1 spec., 23.5 mm, Archers Bay, St. Lucy, 5 Sept 1970, Bullock collection. BONAIRE: 7 spec., 11.7-25.2 mm, Kralendijk, intertidal, 9 Oct 1986, FSBC I 32528. CURAÇAO: 2 spec., 13.5, 18.7 mm, Port Marie, 16-18 Apr 1966, Bullock collection.

TYPE LOCALITY: Barbados (original designation).

DISTRIBUTION: Grand Bahama Island to Grand Cayman Island, Barbados, Bonaire, and Curaçao; intertidal or very shallow depths.

DESCRIPTION OF TYPES: All four types (Figs. 30-33) previously glued to tablet, later removed; 3 glued by ventral surface, 1 by dorsal surface. Foot and viscera remaining in all specimens.

Overall shape elongate, relatively slender, with dimensions 22 x 8 mm, 22 x 10 mm, 19.5 x 8 mm, 19 x 7.5 mm.



Figs. 30-33. *Acanthochitona astrigera* (Reeve, 1847), type specimens; Barbados. **Fig. 30.** Paralectotype, 22.0 mm; BM(NH) 19809/1. **Fig. 31.** Lectotype, 19.0 mm; BM(NH) 19809/4. **Figs. 32, 33.** Paralectotypes, 19.5, 22.0 mm; BM(NH) 19809/3, 2.

Three of four specimens encrusted to varying degrees by coralline algae, although some valves have been cleaned. Valves of smallest specimen in excellent condition.

Girdle brown, encroaching over anterolateral areas of valves so that intermediate valves are shield-shaped. Valve color varying from brown with white maculations laterally to dark blue-green, approaching black; where tegmentum damaged, underlying shell blue-green. Tegmentum covered with small pustules, drop-shaped near jugum, more ovate near center. Pustules of valve i small, ovate near apex, larger, drop-shaped near margins. Jugum of intermediate valves slender, with nearly smooth surface rendered finely striate by linear arrangement of fine pits near margins, pits exposed across entire jugal width near beaks; subsurface striations visible through smooth jugum surface in remaining areas. Valve viii with drop-shaped to ovate pustules as on other valves; mucro relatively low, posterior of center; jugum smooth, but with longitudinal striae visible beneath transparent surface.

Spicules of anterior and sutural girdle tufts extremely dense, white, straight, very slender; numerous very small

spicules on dorsum of girdle; spicules at girdle margin stout, long, approximately $\frac{1}{3}$ length of those in tufts, overlying shorter, sharp-tipped spicules, both types glassy, white; underside of girdle with very fine, short spicules protruding through. Fragments of foraminifera and carbonate particles trapped among girdle spicules.

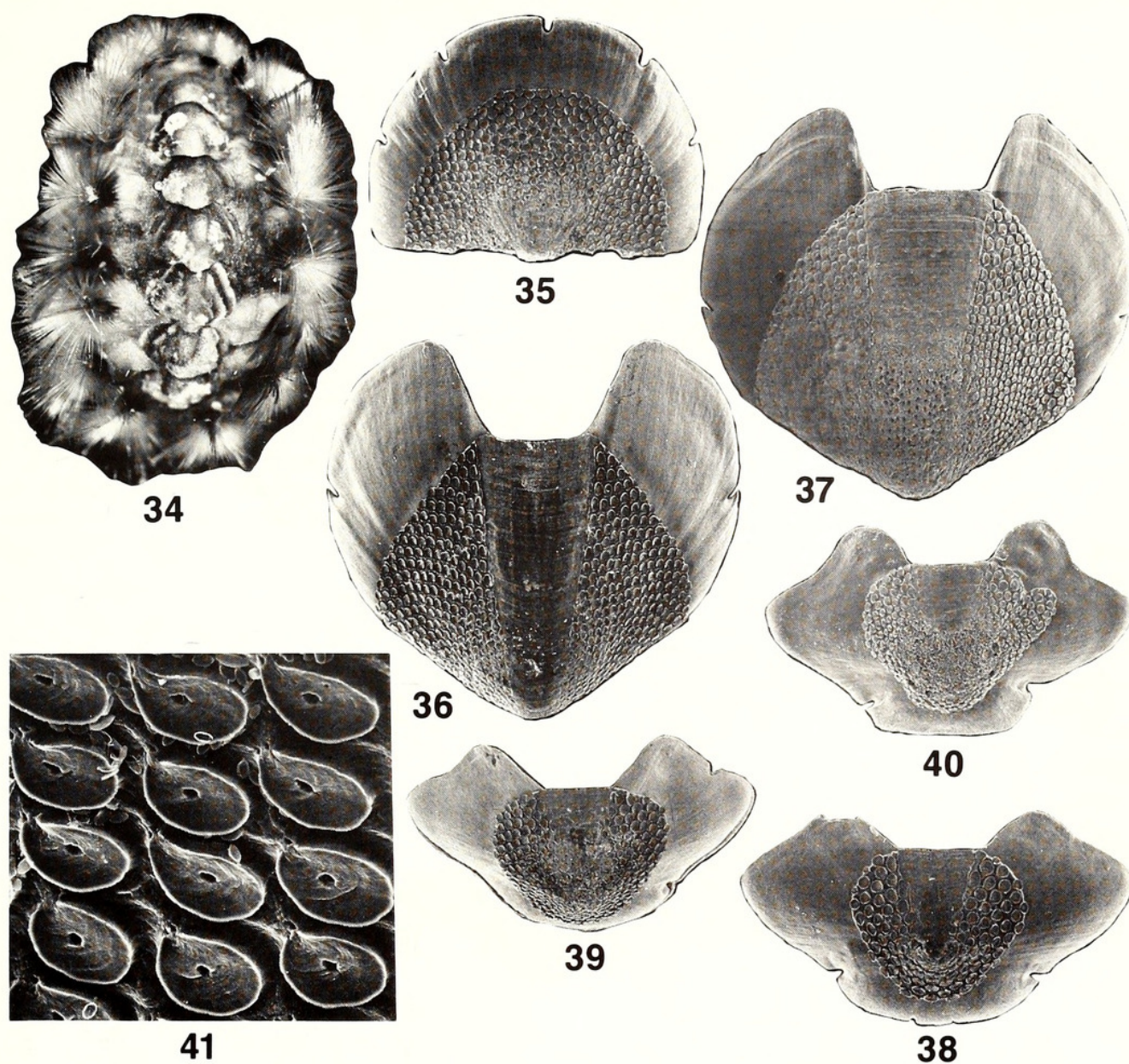
SUPPLEMENTAL DESCRIPTION: Largest specimen (FSBC I 32528) 25.2 mm long, 15.0 mm wide; valves occupying about 30% total specimen width (Fig. 34). Valves dark blue-green to black, usually with white, stripe-like maculations on valves ii and v, less commonly on other valves. Girdle blue-green, brown, or black, virtually obscured by expanded tufts of long, slender spicules.

Valve i semilunate (Fig. 35), wider than long, posterior margin straight, with anterior insertion plate bearing 5 slits; tegmentum occupying approximately 70% of valve length. Intermediate valves ii-vii beaked posteriorly, with smooth jugum widening anteriorly (Figs. 36, 37); tegmentum pentagonal, as long as wide in all but smallest specimens, with straight to slightly convex anterolateral margins; sutural laminae large, broad, curving anteromedially from posterolateral corners of tegmentum, with broadly to acutely rounded tips separated by broad sinus; single narrow slits along lateral margins. Valve viii tegmentum trigonal (Figs. 38-40), widest anteriorly, with anterior margin straight at broad sinus; mucro elevated, posterior of center; sutural laminae very well-developed, broad, slightly or markedly sinuous along margins; two slits in posterior insertion plate distinct, varying in width and depth. Valve viii often misshapen, asymmetrical or missing features (Figs. 39, 40). Pustules of tegmentum ovate to drop-shaped (Fig. 41), shallowly cupped, 80-90 μm long, constricted adapically, with single, large, macrostethete, 1-3 microstethetes at juncture of apex and tegmental plain.

Girdle upper surface dominated by 18 anterior and sutural tufts each comprised of more than 100 white to light amber, long (to 4 mm), slightly curved, slender, sharp-tipped spicules; background spicules of dorsal surface short (100 μm), straight, sharp-tipped, blue, brown, or black; marginal spicules white, approximately 500 μm long, straight, slender, sharp-tipped; underside covered with fine (80 μm), sharp-tipped spicules directed toward periphery.

DISCUSSION: The dark blue-green valves, densely packed, long, slender, sharp-tipped spicules of anterior and sutural girdle tufts, and white maculations on the blue-green tegmentum, often only on valves ii and v, leave no doubt that specimens reported here as *Acanthochitona astrigera* are conspecific with those described by Reeve. Bullock's 23.5 mm specimen from Barbados is identical in all respects with Reeve's syntypes. Reeve's smallest specimen, illustrated in Fig. 31, is designated herein as lectotype.

E. A. Smith (1890) initiated the confusion between *Acanthochitona astrigera* and *A. spiculosa* with the statement: "[Reeve's] figure (47) of the detail of sculpture of *C. spiculosa*, Reeve, which I believe to be the same species [as *C. astrigera*], gives quite as good an idea of the ornamentation [of *astrigera*] as [Reeve's] figure 109." Pilsbry's (1893) diagnostic comments indicate that he correctly recognized



Figs. 34-41. *Acanthochitona astrigera* (Reeve, 1847). **Fig. 34.** Whole specimen, 20.2 mm; Eight Mile Rock, Grand Bahama; FSBC I 32527. **Fig. 35.** Valve i ex 15.0 mm specimen; same lot. **Fig. 36.** Valve iv, same specimen. **Fig. 37.** Valve v ex 18.1 mm specimen; same lot. **Fig. 38.** Valve viii ex 12.2 mm specimen, same lot. **Fig. 39.** Valve viii, same specimen as 35. **Fig. 40.** Valve viii, same specimen as 37. **Fig. 41.** Tegmental pustules, valve iv, same specimen as 38 (field width = 280 μ m).

A. astrigera, but he cited Smith as authority in designating *astrigera* a variety of *A. spiculosa* despite the fact that Smith chose to use *astrigera*, not *spiculosa*, for his material. Pilsbry cited no material of *A. spiculosa* s.s. Thereafter, *A. astrigera* was reported by many authors under the name *A. spiculosa*, as were many specimens of *A. pygmaea* and other taxa. Kaas (1972) reported as *A. spiculosa* specimens of *A. astrigera* from Grand Bahama Island, but he also reported some specimens of *A. pygmaea* as *A. spiculosa* (see remarks for that species). Watters (1981) correctly noted that *A. astrigera* and *A. spiculosa* were distinct, but he included an undescribed species within his concept of *A. astrigera*, and he supported Dall's misconception that *A. spiculosa* represented the species otherwise known as *A. pygmaea* (Pilsbry, 1893). Ferreira (1985) followed Watters' concepts of both *A. astrigera* and *A. spiculosa*.

Thus, published records of *Acanthochitona spiculosa* and *A. astrigera*, its supposed synonym, actually include *A. astrigera*, *A. pygmaea*, and, according to material I have examined, some specimens of *A. andersoni* Watters, 1981, and a new species described hereafter. Specimens illustrated as *A. astrigera* by Watters (1981) from La Parguera, Puerto Rico, and Water Id., Virgin Islands, are the new species. Likewise, Ferreira's (1985) record of *A. astrigera* from Belize was based upon an IRCZM specimen of the new species. The literature can be corrected only when previously reported specimens, including E. A. Smith's Fernando Noronha record, have been re-examined.

Dall (1889a) listed *Acanthochitona astrigera* from Dry Tortugas and the Florida Keys, but I have seen no specimens from Florida. At Grand Bahama Island, *A. astrigera* lives principally among brown algae in the intertidal zone of high wave

energy, rocky shores, a habitat absent from the Florida Keys.

The relationship of *Acanthochitona astrigera* to other New World *Acanthochitona* is discussed under remarks for the new species.

***Acanthochitona lineata* Lyons, sp. nov.**

Figs. 42-51

Acanthochitona astriger, Watters, 1981 (pars, pl. 2d, pl. 4h).

Acanthochitona astrigera, Ferreira, 1985: 206-208 (pars, Belize). [non *A. astrigera* (Reeve, 1847)].

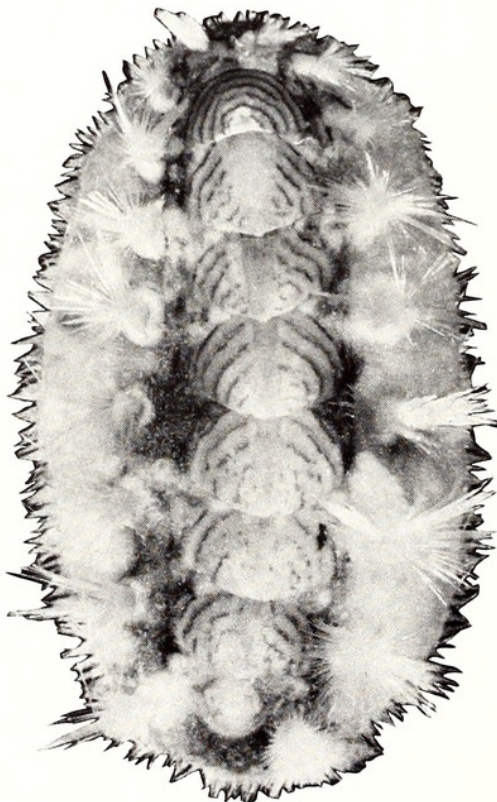
TYPE MATERIAL: HOLOTYPE: 19.5 mm x 10.5 mm, Silver Cove Canal, Freeport, Grand Bahama Island, 0.5-1.5 m, 28 Aug 1984, W. G. Lyons, collector, USNM 859315. PARATYPES: BAHAMAS: 1 spec., 10.8 mm, Bartlett Hill, Eight Mile Rock, Grand Bahama, 0-0.5 m, 29 Aug 1984, FSBC I 32434. —34 spec., 5.6-22.5 mm, same locality and date as holotype, ANSP A12122 (2), RMNH 55986 (2), FSBC I 32433 (29). —2 spec., 22.6, 33.0 mm, McLeanstown, east end Grand Bahama, 1 m, 27 Aug 1984, FSBC I 32432. PUERTO RICO: 4 spec., 7.0-11.1 mm, Magueyes Id., La Parguera, 1967, Bullock collection. —16 spec., 8.5-13.9 mm, Magueyes Id., Bullock collection (12), FSBC I 32565 (4). —1 spec., 21.4 mm, Media Luna Reef, La Parguera, 0-2 m, 15 Aug 1985, FSBC I 32435. —1 spec., 21.8 mm, Cayo Enrique, La Parguera, 0-1 m, 19 Aug 1985, FSBC I 32436. VIRGIN ISLANDS: 1 spec., 9.7 mm, Water Id., July 1959, DMNH 95381. BELIZE: 1 spec., 20.0 mm, Carrie Bow Cay, 0-1 m, 23 Mar 1981, IRCZM 61:052.

TYPE LOCALITY: Silver Cove Canal, Freeport, Grand Bahama Island.

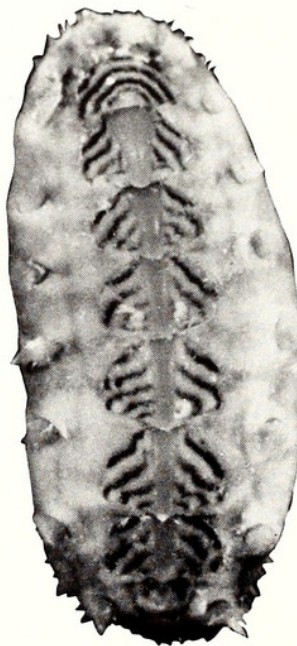
DISTRIBUTION: Grand Bahama Island to Puerto Rico, the Virgin Islands, and Belize, 0.5-2.0 m.

DESCRIPTION: Largest specimen 33.0 mm long, 18.0 mm wide including girdle; valves occupying approximately 30% of total specimen width (Figs. 42-44). Valve i with 6-8 olivaceous, equally spaced concentric lines, expressed on valves ii-vii as 3-7 transverse stripes (chevrons) extending posterolaterally from jugum; stripes varying in strength and number among individual specimens, usually strongest, most numerous, on valves i-iii; valves iii-v occasionally dark green, brown, or black, obscuring stripes; valve viii mostly white, with single large spots on lateral areas. Girdle entirely white or buff, sometimes mottled with brown or blue-green bands, occasionally with large brown or black spot near middle.

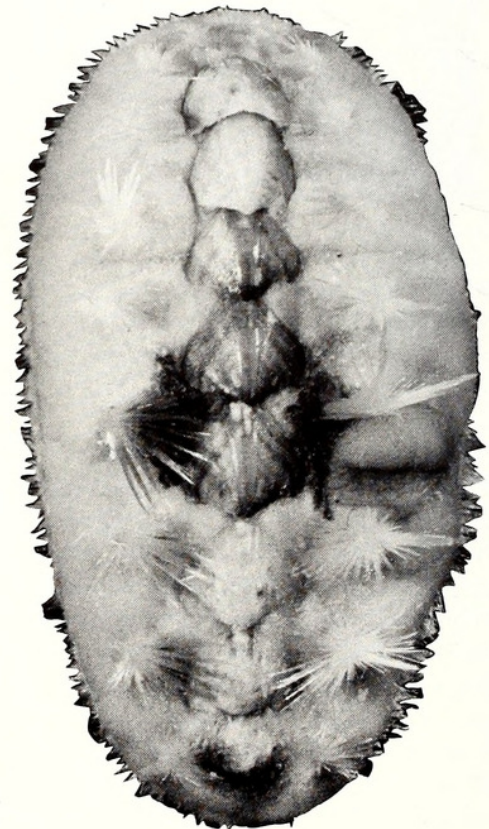
Valve i semilunate (Fig. 45), wider than long, posterior margin straight, with anterior insertion plate bearing 5 slits; tegmentum occupying 80-90% of valve length. Valves ii-vii strongly produced posteriorly; tegmentum pentagonal, with straight to slightly convex anterolateral margins (Fig. 46); sutural laminae well-developed, curving anteromedially from posterior corners of tegmentum, with subacute anterior tips separated by relatively narrow sinus; single slits on lateral margins. Valve viii tegmentum ovate (Fig. 47), widest lateromedially; mucro elevated, slightly posterior of center; sutural laminae well-developed, broadly subquadrate; two slits in posterior insertion plate very large. Proportions of small specimens may differ from those of larger individuals (Figs. 48-50).



42

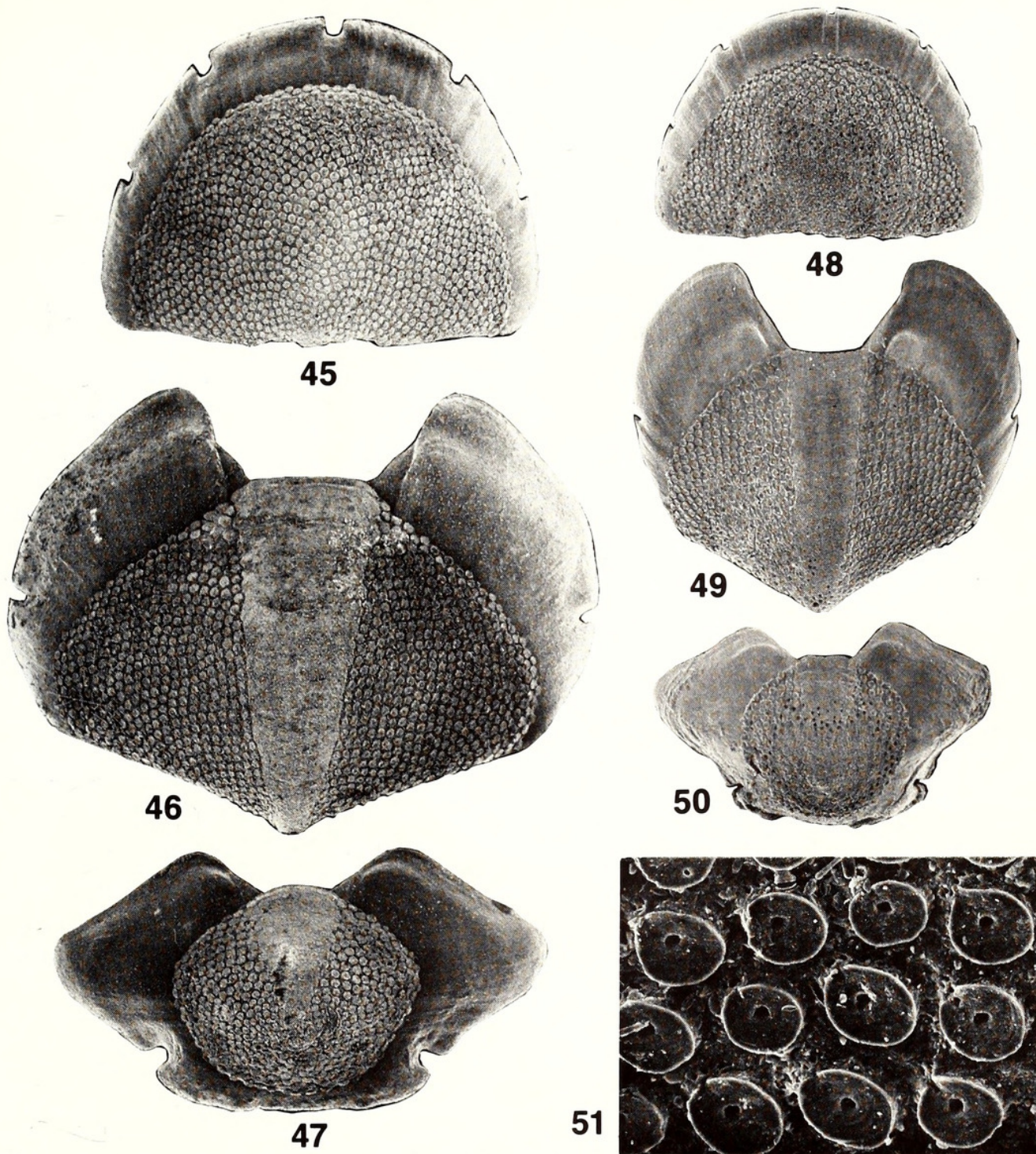


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Figs. 42-44. *Acanthochitona lineata* Lyons, sp. nov. **Fig. 42.** Holotype, 19.5 mm; Freeport, Grand Bahama; USNM 859315. **Fig. 43.** Paratype, 13.1 mm; La Parguera, Puerto Rico; FSBC I 32565. **Fig. 44.** Paratype, 33.0 mm; McLeanstown, Grand Bahama; FSBC I 32432.



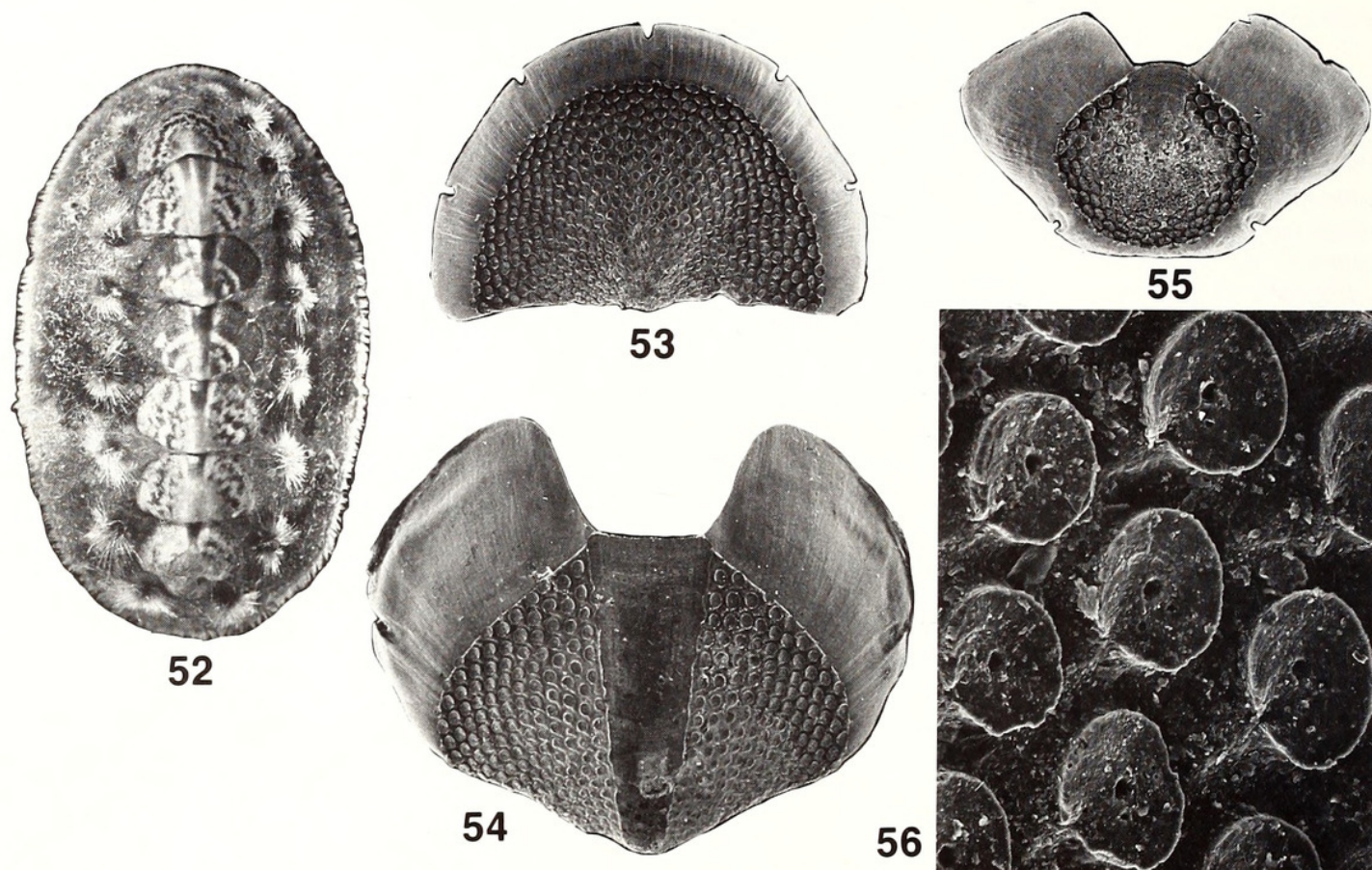
Figs. 45-51. *Acanthochitona lineata* Lyons, *sp. nov.* **Fig. 45.** Valve i ex 16.5 mm paratype; Freeport, Grand Bahama; FSBC I 32433. **Fig. 46.** Valve iv, same specimen. **Fig. 47.** Valve viii, same specimen. **Fig. 48.** Valve i ex 12.0 mm paratype; La Parguera, Puerto Rico; FSBC I 32565. **Fig. 49.** Valve iv, same specimen. **Fig. 50.** Valve viii, same specimen. **Fig. 51.** Tegmental pustules, valve iv, same specimen (field width = 280 μ m).

Jugum smooth, relatively narrow on valves ii-vii, wide anteriorly on valve viii. Tegmentum of all valves covered evenly with small (50 μ m), round to slightly ovate, shallowly cupped pustules (Fig. 51) with single, central macrostethete, 1-2 microstethetes near apex.

Girdle upper surface appearing smooth, actually covered with extremely fine (20-30 μ m) spicules; 18 anterior and sutural dorsal tufts comprised of more than 100 white, occasionally amber, long (to 3.5 mm), straight, very slender, sharp-tipped spicules; marginal spicules white, approximately

800 μ m long, straight, slender, sharp-tipped; underside covered with fine (80 μ m), sharp-tipped spicules directed toward periphery.

DISCUSSION: *Acanthochitona lineata* is related closely to *A. astrigera* of the Caribbean Sea and to *A. hirudiniformis* (Sowerby, 1832) (Figs. 52-56) of the tropical eastern Pacific Ocean; valves of all three species are quite similar. However, the tegmentum of valve viii of *A. astrigera* is widest anteriorly, whereas those of *A. lineata* and *A. hirudiniformis* are widest



Figs. 52-56. *Acanthochitona hirudiniformis* (Sowerby, 1832). **Fig. 52.** Whole specimen, 230 mm; Playa de Jaco, Costa Rica; FSBC I 32566. **Fig. 53.** Valve i ex 14.5 mm specimen, same lot. **Fig. 54.** Valve iv, same specimen. **Fig. 55.** Valve viii, same specimen. **Fig. 56.** Tegmental pustules, valve iv, same specimen (field width = 265 μ m).

mesially. In addition, tegmental pustules of *A. astrigera* are drop-shaped, whereas pustules of the other two species are round, those of *A. hirudiniformis* being approximately 50% larger than those of *A. lineata* on specimens of similar size. Other differences which separate *A. hirudiniformis* from *A. lineata* include the longer spicules of the girdle mat, which give a rough rather than smooth appearance to the dorsal surface, the short green greater than long white spicules of the anterior and sutural tufts, and the diffuse rather than clearly demarked color pattern on the tegmentum. Like *A. astrigera*, *A. hirudiniformis* lives intertidally on high energy rocky shores, whereas *A. lineata* usually occupies shallow, subtidal, relatively more placid areas such as reef flats.

Ferreira (1985) identified the IRCZM specimen of *Acanthochitona lineata* from Carrie Bow Cay, Belize, as *A. astrigera*. The specimen from Water Id., Virgin Islands (DMNH 95381, not 45381) illustrated as *A. astrigera* by Watters (1981: 176, pl. 4h) also is *A. lineata*.

Specimens of *Acanthochitona lineata* I examined seldom exceeded 22 mm length. The 33 mm specimen (FSBC I 32432) was collected among many large (30-50 mm) *A. hemphilli* at the base of a colony of finger coral, *Porites astreoides*.

ETYMOLOGY: From Latin, "*linea*", to denote the lines or stripes on the tegmentum.

Acanthochitona worsfoldi Lyons, sp. nov.

Figs. 57-65

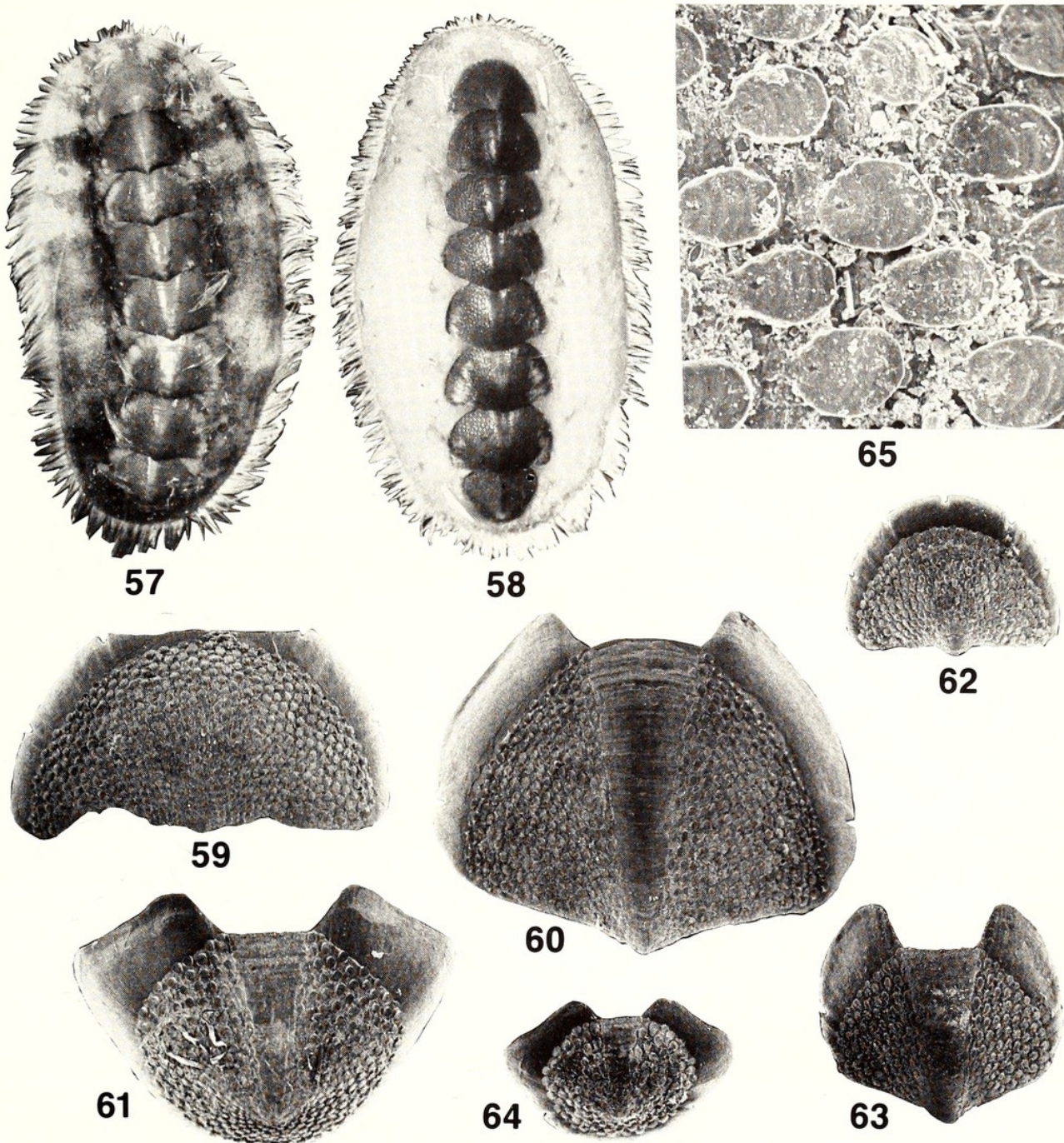
(?) *Choneplax* cf. *lata*, Ferreira, 1985: 208-213 (pars, figs. 16, 17). [*non Choneplax lata* (Guilding, 1829)].

TYPE MATERIAL: HOLOTYPE: Length 14.8 mm, width 6.7 mm, Silver Cove Canal, Freeport, Grand Bahama Island, 0.5-1.5 m, 28 Aug 1984, W. G. Lyons, collector, USNM 859318. PARATYPES: BAHAMAS: 6 spec., 7.7-17.2 mm, same locality and date as holotype, ANSP A12123 (1), FSBC I 32545 (5). —2 spec., 9.0, 13.6 mm, Tamarind Beach Reef, Grand Bahama, 18 m, 28 Aug 1984, RMNH 55987 (1), FSBC I 32544 (1). —2 spec., 7.0, 10.1 mm, Tamarind Beach Reef, 39 m, Sept 1983, FSBC I 32543. —1 spec., 13.5 mm, Gold Rock, Grand Bahama, 24.4 m, 1980, FSBC I 32541. —5 spec., 8.5-12.0 mm, Gold Rock, 24.4 m, Aug 1983, FSBC I 32542. —1 spec., 10.0 mm, 2 km off Bell Channel, Lucaya, Grand Bahama, 18.3-19.8 m, 6 Apr 1974, FSBC I 32539. —1 spec., 12.0 mm, 2 km off Bell Channel, Lucaya, 45.7 m, 10 July 1974, FSBC I 32540.

OTHER MATERIAL EXAMINED: 8 valves, Gold Rock, bottom sediments, 24.4 m, May-July 1981, FSBC I 32534. —53 valves, Grand Bahama, bottom sediments, May 1981, R. Quigley collection.

TYPE LOCALITY: Silver Cove Canal, Freeport, Grand Bahama Island.

DISTRIBUTION: Grand Bahama Island, 0.5-45.7 m, ? Barbados.



Figs. 57-65. *Acanthochitona worsfoldi* Lyons, sp. nov. **Fig. 57.** Holotype, 14.8 mm; Freeport, Grand Bahama; USNM 859318. **Fig. 58.** Paratype, 17.2 mm; same location; FSBC I 32545. **Fig. 59.** Valve i ex 12.0 mm paratype; Gold Rock, Grand Bahama; FSBC I 32542. **Fig. 60.** Valve i ex, same specimen. **Fig. 61.** Valve viii, same specimen. **Fig. 62.** Valve i ex 8.0 mm paratype; Freeport, Grand Bahama; FSBC I 32545. **Fig. 63.** Valve iv, same specimen. **Fig. 64.** Valve viii, same specimen. **Fig. 65.** Tegmental pustules, valve iv, same specimen (field width = 250 μ m).

DESCRIPTION: Largest specimen 17.2 mm long, 7.4 mm wide including girdle; valves occupying about 40% of total specimen width (Figs. 57, 58). Valves highly arched, orange, rust, or bright red, with scattered white maculations on tegmentum. Girdle buff, usually crossed with reddish brown bars which continue onto spicular fringe at margin.

Valve i semilunate (Fig. 59), wider than long, posterior margin straight, with anterior insertion plate bearing 5 shallow slits; tegmentum occupying approximately 80% of valve length. Valves ii-vii beaked posteriorly (Fig. 60); tegmentum pentagonal to subcircular, rounded anteriorly, about as long as wide, with convex anterolateral margins; sutural laminae

small, curving anteromedially from posterior corners of tegmentum; subacute anterior tips separated by wide, shallow sinus; single, small, narrow slits along lateral margins. Valve viii tegmentum subovate (Fig. 61), widest lateromesially, with straight anterior margin; mucro elevated, posterior of center; sutural laminae subrectangular, as wide or wider than long; two slits in posterior insertion plate small, V-shaped. Proportions of small specimens may differ from those of larger individuals (Figs. 62-64).

Jugum smooth, narrow at beaks, expanded anteriorly. Tegmentum of all valves covered evenly with small (50-60 μ m), flattened subspatulate pustules (Fig. 65) with

single subapical macresthete, 1-2 micresthetes at apex.

Girdle upper surface appearing smooth, actually covered with fine (50 μ m) spicules; 18 anterior and sutural dorsal tufts comprised of 10-15 long (1.5 mm), slender, slightly curved, sharp-tipped, reddish brown or white spicules; margin densely fringed with long (1.0-1.2 mm), slender, slightly curved, sharp-tipped spicules similar to those in dorsal tufts; underside covered with fine (80 μ m), narrow, straight, sharp-tipped spicules directed toward periphery.

DISCUSSION: *Acanthochitona worsfoldi* occurs in two color forms. The typical form, exemplified by the holotype (Fig. 57), has rusty orange valves, girdle, and spicules of the dorsal tufts and marginal fringe. Another form, represented by single specimens from 0.5-1.5 m and 38.0 m depths, has bright red valves, a light buff girdle, and only clear, vitreous spicules in the dorsal tufts and marginal fringe (Fig. 58). The two forms are identical morphologically.

Acanthochitona worsfoldi is distinguished from other species by its combination of large, subcircular tegmentum, small sutural laminae, few spicules in dorsal tufts, and dense marginal fringe of large spicules. Valve morphology suggests relationship to the species complex containing *A. astrigera* and *A. lineata*, but tegmental pustules and girdle spicules of those species differ considerably from those of *A. worsfoldi*.

The bathymetric range of *Acanthochitona worsfoldi* generally is greater than that of other Caribbean *Acanthochitona* species; eight of the nine lots examined were collected by divers using SCUBA. Ferreira (1985) diagnosed and illustrated specimens from Barbados which he tentatively assigned to *Choneplax lata*. I was unable to obtain that material for examination, but Ferreira's account suggests that the specimens are *A. worsfoldi*; if so, the range of *A. worsfoldi* would be extended considerably.

ETYMOLOGY: Named for Jack N. Worsfold, teacher and naturalist extraordinaire of Grand Bahama Island, whose collecting efforts contributed invaluable to many studies of marine invertebrates, including the present work.

Acanthochitona pygmaea (Pilsbry, 1893)

Figs. 66-72

Acanthochiton spiculosus, Dall, 1889a: 174, 175 (pars). [non *A. spiculosa* (Reeve, 1847)].

Acanthochites pygmaeus Pilsbry, 1893: 23, pl. 13, figs. 58, 59.

Acanthochiton pygmaeus, Leloup, 1941: 37, figs. 2, 3, pl. 1, fig. 1 (? pars).

Acanthochiton spiculosa, Kaas, 1972: 46-49, figs. 74-81 (pars). Watters, 1981: 173-176, pl. 2a-c, pl. 4f, g. Ferreira, 1985: 214 (pars).

Acanthochitona pygmaea, Kaas, 1972: 49, 50, figs. 82-89 (? pars).

TYPE MATERIAL: PARALECTOTYPE: approximately 8.0 mm, partially disarticulated; Cedar Keys, Florida; ANSP 35782.

OTHER MATERIAL EXAMINED: FLORIDA: 27 spec., 6.4-14.1 m, St. Andrews Bay, Panama City, 1.3-2.0 m, Jan 1982, R. Granada collection (23), FSBC I 32474(4). —2 valves, Florida Mid-

dle Ground, 28°35'N, 84°18'W; bottom sediments, 25.6-38.1 m, 7 Mar 1976, FSBC I 32524. —9 spec., 6.4-13.1 mm, Cedar Keys, CAS 063316. —1 spec., off Crystal River, 1.8 m, 25 Mar 1968, FSBC I 6524. —2 spec., 11.0, 11.9 mm, Anclote Key, 11 Feb 1982, FSBC I 32063. —2 spec., 4.5, 7.4 mm, 6 km west of Anclote Key, 29 Sept 1982, FSBC I 32476. —28 spec., 2.0-9.0 mm, south end Anclote Key, 3-4 m, 1 Feb 1982, FSBC I 32475. —7 spec., 2.0-9.0 mm, south end Anclote Key, 3.5 m, 22 Sept 1982, FSBC I 32473. —5 spec., all curled, Gulfport, RMNH K3731. —6 spec., 12.9-15.5 mm, Tampa Bay, 0.5 m, 9 July 1978, FSBC I 32052. —16 spec., 4.5-16.6 mm, Sarasota Bay, 4 m, CAS 063318. —1 spec., curled, Charlotte Harbor, 2 m, FSBC I 8457. —9 spec., 5.0-11.1 mm, Punta Rassa, 4 m, CAS 063320. —32 lots, 544 spec., Hourglass Stations B, C, J, K (18-37 m) off St. Petersburg and Sanibel Id., eastern Gulf of Mexico, 1965-67. —8 spec., 4.0-9.8 mm, Key West, CAS 063321. —1 spec., 18.0 mm, No Name Key, CAS 063319. —3 spec., 6.0-12.0 mm, West Summerland Key, 0-1 m, 27 Sept 1981, FSBC I 32062. —3 spec., 9.1-13.0 mm, West Summerland Key, 1976, Bullock collection. —13 spec., 5.2-15.0 mm, West Summerland Key, 1978, Bullock collection. —1 spec., 10.0 mm, Sister Creek, Vaca Key, 0-1 m, 4 Oct 1979, FSBC I 32058. —7 spec., 4.5-9.4 mm, Sister Creek, 0.5-1.5 m, 5 Aug 1980, FSBC I 32060. —5 spec., 8.7-14.0 mm, north side Vaca Key, 0-1 m, 30 Sept 1979, FSBC I 32053. —4 spec., 10.7-13.8 mm, 1 spec., disarticulated, Bonefish Key, RMNH K2852. —5 spec., 10.0-12.0 mm, Bonefish Key, CAS 063322. —1 spec., curled, Burnt Point, Crawl Key, 2.5 m, July 1982, FSBC I 32471. —1 spec., curled, Burnt Point, 4 Aug 1982, FSBC I 32472. —1 spec., 10.2 mm, northeast end Grassy Key, 0.5 m, 1 Oct 1979, FSBC I 32054. —1 spec., 11.6 mm, north side Grassy Key, 0-1 m, 1 Oct 1979, FSBC I 32055. —12 spec., 6.2-10.7 mm, north side Grassy Key, 0.5-1.0 m, 5 Aug 1980, FSBC I 32061. —54 spec., 6.5-17.0 mm, Grassy Key Quarry, 0-2 m, Feb 1975-Aug 1980, 4 lots: FSBC I 32051, 32056, 32057, 32059. —19 spec., 6.2-17.2 mm, Duck Key, 23 Aug 1978, Bullock collection. —1 spec., 12.6 mm, Lower Matecumbe Key, CAS 063317. —1 spec., curled, off Hutchinson Id., 11.2 m, 17 Sept 1973, FSBC I 32523. —1 spec., 11.5 mm, Bethel Shoal, 9-15 m, 27 June 1978, IRCZM 61:014. BERMUDA: 2 spec., 12.4, 15.2 mm, Baileys Bay, July 1969, FSBC I 32522. BAHAMAS: 2 spec., 11.5, 12.0 mm, Deadmans Reef, Grand Bahama, 0.5-1.5 m, 25 May 1981, FSBC I 32469. —3 spec., 4.2-6.5 mm, West Hawksbill Creek, Grand Bahama, 28 June 1981, FSBC I 32470. —12 spec., 6.7-10.7 mm, Tamarind Beach Reef, Grand Bahama, 18 m, 28 Aug 1984, FSBC I 32064. —2 valves, Gold Rock, Grand Bahama, bottom sediments, 24.4 m, May-July 1981, FSBC I 32525. —9 valves, Grand Bahama, bottom sediments, May 1981, R. Quigley collection. —1 spec., 9.5 mm, McLeanstown, east end Grand Bahama, 1-2 m, 24 May 1981, FSBC I 32468. —1 spec., 14.0 mm, Green Turtle Cay, Abaco, 0.5 m, 3-9 May 1978, FSBC I 32466. —1 spec., 4.5 mm, Turtle Rocks near Bimini, 5.5 m, ANSP 325864. TURKS AND CAICOS ISLANDS: 1 spec., 21.0 mm, Providenciales, M. Williams collection. PUERTO RICO: 22 spec., 6.0-17.0 mm, Cayo Enrique, La Parguera, Apr 1966, Bullock collection. —8 spec., 8.5-17.7 mm, Cayo Enrique, 0.5-1.0 m, 15 Aug 1985, FSBC I 32066. —6 spec., 4.7-16.1 mm, Cayo Enrique, 0-1 m, 19 Aug 1985, FSBC I 32069. —1 spec., 10.0 mm, Cayo Enrique, May 1985, FSBC I 32071. —2 spec., 15.2, 17.9 mm, 3 km east of La Parguera, 1 m, 17 Aug 1985, FSBC I 32067. —1 spec., 11.8 mm, Media Luna Reef, La Parguera, May 1985, FSBC I 32070. —51 spec., 8.2-21.2 mm, Media Luna Reef, 0-2 m, 15-19 Aug 1985, FSBC I 32065. —3 spec., 8.4-20.2 mm, Isla Turrámote, La Parguera, 0-2 m, 19 Aug 1985, FSBC I 32068. VIRGIN ISLANDS: 1 spec., disarticulated, St. Thomas, RMNH K4686. SABA BANK: 2 spec., 7.5, 9.0 mm, 17°12'N, 63°38'W, 26 m, 8 June 1972, RMNH. MEXICO: 2 spec., 5.0, 6.0 mm, 7 valves, Yucum Balam, 15 km north of Ciudad Campeche, TUDG collection. —4 valves, beach 19 km southwest of Champton, Campeche, TUDG collection. —4 valves, Isla Arenas, 80 km north of Ciudad Campeche, TUDG collection. —2

valves, Punta Palmar Lighthouse, Yucatan, TUDG collection. —7 valves, Isla Cerritos, 5 km west of San Felipe, Yucatan, TUDG collection. —1 spec., 13.0 mm, Isla Mujeres, Quintana Roo, 0-1 m, 29 Sept 1985, FSBC I 32072.

TYPE LOCALITY: Key West, Florida (by subsequent designation, Watters, 1981).

DISTRIBUTION: Bermuda, both coasts of Florida, Campeche to Quintana Roo, Mexico; Bahama Islands to Puerto Rico, Virgin Islands, and Saba Bank; intertidal to about 40 m.

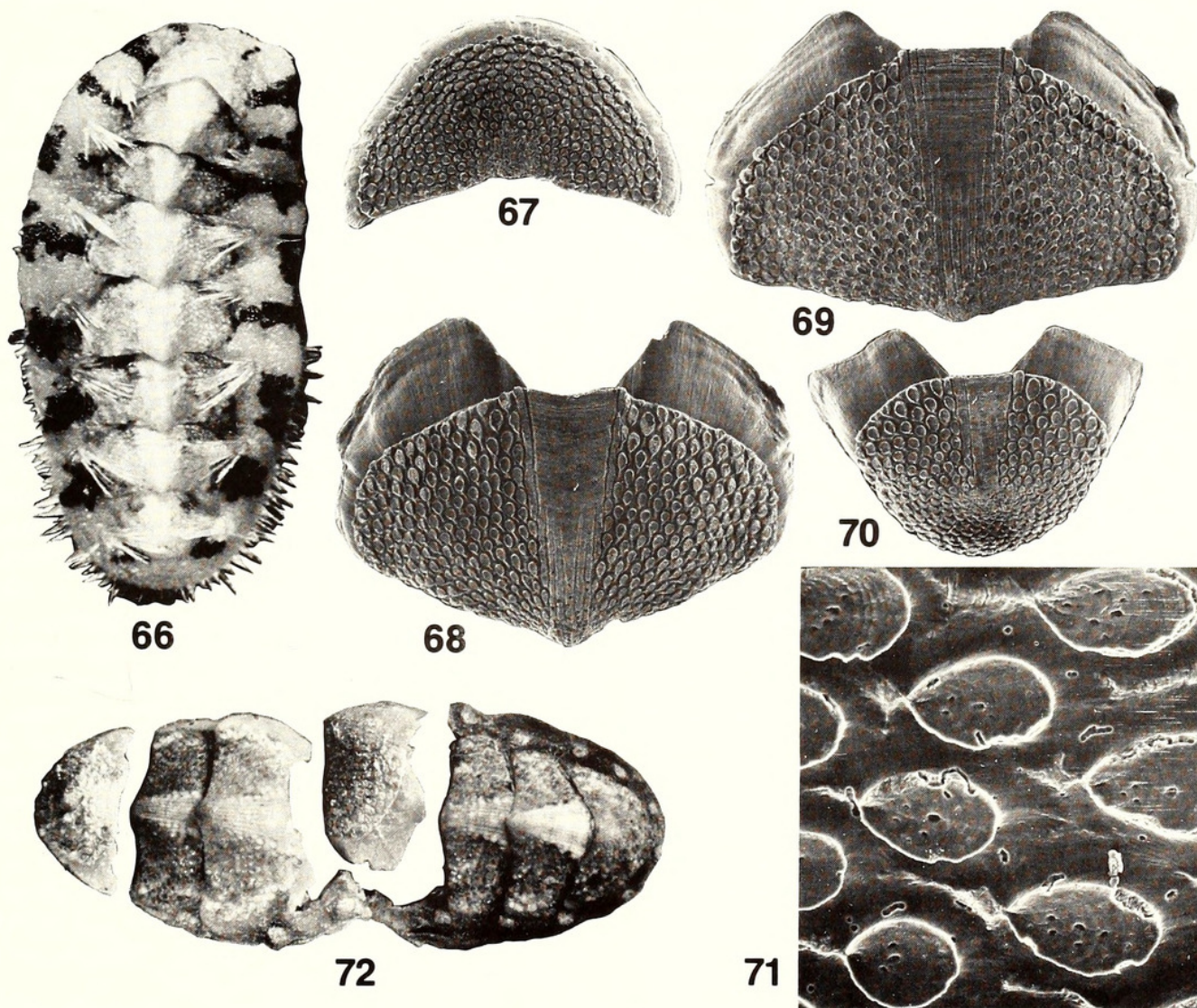
DESCRIPTION: Largest specimen 21.2 mm long, 12.0 mm wide including girdle; valves occupying 40-45% total specimen width (Fig. 66). Valves green, orange, often white variegated with green or brown. Girdle buff or tan, usually with green, blue-green or black bars, sometimes with orange spots; dorsal spicular tufts green, blue-green or white; spicules of marginal fringe white, usually in combination with blue or magenta.

Valve i semilunate (Fig. 67), wider than long, broadly

V-shaped or concave posteriorly, with anterior insertion plate bearing 5 slits; tegmentum occupying about 90% of valve length. Valves ii-vii beaked posteriorly (Figs. 68, 69); tegmentum ovate, about 1.6 times as wide as long, with convex anterolateral margins; sutural laminae with rounded to subacute anterior tips separated by broad sinus; single slits along lateral margins. Valve viii trigonal (Fig. 70), widest at anterolateral tips, rounded posteriorly; tegmentum ovate, slightly wider than long; mucro prominent, subcentral; sutural laminae flared anterolaterally, with straight or concave anterior margins; 2 narrow slits in posterior insertion plate.

Jugum expanded anteriorly, with distinct longitudinal incisions usually over entire length, sometimes rubbed smooth anteriorly, lateral margins irregularly merging with pustules of tegmentum. Tegmental pustules shallowly cupped, ovate to drop-shaped (Fig. 71), about 120 μm long, 70 μm wide, with central macresthete, 3-6 micresthetes.

Girdle upper surface covered densely with slender, vitreous, sharp-tipped spicules about 100-150 μm long; 18



Figs. 66-72. *Acanthochitona pygmaea* (Pilsbry, 1893). **Fig. 66.** Whole specimen, 12.2 mm; Grassy Key, Monroe County, Florida; FSBC I 32056. **Fig. 67.** Valve i ex 13.2 mm specimen; Tampa Bay, Florida; FSBC I 32052. **Fig. 68.** Valve iv, same specimen. **Fig. 69.** Valve v, same specimen. **Fig. 70.** Valve viii, same specimen. **Fig. 71.** Tegmental pustules, valve iv, same specimen (field width = 235 μm). **Fig. 72.** Paralectotype, 8.0 mm; Cedar Keys, Florida; ANSP 35782.

anterior and sutural tufts comprised of 100 or more very slender, straight, sharp-tipped spicules to 2.2 mm long; margin fringed with straight, slender, vitreous, sharp-tipped spicules to 700 μm long; underside covered with short (80 μm), sharp, vitreous spicules directed toward periphery.

DISCUSSION: Pilsbry (1893) described *Acanthochitona pygmaea* based upon specimens from Cedar Keys and Key West, Florida; his illustrations (pl. 13, figs. 58, 59) were of a single intermediate valve with strongly incised jugum and an enlarged view of tegmental pustules. Watters (1981) published a photograph of an intact 9 mm specimen from Key West and designated it the lectotype (ANSP 35783), although the partially disarticulated specimen from Cedar Keys (ANSP 35782) probably is the one Pilsbry illustrated. Watters' illustration of very wide valves and his description of a striated jugum indicate that the Key West lectotype and the Cedar Keys specimen are conspecific.

The Cedar Keys specimen (Fig. 72), now a paralectotype, is broken into five pieces: valves i-iii, valves vi-vii, valve viii, a broken intermediate valve (iv or v), and a fragment of that valve imbedded in a piece of the girdle. Overall length of the total specimen, estimated from its parts, is about 8 mm. The strongly incised jugum demonstrates that the specimen is conspecific with those reported as *Acanthochitona pygmaea* herein.

Despite a great quantity of literature which states otherwise, *Acanthochitona pygmaea* (Pilsbry, 1893) is not *A. spiculosa* (Reeve, 1847). That conclusion is supported by several observations: 1) there are no incisions on the jugum of *A. spiculosa*; 2) intermediate valves of *A. pygmaea* are much wider than long, whereas those of *A. spiculosa* are relatively more narrow; 3) the syntypes of *A. spiculosa* are considerably larger than nearly all of the 924 intact *A. pygmaea* examined herein; only two specimens of *A. pygmaea* were as large (21.0 mm, Turks and Caicos Ids., 21.2 mm, Puerto Rico) as the smallest of the five syntypes (21.0-33.0 mm) of *A. spiculosa*.

Because this species is so common in Florida and the northern Caribbean, most literature records of *Acanthochitona spiculosa* actually represent *A. pygmaea*. Dall (1889a) launched more than 90 years of taxonomic turmoil by including Cedar Keys, west Florida, and the Florida Keys within the range of *A. spiculosa*, indicating that his concept of *A. spiculosa* included the species Pilsbry later described as *A. pygmaea*. *A. pygmaea* is the only species of *Acanthochitona* which occurs at Cedar Keys and nearshore west Florida. Likewise, the *A. spiculosa* of Bermuda (Peile, 1926; Jensen and Harasewych, 1986) is *A. pygmaea*. Among material I examined were specimens of *A. pygmaea* previously identified as *A. spiculosa* by Kaas (RMNH), Watters (Bullock collection), and Ferreira (CAS, IRCZM). Leloup (1941) recognized *A. pygmaea* and illustrated valve viii of a specimen from Florida, but specimens he reported from Venezuela and Colombia could have been a new species described hereafter. Kaas (1972) treated *A. pygmaea* and *A. spiculosa* separately, but specimens he reported as *A. spiculosa* from Gulfport (RMNH K3731) and Bonefish Key (RMNH K2852), Florida, are *A. pygmaea*. It is doubtful that the specimens Kaas reported as

A. pygmaea were that species, as evidenced by his description of only 12-15 spicules in dorsal tufts and other features more characteristic of several other species.

Where both species occur together in Florida and the northern Caribbean, it is not uncommon to find specimens of *Acanthochitona andersoni* in lots of *A. pygmaea*. Lots examined here that included both species are CAS 063321, collected at Key West by Hemphill; ANSP 325864, a paratype lot of *A. andersoni* Watters; and two unnumbered lots from West Summerland Key in the Bullock collection.

Acanthochitona pygmaea is common in Florida, the Bahama Islands, Yucatan, and Puerto Rico, but I have seen no specimens southward from Saba Bank. In addition to Leloup's (1941) records from Venezuela and Colombia, *A. pygmaea* has been reported from several locations in Brazil by Righi (1971), who illustrated only the short dorsal spicules, marginal spicules, and radula; those records need confirmation.

Acanthochitona venezuelana Lyons, sp. nov.

Figs. 73-80

TYPE MATERIAL: HOLOTYPE: Length approximately 20.0 mm (curled), North of La Guardia, Isla de Margarita, Venezuela, 12 June 1987, C. Franz, collector, USNM 859317. PARATYPES: 4 spec., all curled, approximately 16.0-19.0 mm, collected with holotype, FSBC I 32569 (2), RMNH 55988 (1), Bullock collection (1).

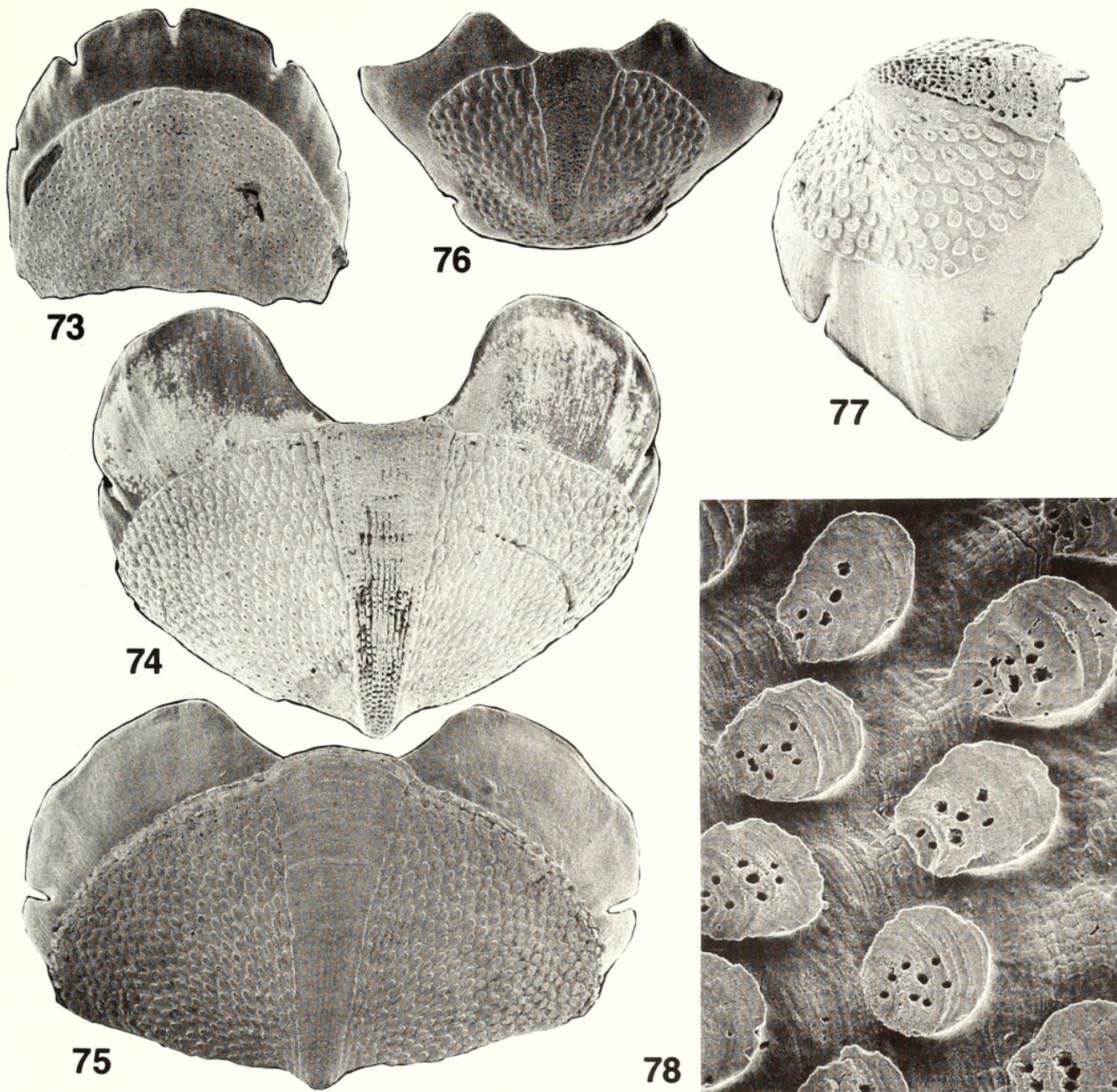
TYPE LOCALITY: North of La Guardia, Isla de Margarita, Venezuela.

DISTRIBUTION: Isla de Margarita, Venezuela.

DESCRIPTION: Largest specimen (holotype) approximately 20.0 mm long, 10.0 mm wide including girdle; valves occupying about 50% of total specimen width. Valves i-vii white with scattered black maculations arranged in vaguely concentric arcs anterior of beaks; jugum yellow-brown or mauve, usually with faint flush of mauve on tegmentum near beak. Valve viii with black maculation covering most of tegmentum. Girdle noticeably spiculose, tan to gray, with pale green spicules in anterior and sutural dorsal tufts.

Valve i semilunate (Fig. 73), wider than long, posterior margin straight, with anterior insertion plate bearing 5 U-shaped slits; tegmentum occupying approximately 70% of valve width. Valves ii-vii beaked posteriorly (Figs. 74, 75); tegmentum oblate, about 1.6 times as wide as long, with convex anterolateral margins; sutural laminae prominent, very wide, broadly rounded anteriorly, separated by wide, U-shaped sinus, with single deep slits along anterolateral margins. Valve viii pentagonal (Fig. 76), widest anterolaterally, dropping away rapidly behind posterior, elevated, prominently pointed mucro (Fig. 77); sutural laminae well-developed, markedly concave anteriorly, sharply produced at anterolateral corners; 2 narrow slits in posterior insertion plate.

Surface of jugum with smooth veneer overlying layer of numerous thin, longitudinal striae; both layers fragile, easily damaged, revealing honeycombed subjugal constructional elements beneath. Tegmentum of all valves with flat, oval pustules 220 μm long, elongate near jugum, smaller (130 μm),



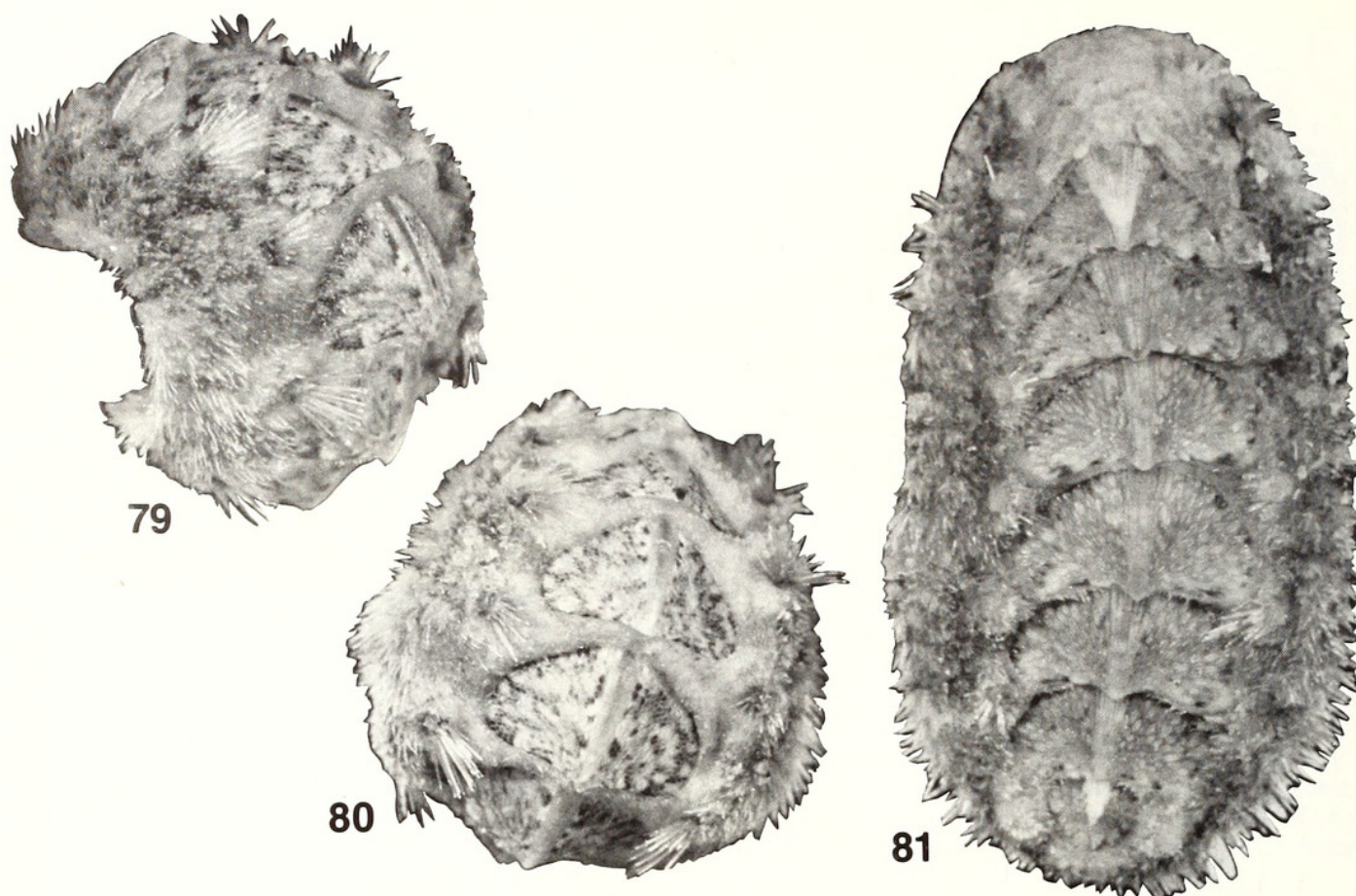
Figs. 73-78. *Acanthochitona venezuelana* Lyons, *sp. nov.* **Fig. 73.** Valve i ex 19.0 mm paratype; Margarita Id., Venezuela; FSBC I 32569. **Fig. 74.** Valve iv, same specimen. **Fig. 75.** Valve v, same specimen. **Fig. 76.** Valve viii, same specimen. **Fig. 77.** Valve viii, 18.0 mm paratype; same lot; lateral view. **Fig. 78.** Tegmental pustules, valve iv, same specimen (field width = 315 μ m).

more rounded, subspatulate near outer margins (Fig. 78); macresthete subcentral, 5-8 micresthetes of nearly same diameter as macresthete clustered mostly on adapical half of pustule surface.

Girdle upper surface obviously spiculose, densely covered with straight to slightly curved, sharp-tipped, clear, glassy spicules (Figs. 79, 80), round in cross-section, about 300-600 μ m long, overlying and generally obscuring mat of tiny (75 μ m) slender spicules. Dorsal spicules gradually increasing in length to merge with marginal fringe, where they are longest (about 1 mm); no demarcation or change in form between dorsal and marginal spicules; 18 anterior and dorsal tufts with about 25 pale green, slender, straight, sharp-pointed spicules up to 1.5 mm long; lower surface covered with small (100 μ m), densely packed, straight, slender spicules

directed toward periphery.

DISCUSSION: *Acanthochitona venezuelana* most resembles *A. avicula* (Carpenter, 1864). Watters (1981) noted the relationship between the western Atlantic *A. pygmaea* (as *A. spiculosa*) and the eastern Pacific *A. avicula*. Like *A. pygmaea*, *A. avicula* has broad intermediate valves (Fig. 81), longitudinal incisions on the jugum, and drop-shaped pustules. *A. venezuelana* has broad valves with drop-shaped to spatulate pustules but lacks jugal incisions. Most notably, dorsal girdle spicules of *A. avicula* and *A. venezuelana* virtually are identical. The combination of high, pointed mucro, more narrow anterior end of the jugum, and possession of mostly ovate to subspatulate tegmental pustules separate *A. venezuelana* from *A. avicula*.



Figs. 79, 80. *Acanthochitona venezuelana* Lyons, *sp. nov.* **Fig. 79.** Holotype, approximately 20.0 mm (curled), lateral view; Margarita Id., Venezuela; USNM 859317. **Fig. 80.** Holotype, dorsal view. **Fig. 81.** *Acanthochitona avicula* (Carpenter, 1864); entire specimen, 12.4 mm; Puertocitos, Baja California, Mexico; FSBC I 32570.

Acanthochitona avicula, *A. pygmaea* and *A. venezuelana* join *A. asterigera*, *A. hirudiniformis*, and *A. lineata* and *A. hemphilli*, *A. rhodea*, and *A. ferreirai* as groups with one eastern Pacific and two western Atlantic species. Although specimens of *A. venezuelana* have been seen only from Margarita Island, the species probably has a wider distribution across the Caribbean coast of South America and could replace *A. pygmaea* in that region. Dautzenberg (1900) reported a curled specimen (2.5 x 2.5 mm) of *A. pygmaea* dredged from 11 m at Los Testigos very near Isla Margarita, and Leloup (1941) reported a curled specimen (3 x 2.5 mm) of *A. pygmaea* dredged from 12-15 fm (22-27 m) off Cabo la Vela, Colombia; a specimen from Florida, not the southern Caribbean, was illustrated by Leloup (his fig. 2, reproduced as figs. 82-84 by Kaas, 1972). Kaas (1972) reported no specimens of *A. pygmaea* from farther south than St. Barts, Saba, and St. Eustatius, and I have seen no *A. pygmaea* from any area south of Saba Bank. Thus, it is possible that specimens reported by Dautzenberg and by Leloup as *A. pygmaea* could have been *A. venezuelana*.

ETYMOLOGY: Named for Venezuela, the Caribbean nation where the specimens were collected.

Acanthochitona roseojugum* Lyons, *sp. nov.

Figs. 82-92

Acanthochitona pygmaea, Lyons, 1981: 36 (pars, Dry Tortugas sta. 2 only) [non *A. pygmaea* (Pilsbry, 1893)].

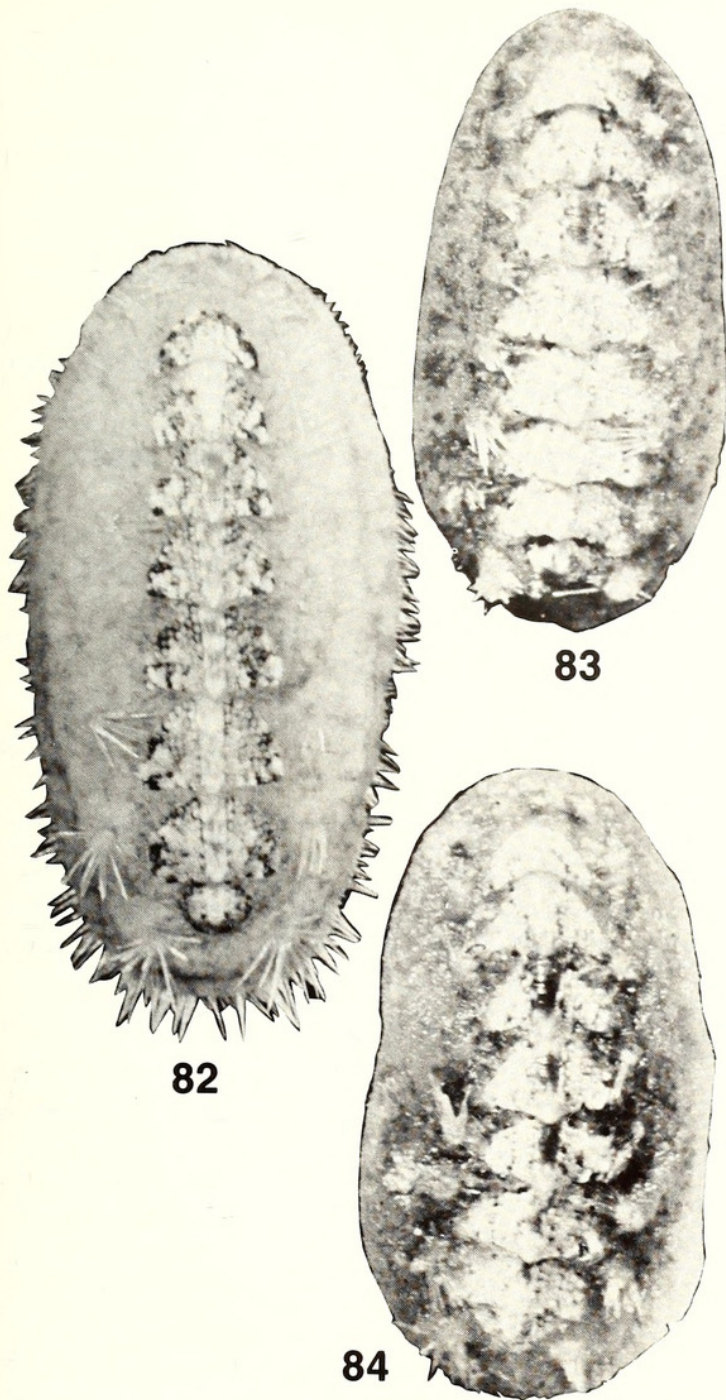
TYPE MATERIAL: **HOLOTYPE:** Length 12.2 mm, width 6.0 mm, Bartlett Hill, Eight Mile Rock, Grand Bahama Island, 0-0.5 m, 29 Aug 1984, W. G. Lyons, collector, USNM 859316. **PARATYPES:** **FLORIDA:** 4 spec., 8.1-8.7 mm, Bird Key Reef, Dry Tortugas, 0.5-1.0 m, 4 Oct 1979, FSBC I 32535. —1 spec., 6.4 mm, Florida Middle Ground, 28°35.0'N, 84°14.9'W, 31 m, 19 May 1977, FSBC I 24598. —1 spec., 10.6 mm, Peanut Id., Palm Beach Inlet, 0-1 m, 29 Aug 1982, FSBC I 32536. **BAHAMAS:** 4 spec., 10.0-12.2 mm (2 curled), collected with holotype, ANSP A12124 (1), RMNH 55989 (1), FSBC I 32537 (2). —1 spec., 12.4 mm, Caravel Beach, Freeport, Grand Bahama, 1 m, 30 Aug 1984, FSBC I 32538.

OTHER MATERIAL EXAMINED: **FLORIDA:** 1 valve, Florida Middle Ground, 28°38.1'N, 84°16.3'W, bottom sediments, 28.6 m, 21 May 1977, FSBC I 32533. —8 valves, Florida Middle Ground, 28°35'N, 84°18'W, bottom sediments, 25.6-38.1 m, 7 Mar 1976, FSBC I 32532. **BAHAMAS:** 4 valves, Gibson Cay, Andros, beach drift, 2 Sept 1971, FSBC I 32531. **HONDURAS:** 1 spec., 16.2 mm, Utila Id., June 1987, Sunderland collection.

TYPE LOCALITY: Bartlett Hill, Eight Mile Rock, Grand Bahama Island.

DISTRIBUTION: Eastern Gulf of Mexico at Florida Middle Ground to Dry Tortugas, southeast Florida, the Bahama Islands, and Honduras; intertidal to 31 m.

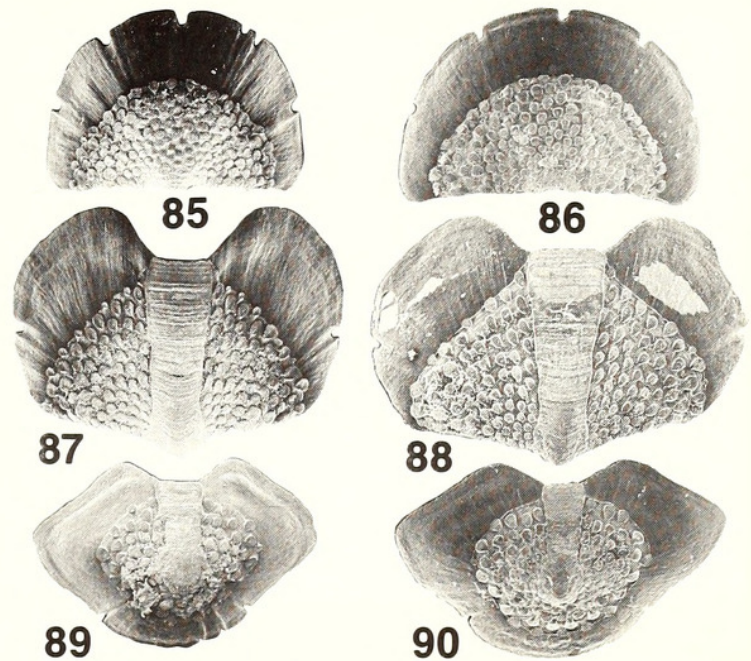
DESCRIPTION: Largest specimen 16.2 mm long, 8.3 mm wide including girdle; valves occupying 30-35% of total specimen width (Figs. 82-84); tegmentum variously white with brown flecks or pale pinkish white variegated with greenish black;



Figs. 82-84. *Acanthochitona roseojugum* Lyons, *sp. nov.* **Fig. 82.** Holotype, 12.2 mm; Eight Mile Rock, Grand Bahama; USNM 859316. **Fig. 83.** Paratype, 8.5 mm; Dry Tortugas, Florida; FSBC I 32535. **Fig. 84.** Paratype, 8.1 mm; same lot as 83.

jugum white or pink, suffused on some valves with bright rose spots; girdle white or buff.

Valve i semilunate (Figs. 85, 86), wider than long, margin straight posteriorly, with anterior insertion plate bearing 5 U-shaped slits; tegmentum occupying 60-65% of valve length. Valves ii-vii beaked posteriorly (Figs. 87, 88); tegmentum subpentagonal, wider than long, with convex to slightly sinuous anterolateral margins; sutural laminae large, flared anterolaterally, with broadly rounded anterior tips separated by broad, U-shaped sinus; single shallow slits along lateral margins. Valve viii with tegmentum subovate (Figs. 89, 90),



Figs. 85-90. *Acanthochitona roseojugum* Lyons, *sp. nov.* **Fig. 85.** Valve i ex 10.0 mm paratype; Eight Mile Rock, Grand Bahama; FSBC I 32537. **Fig. 86.** Valve i ex 8.2 mm paratype; Dry Tortugas, Florida; FSBC I 32535. **Fig. 87.** Valve iv, same specimen as 85. **Fig. 88.** Valve iv, same specimen as 86. **Fig. 89.** Valve viii, same specimen as 85. **Fig. 90.** Valve viii, same specimen as 86.

widest between mucro and anterior margin; mucro elevated, slightly posterior of center; sutural laminae large, broad, subquadrate; 2 small slits in posterior insertion plate.

Jugum elevated, strongly demarked, smooth, narrow, sides parallel, extending anteriorly beyond tegmental margin. Tegmentum of all valves covered with subovate to spatulate, flattened pustules (Figs. 91, 92) 120-140 μm long, 80 μm wide, with single, subcentral macresthete, two pairs of micresthetes, second pair near juncture of apex and tegmental plain.

Girdle upper surface covered with small (40 μm) slender, sharp-tipped spicules; 18 anterior and sutural tufts with 10-18 straight, relatively robust, vitreous spicules 1.25 mm long, surrounded by many similar but smaller (250 μm) spicules; marginal spicules sharp-tipped, vitreous, short (300 μm) anteriorly and laterally, more than twice as long posteriorly; underside covered with fine (80 μm), sharp-tipped, vitreous spicules directed toward periphery.

DISCUSSION: Florida specimens generally have paler color on the tegmentum and girdle, and valves seem to be slightly more protracted. However, the rose spots, extended jugum, and tegmental pustule morphology indicate that Bahamian and Florida populations are conspecific.

Intact specimens of *Acanthochitona roseojugum* hardly seem separable from *A. andersoni* Watters, 1981. Differences useful to sort specimens are almost subjective. Intermediate valves of *A. roseojugum* are wider and more flattened anteriorly, whereas those of *A. andersoni* are more narrow and arched. The jugum of *A. roseojugum* is separated more distinctly from the tegmentum than is that of *A. andersoni*. Rose-colored spots occur on all or part of the jugum of at least valve iii



91



92

Figs. 91, 92. *Acanthochitona roseojugum* Lyons, *sp. nov.*, tegmental pustules (field widths = 385 μ m). **Fig. 91.** Bahamas; same specimen as 85. **Fig. 92.** Florida; same specimen as 86.

of *A. roseojugum* and sometimes occur on the jugum of all intermediate valves (ii-vii); sutural laminae and undersides of all valves are pink. I have seen two entirely rose-colored specimens of *A. andersoni*, but those specimens were distinguishable by their highly arched, more narrow intermediate valves. Some specimens of *A. pygmaea* from the Bahamas and Puerto Rico are flushed with pale pink on some intermediate valves, but these are immediately separated from *A. roseojugum* by strongly incised grooves on the jugum, wider tegmentum on intermediate valves, smaller sutural laminae, and many green spicules rather than few white spicules in the anterior and sutural tufts.

Any resemblance of *Acanthochitona roseojugum* to *A. andersoni* and *A. pygmaea* is dispelled by inspection of disarticulated valves. The proportionately large insertion plate and small tegmentum of valve i, flared sutural laminae and ex-

tended, strongly demarked, smooth jugum of valves ii-viii, and small slits of valve viii all resemble features of species in the *A. hemphilli* complex. However, the straight posterior margin of valve i and the girdle species of *A. roseojugum* differ considerably from those of species in the *A. hemphilli* complex.

The additional asymmetrical slits on insertion plates of valves i and viii of the illustrated Bahamian specimen (Figs. 85, 89) represent anomalies that occur occasionally in many species of *Acanthochitona*.

ETYMOLOGY: From Latin "*roseus*", rose-colored, and "*iugum*", a ridge (i.e. jugum).

***Acanthochitona balesae* Abbott, 1954**

Figs. 93-104

Acanthochitona balesae Pilsbry, 1940: pl. 12, fig. 5 (*nomen nudum*). Abbott, 1954: 318; 1974: 406. Watters, 1981: 175, 176, pl. 3, figs. a-c.

Acanthochitona elongata Kaas, 1972: 51-53, figs. 90-94, pl. 2, fig. 3. Ferreira, 1985: 212.

Acanthochitona interfissa Kaas, 1972: 53-55, figs. 95-107.

Choneplax lata, Ferreira, 1985: 208-213 (pars) [*non Choneplax lata* (Guilding, 1829)].

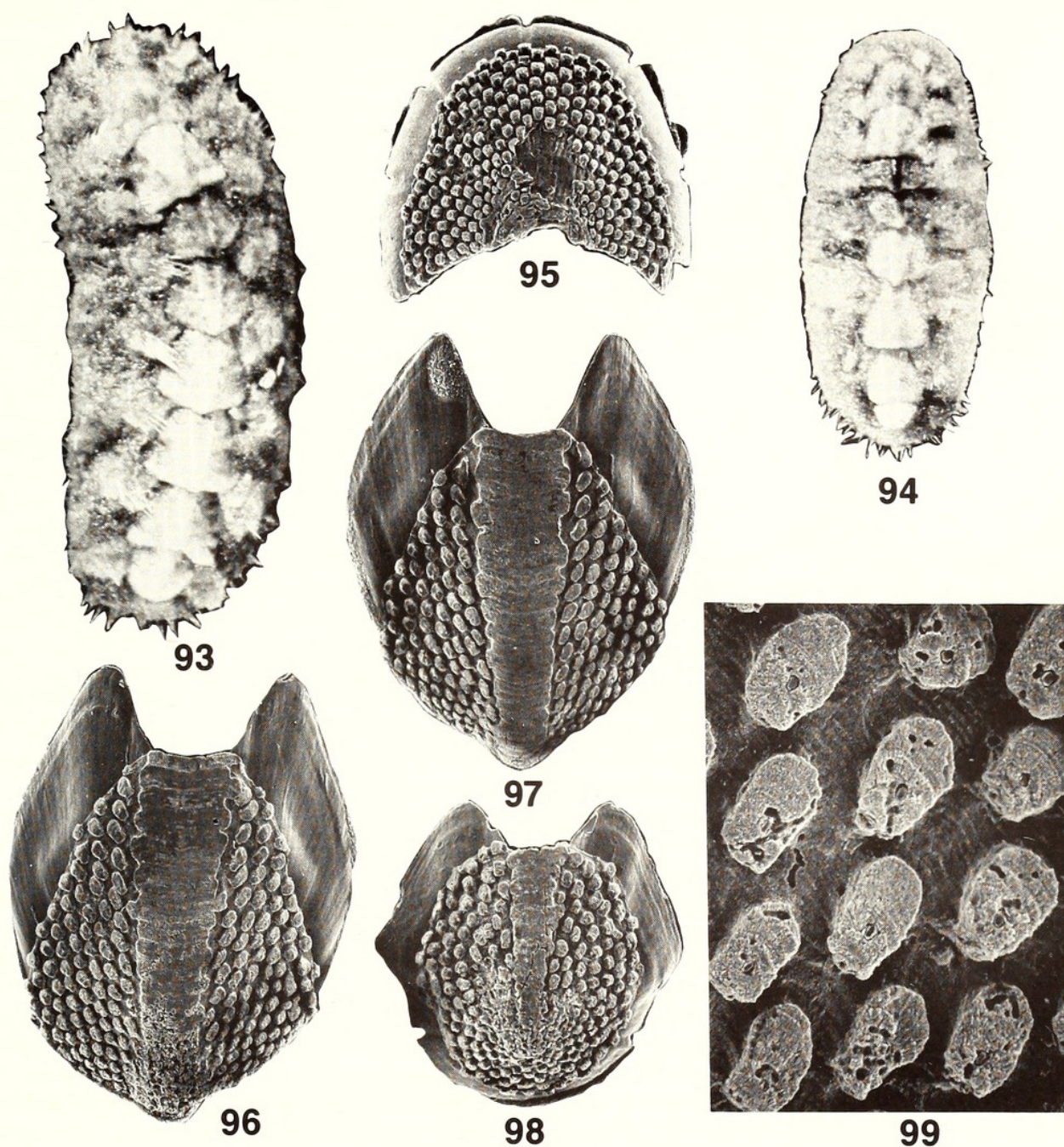
TYPE MATERIAL: HOLOTYPE: *A. balesae*: ANSP 349331 (not examined). *A. interfissa*: 5.5 mm; Monos, Avalon Bay, Trinidad; 10 Jan 1955; RMNH 9092. PARATYPES: *A. interfissa*: TRINIDAD: 1 spec., 7.0 mm; collected with holotype; RMNH 9093. ARUBA: 5 disarticulated intermediate valves; Malmok, Arasji; 14 Aug 1955; RMNH 4502. —1 spec., 8.8 mm; same locality and date; RMNH 9094.

OTHER MATERIAL EXAMINED: FLORIDA: 2 spec., 6.7, 9.6 mm, north side Vaca Key, 0-1 m, 1 Oct 1979, FSBC I 32558. —1 spec., curled, same locality, 4 Aug 1980, FSBC I 32571. —1 spec., 9.2 mm, Bonefish Key, CAS 063327. —1 spec., 9.3 mm, Peanut Id., Palm Beach Inlet, 0-1 m, 17 Aug 1982, FSBC I 30761. —2 spec., 4.4, 6.8 mm, 3 km south of St. Lucie Inlet, 2-3 m, 18 May 1978, IRCZM 61:008. —1 spec., 3.7 mm, same location and date, IRCZM 61:007. BAHAMAS: 1 spec., 8.4 mm, Eight Mile Rock, Grand Bahama, 0.5-1.0 m, 21-23 May 1981, FSBC I 32559. —2 spec., 9.5, 10.6 mm, Bartlett Hill, Eight Mile Rock, 0-0.5 m, 29 Aug 1984, FSBC I 32040. JAMAICA: 1 intermediate valve, Drunkeman's Key, RMNH. ST. EUSTATIUS: 8 spec., 2.4-4.4 mm, Tumble Down Dick Bay, RMNH. TRINIDAD: See type material. VENEZUELA: 1 spec., 7.8 mm, Tortuga Id., CAS 063326. ARUBA: 3 spec., 2.5-8.3 mm, Malmok, 14 Aug 1955, RMNH. —1 spec., 7.0 mm, Seroe Colorado, 2 May 1955, RMNH. —1 spec., 5.1 mm, Rincon, 7 May 1955, RMNH. See also type material. PANAMA: 9 spec., 2.0-4.0 mm, Galeta Id., Canal Zone, Bullock collection. —10 spec., 3.0-5.0 mm, Galeta Id., Bullock collection. —10 spec., 3.0-7.0 mm, Galeta Id., Bullock collection.

TYPE LOCALITY: Bonefish Key (= Fat Deer Key, between Vaca Key and Crawl Key, Monroe County, Florida; see Kaas, 1972) (original designation).

DISTRIBUTION: South Florida and Grand Bahama Island to Caribbean coast of Panama and Trinidad.

DESCRIPTION: Largest specimen 10.6 mm long, 3.7 mm wide including girdle; valves occupying about 33% total specimen width (Figs. 93, 94). Exposed valves white, usually with beige, olive, or brown maculations, occasionally some valves entirely brown-black; intermediate valves noticeably longer than wide.



Figs. 93-99. *Acanthochitona balesae* Abbott, 1954. **Fig. 93.** Whole specimen, 9.6 mm; Vaca Key, Monroe County, Florida; FSBC I 32558. **Fig. 94.** Entire specimen, 6.7 mm; same lot. **Fig. 95.** Valve i ex curled specimen; Vaca Key, Florida; FSBC I 32571. **Fig. 96.** Valve iv, same specimen. **Fig. 97.** Valve v, same specimen. **Fig. 98.** Valve viii, same specimen. **Fig. 99.** Tegmental pustules, valve iv, same specimen (field width = 240 μ m).

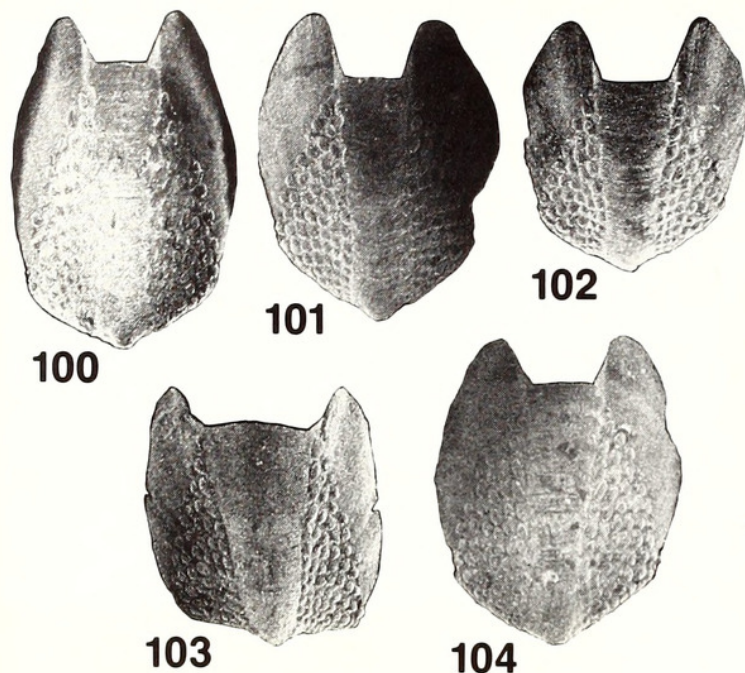
Girdle beige to tan (bleached totally white in some preserved specimens), with green, brown, or black patches between white spicule clusters of dorsal tufts.

Valve i semilunate (Fig. 95), slightly wider than long, markedly concave posteriorly, with anterior insertion plate bearing 5 slits; tegmentum occupying about 90% total valve length. Posterior margins of valves iii-vi strongly produced (Figs. 96, 97), those of remaining valves nearly straight; tegmentum longer than wide, subpentagonal, widest at posterolateral corners, with straight anterolateral margins; sutural laminae long, narrow, separated at anterior, acute tips by U-shaped sinus, margins parallel with longitudinal axis of valves, with or without single, narrow slits along margins. Valve

viii about as wide as long (Fig. 98), rounded posteriorly, with mucro posterior of center; tegmentum subpentagonal, longer than wide, dropping rapidly behind mucro; sutural laminae long, narrow, with straight anterolateral margins, subacute anterior tips separated by U-shaped sinus; 2 small slits in posterior insertion plate.

Jugum moderately expanded anteriorly, smooth, with irregular lateral margins merging with tegmental pustules. Tegmentum of all valves with peg-like, elevated, ovate to spatulate pustules (Fig. 99) about 90 μ m long, 45 μ m wide, with single subcentral macrostethete, usually 3-4 microstethetes.

Girdle upper surface evenly covered with short (80 μ m), straight to slightly bent, blunt or sharp-tipped, light or dark



Figs. 100-104. *Acanthochitona balesae* Abbott, 1954. Intermediate valves of disarticulated paratype of *A. interfissa* Kaas, 1972; Malmok, Arasji, Aruba; RMNH 4502. Length of largest valve (Fig. 100) 1.6 mm, including sutural laminae.

colored spicules; 18 anterior and sutural tufts comprised of about 50 straight, slender, sharp-tipped, vitreous spicules up to 700 μm long; margin fringed with straight, slender, sharp-tipped spicules 250-280 μm long; underside evenly covered with short (50-60 μm), straight, sharp-tipped spicules directed toward periphery.

DISCUSSION: Several names have been proposed for this species. Pilsbry (1940) illustrated without text a chiton he called *Acanthochitona balesae* from Bonefish Key, Florida, thereby creating a *nomen nudum*. Abbott (1954) included *A. balesae* 'Pilsbry 1940' from Bonefish Key, with brief differential diagnostic remarks. Kaas (1972) recognized the nude status of Pilsbry's name; to rectify that problem, he described four specimens from Bonefish Key (RMNH) and named them *A. elongata*. In the same paper, Kaas named *A. interfissa* from Trinidad and Aruba and noted similarities between that species and *A. elongata*. Abbott (1974) included *A. balesae* 'Pilsbry' Abbott, repeated his diagnostic comments, and stated that *A. elongata* was a synonym. Bullock (1974) pointed out that Kaas "overlooked the fact that Abbott ... validated Pilsbry's name, and *A. elongata* Kaas must be considered a junior synonym of *A. balesae* 'Pilsbry' Abbott." Bullock also remarked that the relationship between *A. interfissa* and *A. balesae* should be investigated. Watters (1981) relegated both *A. elongata* and *A. interfissa* to the synonymy of *A. balesae* and designated a lectotype (ANSP 349331; Bonefish Key) for *A. balesae*. Ferreira (1985) incorrectly stated that Abbott (1974) regarded *A. balesae* to be a synonym of *A. elongata*. Ferreira clearly considered Abbott's diagnosis inadequate and without priority over *A. elongata*. He agreed with Watters that *A. interfissa* is a synonym of *A. elongata*, but he also relegated

A. andersoni Watters, 1981, to the synonymy of *A. elongata*. Finally, Ferreira declared all the above taxa to be juveniles and secondary synonyms of *Choneplax lata* (Guilding, 1829).

The International Code of Zoological Nomenclature requires that, to be available, a species name introduced after 1930 must be accompanied by a description or definition that states in words characters that are purported to differentiate the taxon [Article 13(a)(i); ICZN, 1985]. Abbott's (1954) account of *Acanthochitona balesae*, although brief, addressed size, proportions, pustule morphology, shape and ornamentation of the jugum, and a location where the species occurs; some characters were compared with those of *A. pygmaea*. Such treatment satisfies the requirements of ICZN Article 13, so *A. balesae* Abbott, 1954, is valid, and *A. elongata* Kaas, 1972, is a junior synonym.

I examined the holotype and three of the four paratypes of *Acanthochitona interfissa* Kaas and the holotype and seven paratypes of *A. andersoni* Watters. I found no characters upon which to separate the holotype and paratypes of *A. interfissa* from topotypic specimens of *A. balesae* from Bonefish Key, so I cannot refute contentions by Watters (1981) and Ferreira (1985) that *A. interfissa* is a synonym of *A. balesae*. However, *A. andersoni* is not a synonym of *A. balesae*, and neither name is a synonym of *Choneplax lata*.

Several problems are associated with the original description and type series of *Acanthochitona interfissa*. Kaas reported the holotype and a paratype from Trinidad and three paratypes from Aruba. He reported that he disarticulated and illustrated the paratype from Trinidad. However, although the valves and spicules of that specimen now are almost totally dissolved in preservative, the specimen is intact, as is the holotype. One of the Aruba paratypes has been disarticulated. Five of the valves remain (Figs. 100-104), but valves i, viii, and an intermediate valve are missing; none of the valves resembles the curiously misshapen valve ii illustrated by Kaas.

Except for valve viii, the description and illustrations of valves of *Acanthochitona interfissa* (Kaas, 1972: figs. 95-101) seem indistinguishable from those of *A. balesae*. Valve viii of *A. interfissa* as illustrated by Kaas (his figs. 95-97) differs from the corresponding valve of *A. elongata* (= *A. balesae*) (Kaas, 1972: figs. 90, 91) by tegmental shape, pustule configuration and size, jugal length and expansion, by possession of a greatly flared insertion plate and laminae, and most notably, by possession of a medial third slit in the posterior insertion plate. Conversely, valves i, ii, and iv of *A. interfissa* (Kaas, 1972: figs. 98-101) are indistinguishable from those of *A. balesae* whose corresponding valves Kaas described but did not illustrate in the account of *A. elongata* which immediately preceded that of *A. interfissa*.

Ferreira (1985) could have been prompted to combine *Acanthochitona andersoni* with *A. interfissa* because of Kaas' description of valve viii of the latter. Among the Caribbean *Acanthochitona* species, valve viii of *A. interfissa* as illustrated by Kaas most resembles that of *A. andersoni*, if the third slit of *A. interfissa* is ignored. I found a single specimen of *A. andersoni* among three *A. balesae* in an uncatalogued lot (RMNH) from Malmok, Aruba, collected on the same date as

were the paratypes of *A. interfissa*. However, no species of *Acanthochitona* normally possesses a third slit in valve viii. Because the 3-slitted valve no longer accompanies the type material, it seems best to regard the third slit as an anomalous, additional one of the kind that sometimes occurs on other normally 2-slitted species.

Kaas (1972) described the sutural laminae of intermediate valves of *Acanthochitona elongata* as "unslit, but with little excavations where the slits might be expected"; for *A. interfissa*, he described "valves with 1 slit, except valves iv-vi which are unslit." The specimen of *A. balesae* I dissected, collected within 1 km of the type-locality, has distinct slits on valves ii and vii but lacks slits on valves iii-vi. Kaas also described a longitudinally striate jugum for *A. elongata*, which he contrasted with the smooth jugum of *A. interfissa*. Although longitudinal striae were sometimes visible beneath the surface, I saw only a smooth jugum on all specimens of *A. balesae* I examined.

Despite my inability to find objective differences between the two taxa, it should be noted that specimens of the northern Caribbean *Acanthochitona balesae* and those of the southern *A. interfissa* can be sorted by seemingly subjective characters. Basically, southern specimens are smaller, more drab, and have finer spicules and sculpture than northern specimens. Using those "characters", all Florida and Bahamian specimens are assignable to *A. balesae* and all specimens from St. Eustatius to Trinidad, Venezuela, Aruba and Panama are assignable to *A. interfissa*. Further work may yet reveal objective characters which can be used to demonstrate two species within the group.

Watters' (1981) drawings of valves from Puerto Rico are too schematic to reveal with certainty whether they belong to *A. balesae*.

***Acanthochitona andersoni* Watters, 1981**

Figs. 105-109

Acanthochitona andersoni Watters, 1981: 173-176, pl. 2e-g, pl. 4i.

Acanthochitona pygmaea, Lyons, 1981: 36 (pars, Dry Tortugas sta. 4 only) [non *A. pygmaea* (Pilsbry, 1893)].

Choneplax lata, Ferreira, 1985: 208-213 (pars) [non *C. lata* (Guilding, 1829)].

TYPE MATERIAL: HOLOTYPE: 11.3 mm, Calliagua, St. Vincent, Feb 1972, ANSP 332171. PARATYPES: FLORIDA: 1 spec., 6.4 mm, off Destin, 55 m, ANSP 220834. —2 spec., 5.7, 7.5 mm, West Summerland Key, Oct 1973, Bullock collection. —1 spec., curled, West Summerland Key, 1 June 1974, Bullock collection. —1 spec., 5.3 mm, off Boynton, 55 m, ANSP 220833. BAHAMAS: 1 spec., 9.5 mm, west of Haulover, North Bimini, ANSP 325808. —1 spec., 7.5 mm, east of Turtle Rocks, 6 m, ANSP 325864.

OTHER MATERIAL EXAMINED: FLORIDA: 1 spec., 5.7 mm, Garden Key, Dry Tortugas, 0-2 m, 5 Oct 1979, FSBC I 32551. —3 spec., 4.6-7.5 mm, Garden Key, 30 Apr 1975, CAS 063329. —1 spec., 6.3 mm, Key West, CAS 063321. —1 spec., 11.5 mm, West Summerland Key, 1976, Bullock collection. —1 spec., curled, West Summerland Key, 1978, Bullock collection. —1 spec., 8.0 mm, Missouri Key, 0.5-1.0 m, 25 July 1987, FSBC I 32557. —1 spec., curled, Burnt Point, Crawl Key, 2.5 m, 4 Aug 1982, FSBC I 32426. —1 spec., 4.7 mm, Tennessee

Reef, off Long Key, 13.7 m, 12 July 1986, FSBC I 32556. —1 spec., 7.0 mm, Elbow Reef, 25°07.7'N, 80°15.9'W, 18.3 m, 7 June 1979, IRCZM 61:018. —3 spec., curled, east of Elliott Key, RMNH. —1 spec., 8.8 mm, Peanut Id., Palm Beach Inlet, 0-1 m, 29 Aug 1982, FSBC I 30762. BAHAMAS: 2 spec., 3.4, 10.1 mm, Bartlett Hill, Eight Mile Rock, Grand Bahama, 0-0.5 m, 29 Aug 1984, FSBC I 32553. —1 spec., 7.5 mm, Tamarind Beach Reef, Grand Bahama, 18 m, 28 Aug 1984, FSBC I 32552. —2 spec., 7.2, 8.0 mm, Green Turtle Cay, Abaco, 0.5 m, May 1978, FSBC I 32550. PUERTO RICO: 1 spec., 6.0 mm, Isla Turrámote, La Parguera, May 1985, FSBC I 32554. SABA: 5 spec., curled, Fort Bay pier, 7 July 1973, RMNH. ST. LUCIA: 2 spec., 8.0, 9.0 mm, Anse Chastenet, 1-3 m, 4 Nov 1984, Bullock collection (1), FSBC I 32572 (1). ARUBA: 1 spec., 3.0 mm, Malmok, Arasji, 14 Aug 1955, RMNH. BONAIRE: 1 spec., 9.0 mm, 2 km north of Kralendijk, 4 m, 7 Oct 1986, FSBC I 32555. CURAÇAO: 1 spec. (?), 2.0 mm, Piscadera Baai, 0-4 m, Apr 1966, Bullock collection. —1 spec. (?), 2.5 mm, Knip Baai, 6 Feb 1949, RMNH. VENEZUELA: 1 spec., crushed, Tortuga Id., 1 Aug 1936, RMNH.

TYPE LOCALITY: Calliagua, St. Vincent (original designation).

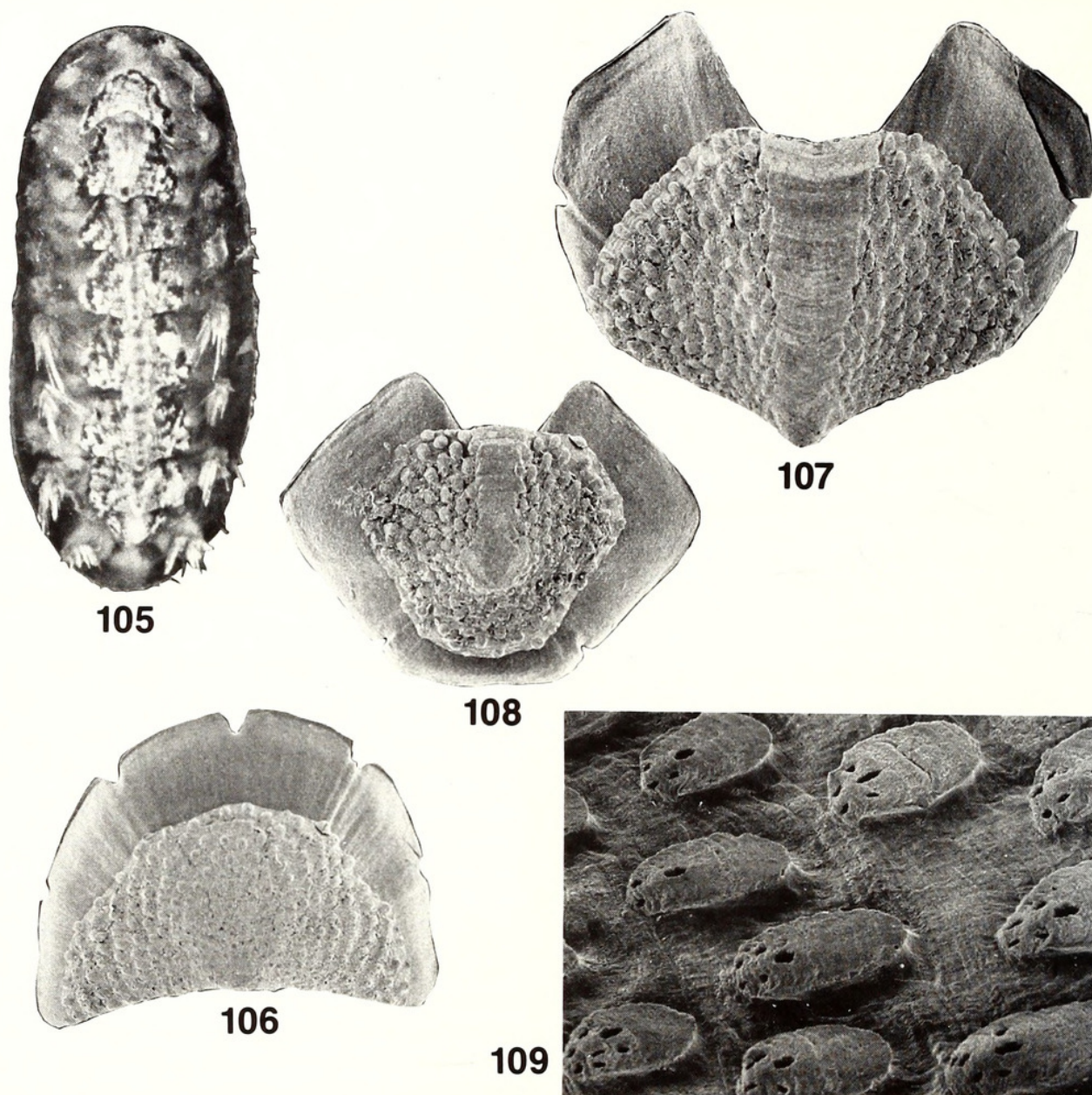
DISTRIBUTION: Both coasts of Florida, the Bahama Islands, the Lesser Antilles, southern Netherlands Antilles, and Venezuela. Watters (1981) also reported specimens from Quintana Roo, Mexico, and Caribbean Panama.

DESCRIPTION: Largest specimen (holotype) 11.3 mm long, 4.8 mm wide including girdle; valves occupying about 50% of total specimen width (Fig. 105). Exposed parts of valves of holotype white, extensively mottled with black; most other specimens white or light green with few brown or black flecks, few specimens apricot or rose. Girdle white, buff, tan, or dark brown, often with bar-like maculations; spicules translucent white.

Valve i semilunate (Fig. 106), wider than long, slightly to markedly concave posteriorly, with anterior insertion plate bearing 5 slits; tegmentum occupying 70-75% total valve length. Valves ii-vii prominently beaked posteriorly (Fig. 107); tegmentum pentagonal, as wide or wider than long, with slightly convex anterolateral margins; sutural laminae moderately to considerably produced anteriorly, with vague to distinct anterolateral angle, subacutely rounded anteriorly, separated by wide anterior sinus; single slits along lateral margins. Valve viii pentagonal (Fig. 108), widest at anterolateral corners, dropping away rapidly behind elevated, postcentral mucro; sutural laminae well-developed, with straight margins and sharply angled corners; 2 narrow, relatively small slits in posterior insertion plate.

Jugum smooth, narrow, little expanded anteriorly, merging laterally with tegmental pustules. Tegmentum of all valves covered with ovate or subspatulate pustules (Fig. 109) 90-130 μ m long, 60-80 μ m wide, with single adapical macrostethete, 2-6 micresthetes between macrostethete and apex.

Girdle upper surface covered with dense mat of very small (40 μ m) slender spicules; 18 anterior and sutural tufts comprised of 12-20 stout, straight, sharp-tipped vitreous spicules up to 1.2 mm long, accompanied at base by many sharp, slender, needle-like spicules about 200 μ m long; margin fringed with stout, straight to slightly curved vitreous spicules about 140 μ m long, with markedly larger (200 μ m) but other-



Figs. 105-109. *Acanthochitona andersoni* Watters, 1981. **Fig. 105.** Holotype, 11.3 mm; Calliagua, St. Vincent; ANSP 332171. **Fig. 106.** Valve i ex 8.0 mm specimen; Anse Chastenot, St. Lucia; FSBC I 32572. **Fig. 107.** Valve iv, same specimen. **Fig. 108.** Valve viii, same specimen. **Fig. 109.** Tegmental pustules, valve iv ex 8.0 mm specimen; Green Turtle Cay, Abaco, Bahamas; FSBC I 32550 (field width = 365 μ m).

wise similar spicules sparsely scattered throughout; underside covered with slender, sharp-tipped, vitreous spicules about 80 μ m long directed toward periphery.

DISCUSSION: Specimens of *Acanthochitona andersoni* have been confused with *A. pygmaea*, *A. balesae*, and *Choneplax lata*. The smooth, not incised jugum and relatively narrow, not widely rectangular intermediate valves distinguish *A. andersoni* from *A. pygmaea*. The tegmentum of intermediate valves of *A. andersoni* is as wide or slightly wider than long, whereas that of *A. balesae* is longer than wide. Morphology of tegmental pustules is also distinctive for each of the three species. *A. andersoni* is not *C. lata*, as evidenced by possession of 2 distinct slits on valve viii. Ferreira (1985) identified lots CAS 063329 from Dry Tortugas and IRCZM 61:108 from Elbow Reef as *Choneplax lata* and CAS 063321 from Key West as *Acantho-*

chitona spiculosa.

***Acanthochitona bonairensis* Kaas, 1972**

Figs. 110-113

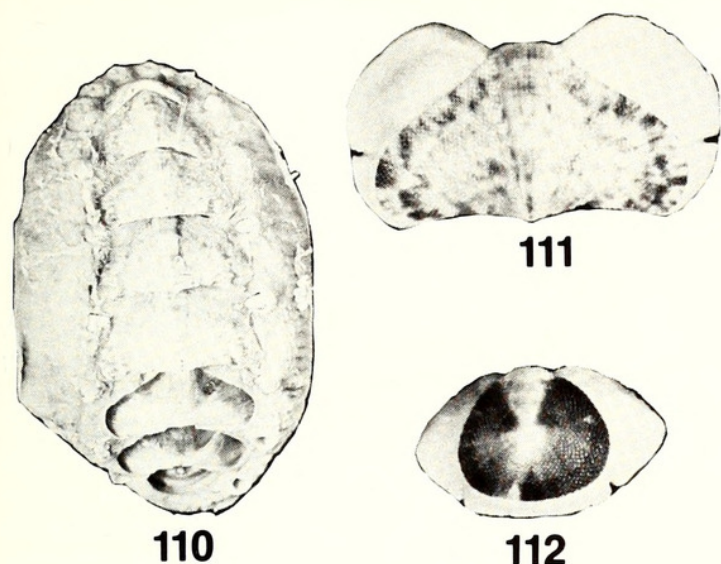
Acanthochitona bonairensis Kaas, 1972: 44, 45, figs. 72, 73, pl. 3, figs. 1, 2. Ferreira, 1985: 207, 214.

Acanthochitona communis, Watters, 1981: 173.

Acanthochitona fascicularis, Kaas, 1985: 586.

TYPE MATERIAL: HOLOTYPE: 33 mm x 22 mm, Bonaire, RMNH.

DISCUSSION: Nothing can be added to the original description. Kaas (1972) noted the similarity in valve morphology between *Acanthochitona bonairensis* and the European species *A. communis* (Risso, 1826), but also described considerably shorter, more delicate girdle spicules on *A. bonairensis* than



Figs. 110-112. *Acanthochitona bonairensis* Kaas, 1972. **Fig. 110.** Holotype, 33.0 mm; Punt Vierkant, Bonaire; RMNH. **Fig. 111.** Valve vii of holotype. **Fig. 112.** Valve viii of holotype.

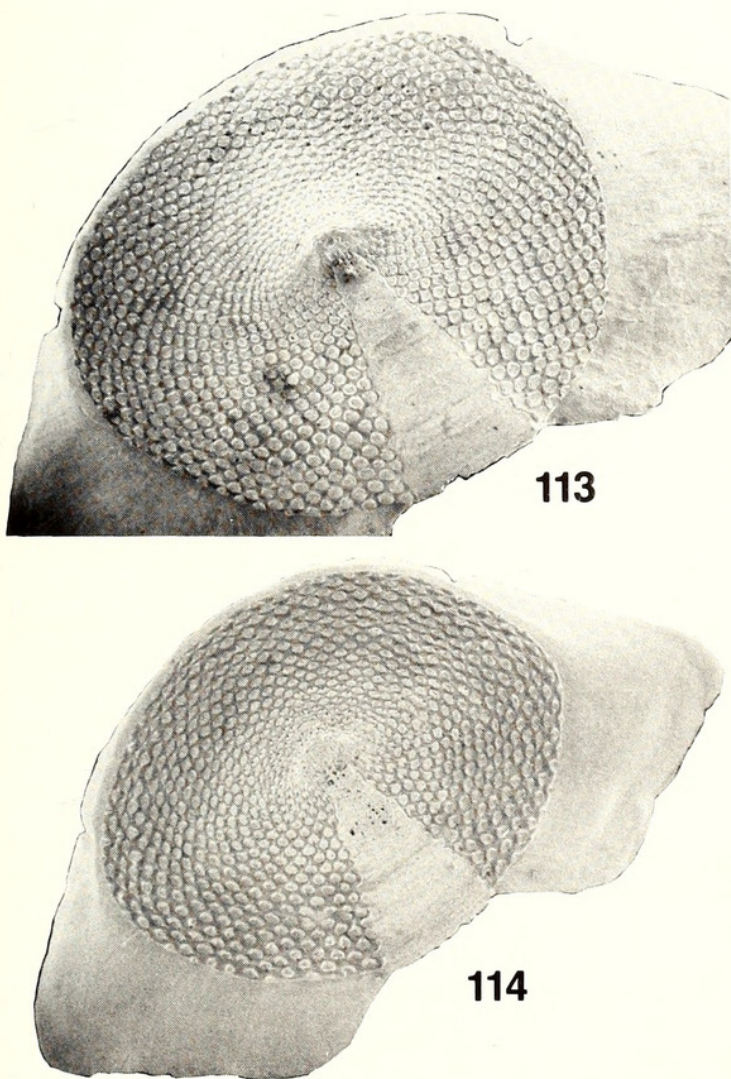


Fig. 113. *Acanthochitona bonairensis* Kaas, 1972. Valve viii of holotype. **Fig. 114.** *Acanthochitona fascicularis* (Linné, 1767). Valve viii ex specimen from Roscoff, France; FSBC I 32427. Compare outline of tegmentum with that of specimen in Fig. 113.

on *A. communis*. Watters (1981) ignored the described differences and declared *A. bonairensis* to be a synonym of *A. communis*. Kaas (1985) followed that synonymy in his review of *A. fascicularis* (Linné, 1767), a senior synonym of *A. communis*. However, Ferreira (1985) retained *A. bonairensis* as one of the few Caribbean species he considered distinct.

I compared the holotype of *Acanthochitona bonairensis* (Figs. 110-112) with specimens of *A. fascicularis* from Roscoff, France (FSBC I 32427). Differences in valve morphology (Figs. 113, 114) noted by Kaas (1972), although subtle, were confirmed, as were marked differences in girdle spicules. *A. bonairensis* remains known only from the holotype. Discovery of more Caribbean specimens would help considerably in interpretation of differences noted to date. Until such specimens are found, I believe the differences in girdle spicules provide sufficient reason to maintain *A. bonairensis* as a Caribbean species distinct from the European *A. fascicularis*.

Acanthochitona zebra Lyons, sp. nov.

Figs. 115-127

(?) *Choneplax lata*, Kaas, 1972: 55-58, figs. 108-116, pl. 2, fig. 4 (pars) [non *C. lata* (Guilding, 1829)].

Acanthochitona sp. Lyons, 1981: 35, 36.

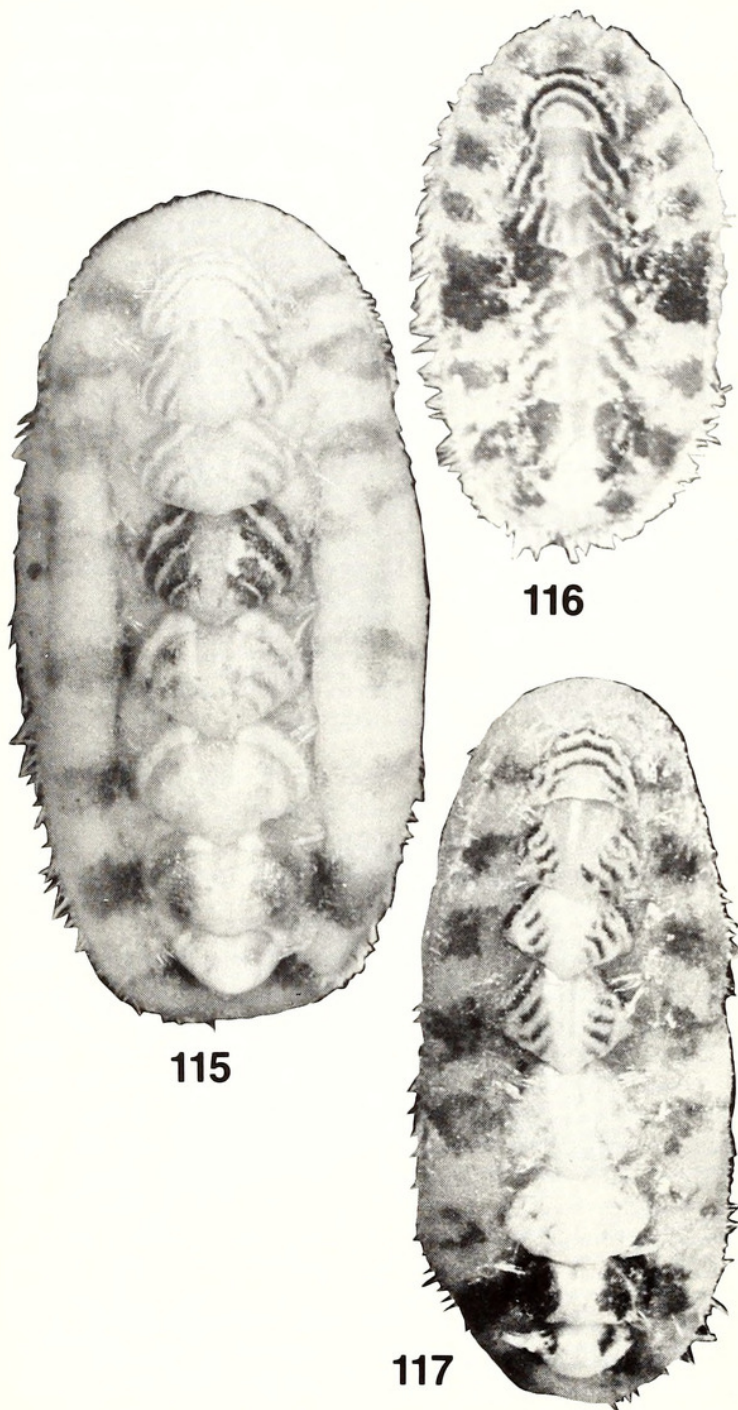
Choneplax lata, Ferreira, 1985: 208-213 (pars). [non *C. lata* (Guilding, 1829)].

TYPE MATERIAL: HOLOTYPE: Length 15.0 mm, Silver Cove Canal, Freeport, Grand Bahama Island, 0.5-1.5 m, 28 Aug 1984, W. G. Lyons, collector, USNM 859319. PARATYPES: FLORIDA: 1 spec., 12.0 mm, Long Key Reef, Dry Tortugas, intertidal, 11-12 May 1979, FSBC I 32479. —6 spec., 7.0-11.2 mm, patch reef near Long Key Reef, Dry Tortugas, 1.5-2.5 m, 11-12 May 1979, ANSP A12125 (1), FSBC I 32478 (5). —1 spec., 4.5 mm, Tennessee Reef, off Long Key, 13.7 m, 12 July 1986, FSBC I 32485. BAHAMAS: 1 spec., 11.3 mm, same locality and date as holotype, FSBC I 32483. —1 spec., 9.7 mm, Caravel Beach, Freeport, Grand Bahama, 1 m, Jan 1981, FSBC I 32480. —6 spec., 5.0-10.0 mm, Tamarind Beach Reef, Grand Bahama, 18 m, 28 Aug 1984, RMNH 55990 (1), FSBC I 32482 (5). —1 spec., 8.2 mm, Salt Pond, Long Island, Aug 1975, CAS 063328. PUERTO RICO: 2 spec., 7.2, 9.3 mm, Isla Turrámote, La Parguera, 9.1 m, May 1985, FSBC I 32484. BELIZE: 1 spec., 15.0 mm, Carrie Bow Cay, 0-1 m, 23 Mar 1981, IRCZM 61:092.

OTHER MATERIAL EXAMINED: FLORIDA: 1 spec., 3.4 mm, east of Elliott Key, 2-6 m, 5 Sept 1963, RMNH. BAHAMAS: 7 intermediate valves, Gold Rock, Grand Bahama, bottom sediments, 24.4 m, May-July 1981, FSBC I 32481. —7 intermediate valves, Grand Bahama, bottom sediments, May 1981, R. Quigley collection. ARUBA: 2 spec. (?), both small, missing valve viii, Paardenbaai rif, 28 Apr 1955, RMNH. CURAÇAO: 3 spec., 5.2-7.3 mm, Piscadera Baai, 27 July 1973, RMNH. —2 spec. (?), 2.7, 2.9 mm, Caracas Baai, 22 Apr 1955, RMNH. —1 spec., 6.5 mm, Spaanse Water, 17 Nov 1968, RMNH. —1 spec. (?), 3.4 mm, Awa di Oostpunt, 0.25-1.0 m, 22 Feb 1970, RMNH.

TYPE LOCALITY: Silver Cove Canal, Freeport, Grand Bahama Island.

DISTRIBUTION: Dry Tortugas, Florida Keys, and Grand Bahama Island to Puerto Rico and Belize, Aruba and Curaçao; intertidal to 18 m, single valves from sediments in 24.4 m.



Figs. 115-117. *Acanthochitona zebra* Lyons, sp. nov. **Fig. 115.** Holotype, 15.0 mm; Freeport, Grand Bahama; USNM 859319. **Fig. 116.** Paratype, 8.3 mm; Tamarind Beach Reef, Grand Bahama; FSBC I 32482. **Fig. 117.** Paratype, 11.1 mm; Dry Tortugas, Florida; FSBC I 32478.

DESCRIPTION: Largest specimen (holotype) 15.0 mm long, 7.2 mm wide including girdle; valves and girdle occupying approximately equal portions of total specimen width (Figs. 115-117). Valve i with 3-5 olivaceous or brown concentric bands, expressed on valves ii-vii as transverse stripes (chevrons) extending posterolaterally from jugum; bands usually strongest on valves i-v, commonly obscured by overall dark olive or brown color on valves iv and vii; valve viii mostly white, with single large olivaceous spots on lateral areas. Girdle white with irregular olivaceous or green bands cross-

ing upper surface from valves to peripheral margins, sometimes with broad, black spots at middle or elsewhere on each side.

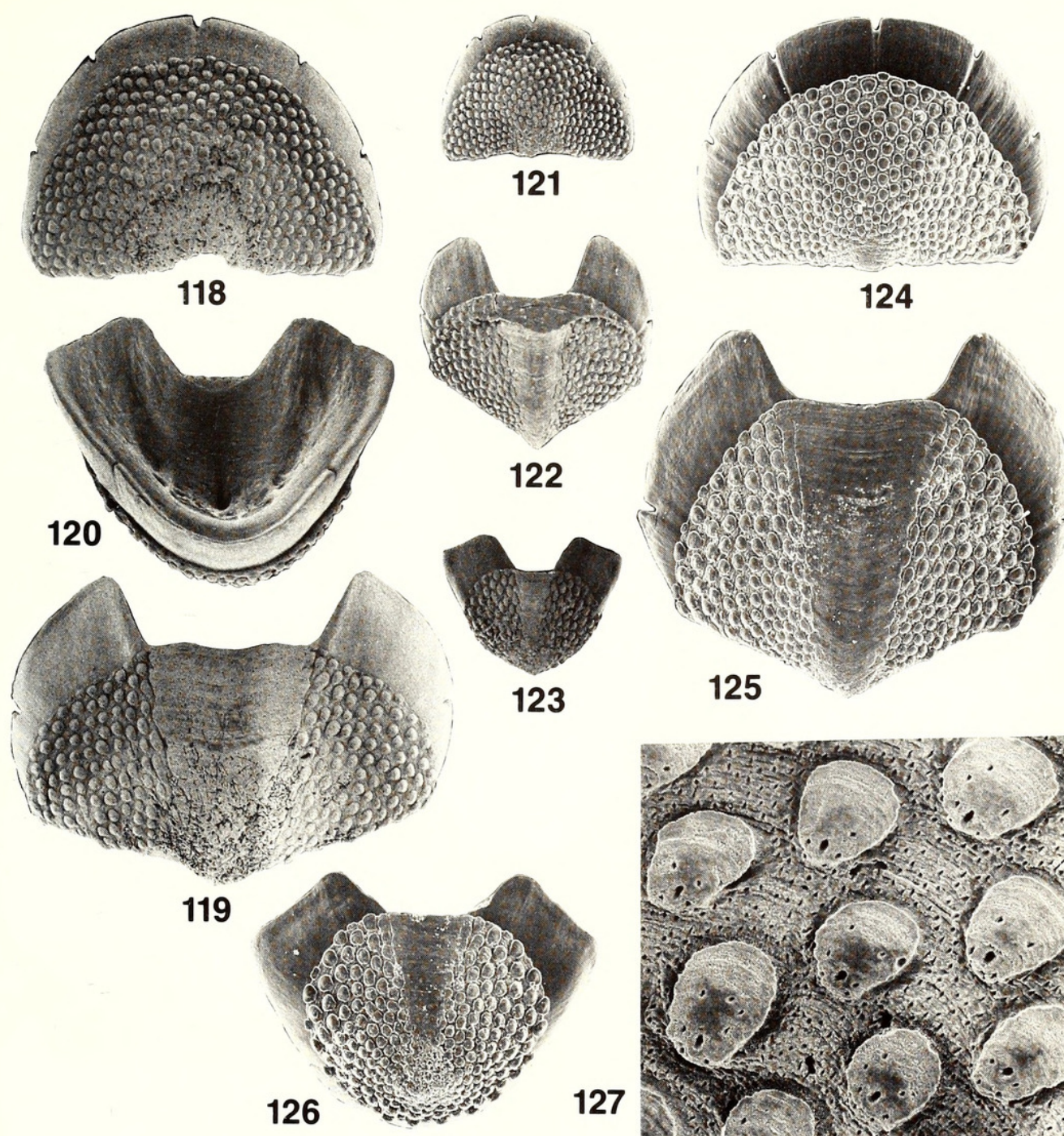
Valve i semilunate (Fig. 118), wider than long, posterior margin straight, slightly beaked, with anterior insertion plate bearing 5 slits; tegmentum occupying 80-85% of valve length. Valves ii-vii strongly beaked posteriorly (Fig. 119); tegmentum evenly to broadly pentagonal, with convex anterolateral margins; sutural laminae moderately narrow, curving anteromedially from posterolateral corners of tegmentum, with subacute anterior tips separated by broad sinus of same width as anterior end of jugum; single narrow slits along lateral margins. Valve viii tegmentum roughly ovate, widest mesially, truncate anteriorly, extending to overhang posterior edge of insertion plate (Fig. 120). Mucro distinctly posterior; sutural laminae extending obliquely anteriorly, subquadrate, of moderate length; two slits in posterior insertion plate very fine, barely discernible with dissecting microscope. Valve morphology of Puerto Rican juveniles and Floridan adults as illustrated (Figs. 121-126).

Jugum of valves ii-viii smooth, wedge-shaped, widest anteriorly. Tegmentum covered with densely packed, flattened, spatulate pustules (Fig. 127), approximately 80-100 μm long, 70 μm wide, radiating anteriorly from beak of valve i, anterolaterally from jugum of valves ii-vii, and from mucro of valve viii; pustules with single macrostethete near apex, 4-7 microstethetes surrounding macrostethetes, sometimes more on Florida specimens; many additional microstethetes dispersed across surface of tegmental plain.

Girdle upper surface covered with fine (100 μm) spicules; 18 anterior and sutural tufts comprised of 8-10 reddish brown, amber, or white, moderately long (to 650 μm), slightly curved, blunt-tipped spicules; marginal spicules straight or slightly curved, approximately 550 μm long, with blunt tips, white, sometimes alternating with amber; underside covered with fine (60 μm), sharp-tipped spicules directed toward periphery.

DISCUSSION: The olivaceous stripes on the tegmentum of *Acanthochitona zebra* strongly resemble those of *A. lineata*, and *A. astrigera* sometimes has white stripes or maculations on the dark blue-green tegmentum of some valves. Moreover, all three species occurred together at the type-locality of *A. zebra*. However, *A. zebra* can be separated readily from the other two species by its extremely posterior mucro, from which the tegmentum drops rapidly to overhang the posterior insertion plate, and by the dorsal tufts of the girdle, which contain only 8-10 blunt-tipped spicules. Pustular shape, as well as location of macrostetheses and microstethetes, further distinguish *A. zebra* from *A. astrigera* and *A. lineata*.

Valve proportions of Florida specimens differ somewhat from those of specimens from the Bahamas and Puerto Rico, but morphology of valve viii and the tegmental pustules, as well as the color pattern, indicate they are conspecific. Five RMNH lots from Aruba and Curaçao appear to be this species, but the concentric bands and stripes are only weakly expressed on the four largest (5.2-7.3 mm) specimens and are not evident at all on the five smaller (2.7-3.4 mm) specimens.



Figs. 118-127. *Acanthochitona zebra* Lyons, *sp. nov.* **Fig. 118.** Valve i ex 10.0 mm paratype; Tamarind Beach Reef, Grand Bahama; FSBC I 32482. **Fig. 119.** Valve iv, same specimen. **Fig. 120.** Valve viii, same specimen; ventral view showing underhung posterior insertion plate with vestigial slits. **Fig. 121.** Valve i ex 7.2 mm paratype; Isla TurrMOTE, Puerto Rico; FSBC I 32484. **Fig. 122.** Valve iv, same specimen. **Fig. 123.** Valve viii, same specimen. **Fig. 124.** Valve i ex 11.0 mm paratype; Dry Tortugas, Florida; FSBC I 32478. **Fig. 125.** Valve iv, same specimen. **Fig. 126.** Valve viii, same specimen. **Fig. 127.** Tegmental pustules, valve iv, same specimen as 118 (field width = 335 μ m).

Ferreira (1985) identified the CAS specimen from Long Island, Bahamas, and the IRCZM specimen from Carrie Bow Cay, Belize, as *Choneplax lata*.

ETYMOLOGY: From the Amharic "zebra", as in *Equus zebra*, an African equine with similar markings.

Genus *Choneplax* Dall, 1882
***Choneplax lata* (Guilding, 1829)**

Figs. 128-145

Chitonellus latus Guilding, 1829: 28.

Chiton strigatus Sowerby, 1840: 289.

(?) *Chiton hastatus* Sowerby, 1840: 290, pl. 16, fig. 4.

Choneplax latus, Pilsbry, 1893: 60, pl. 8, fig. 15.

Choneplax lata, Kaas, 1972: 55-58, figs. 108-116, pl. 2, fig. 4 (pars). Ferreira, 1985: 208-213 (pars).

MATERIAL: BAHAMAS: 4 spec., large, curled, West End, Grand Bahama, intertidal, May 1977, FSBC I 32546. —3 spec., 17.7-22.4 mm, Settlement Point, West End, Grand Bahama, 2 m, 23 May 1981, FSBC

I 32547. —55 spec., 6.5-32.0 mm, Bahama Beach Canal, West End, Grand Bahama, intertidal, 29 Aug 1984, FSBC I 32548. —1 spec., 26.0 mm, New Providence, CAS 063325. —1 spec., 15.0 mm, Nicolls Town, Andros, 2 m, July 1976, CAS 063323. CUBA: 2 spec., 15.9, 17.0 mm, Phillips Park, Guantanamo Bay, intertidal, 9 Apr 1984, FSBC I 32549. BELIZE: 3 spec., 19.0-22.0 mm, Carrie Bow Cay, 0-1 m, 23 Mar 1981, IRCZM 61:051. —1 spec., 9.0 mm, same locality and date, IRCZM 61:053. HONDURAS: 1 spec., 10.0 mm, First Bight, Roatan, 1-2 m, Aug 1982, FSBC I 32073. GUADELOUPE: 4 spec., 13.0-20.0 mm, Guadeloupe, 28 May 1978, CAS 063324.

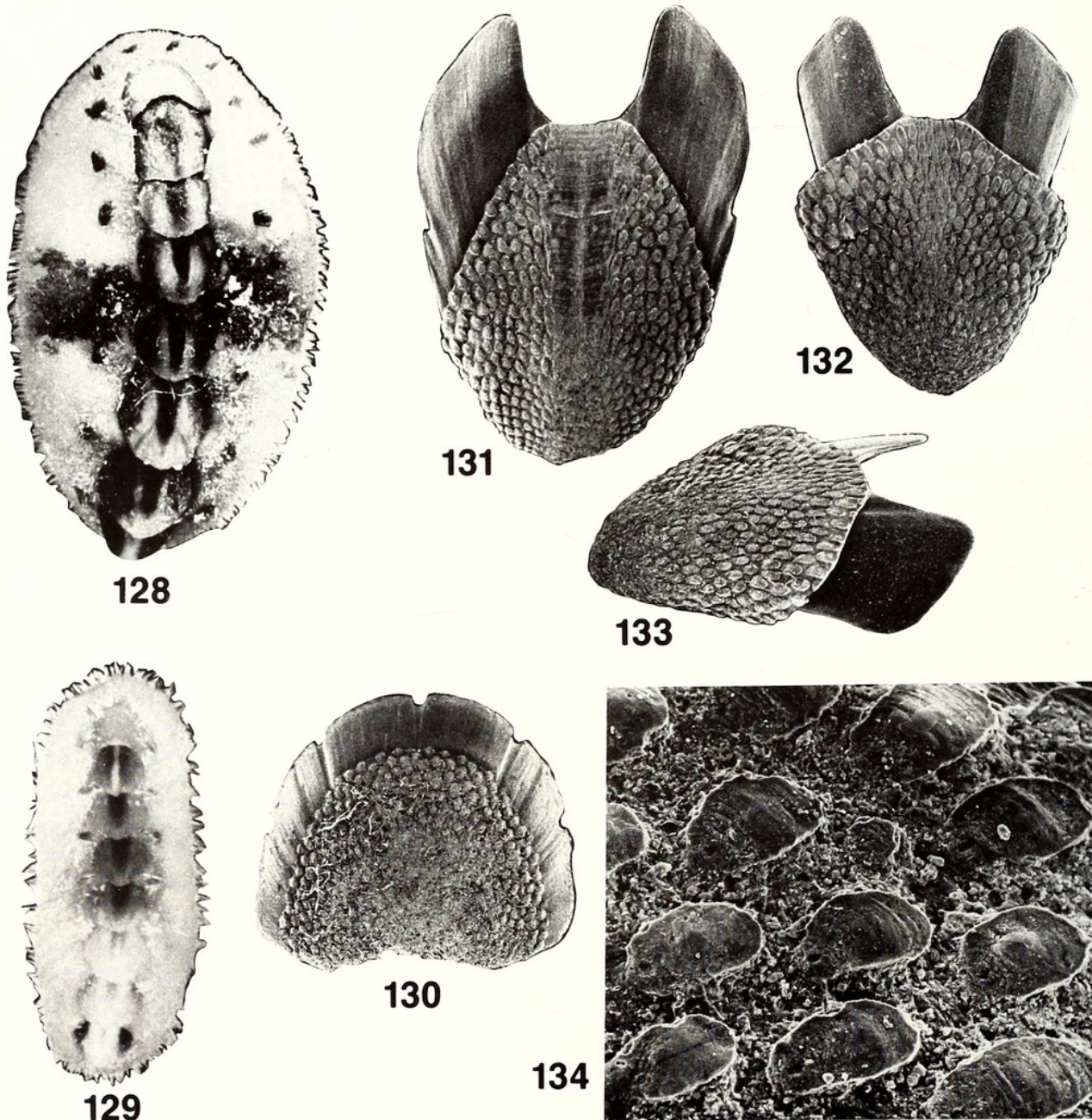
TYPE LOCALITY: St. Vincent (original designation).

DISTRIBUTION: Grand Bahama Island, Cuba, Belize, Honduras, Guadeloupe, St. Vincent; intertidal and shallow (1-2 m)

subtidal zones. Kaas (1972) reported specimens from the Virgin Islands, Tobago, Bonaire, and Curaçao.

DESCRIPTION: Largest specimen 32.0 mm long, 13.7 mm wide including girdle; valves occupying approximately 33% of total specimen width (Fig. 128), proportionally more in juveniles (Fig. 129). Valves brown-black, frequently eroded to create bluish white bands between jugum and lateral margins. Girdle yellow to greenish gold, often with brown or black band across middle.

Valve i semilunate (Fig. 130), wider than long, slightly sinuous posteriorly, with anterior insertion plate bearing 5 distinct slits which continue as shallow grooves leading to anterior edge of tegmentum; tegmentum occupying approx-



Figs. 128-134. *Choneplax lata* (Guilding, 1829). **Fig. 128.** Whole specimen, 22.4 mm; Settlement Point, Grand Bahama; FSBC I 32547. **Fig. 129.** Juvenile, 6.5 mm; West End, Grand Bahama; FSBC I 32548. **Fig. 130.** Valve i ex 13.0 mm specimen; same lot as 129. **Fig. 131.** Valve i, same specimen. **Fig. 132.** Valve viii, same specimen, dorsal view. **Fig. 133.** Same valve viii, lateral view. **Fig. 134.** Tegmental pustules, valve iv, same specimen (field width = 315 μ m).

imately 85% of valve length. Valves ii-vii elongate (Fig. 131), strongly produced posteriorly to overhang following valves; tegmentum elongate, pentagonal, widest behind middle, with straight anterolateral margins; sutural laminae long, nearly in line with plane of valves, curving anteromedially from posterolateral corners of tegmentum, with subacute tips separated anteriorly by deep, U-shaped sinus; single, shallow, notch-like slits along lateral margins. Valve viii tegmentum pentagonal (Fig. 132), widest anteromesially, produced posteriorly, with mucro at posterodistal tip (Fig. 133); jugum absent; sutural laminae extending tooth-like from anterolateral margins of tegmentum; posterior insertion plate and slits absent. Tegmental morphology of small specimens varies considerably from that of larger specimens (Figs. 135-142). Valves of very large specimens usually so eroded that posterior edges are straight instead of pointed.

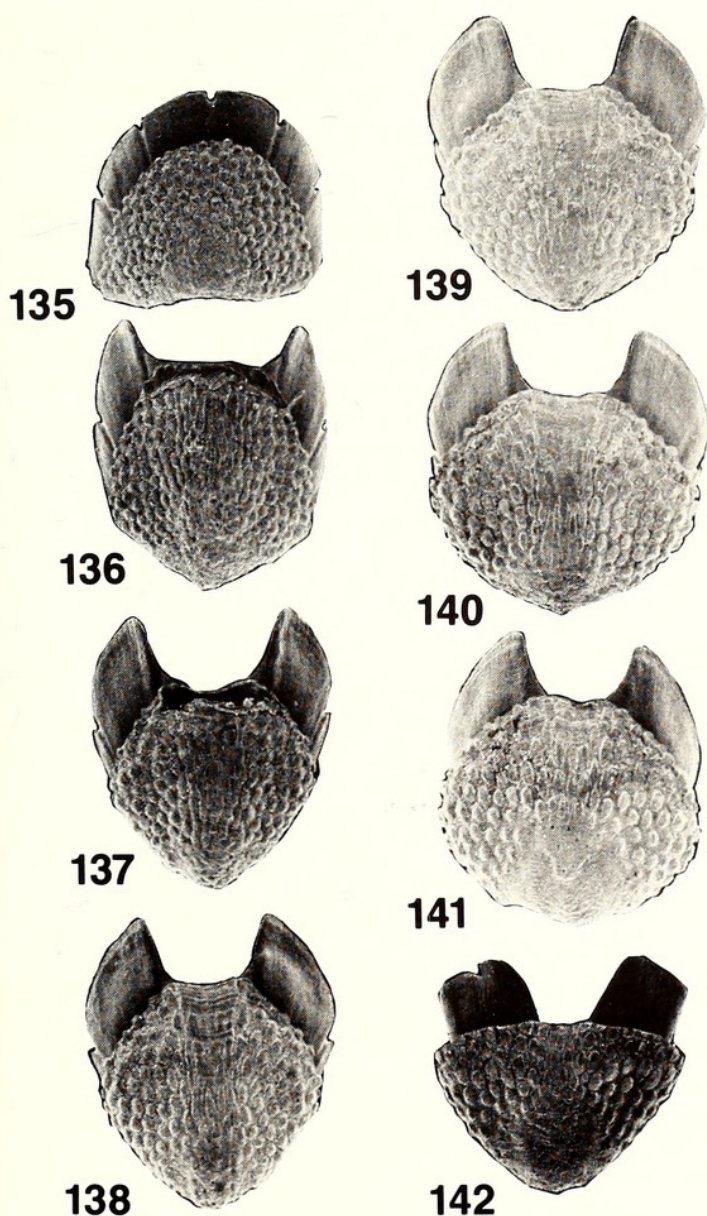
Jugum of valves ii-vii smooth, relatively narrow, little

expanded anteriorly; jugum indistinct on valves of small specimens. Tegmentum of all valves covered evenly with coarse, spatulate pustules (Fig. 134) approximately 90 μm long, 50 μm wide, generally flattened but with raised, central dome and adapical macrostethete, few or no microstethetes.

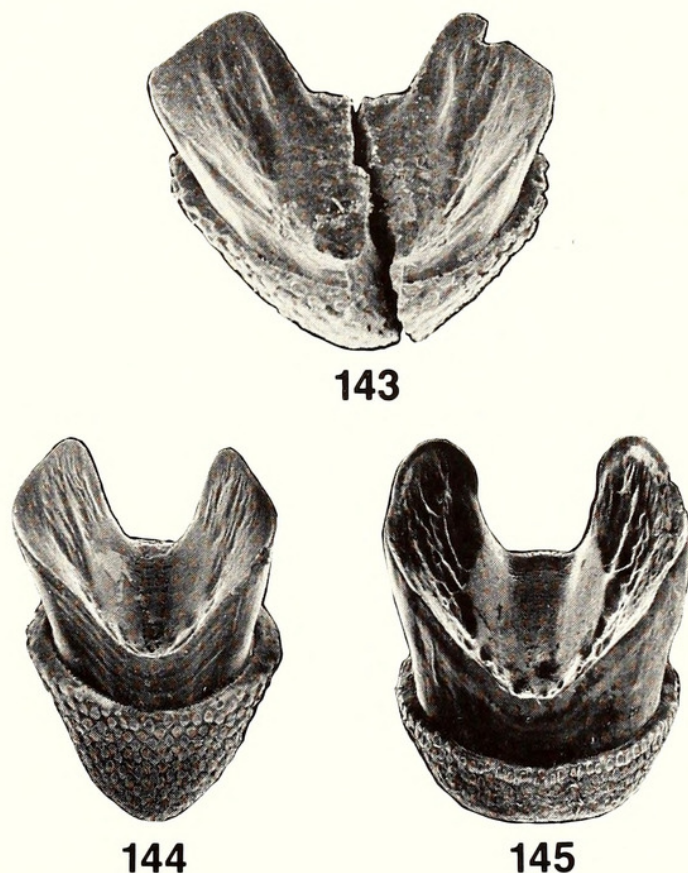
Girdle upper surface covered with small (100 μm), densely packed, club-shaped spicules; anterior and sutural tufts poorly developed, comprised of about 18-22 short (to 1.0 mm), stout, smooth, sharp-tipped, reddish brown or sometimes white spicules; marginal spicules 500 μm long, smooth, straight or slightly curved, white, rarely reddish brown; underside covered with small (100 μm), straight, sharp-tipped, clear spicules.

DISCUSSION: *Choneplax lata* is distinguished from all species of *Acanthochitona* by lacking slits on the posterior margin of valve viii (Figs. 143-145). Kaas (1972) and Ferreira (1985) discussed uncertainty regarding the number of slits on valve i and intermediate valves. The three specimens I dissected (6.7-30.0 mm) each had 5 distinct slits on valve i, not 3 as reported by Pilsbry (1893), and single, notch-like slits on intermediate valves. Based on the 5-slitted valve i, *Choneplax* is more similar to *Acanthochitona* than to *Cryptoplax*, which has 3 slits; however, *Choneplax* shares the unslit tail valve with *Cryptoplax*.

Chiton strigatus Sowerby, 1840, has long been



Figs. 135-142. *Choneplax lata* (Guilding, 1829). Valves i-viii ex 6.7 mm juvenile; West End, Grand Bahama; FSBC I 32548.



Figs. 143-145. *Choneplax lata* (Guilding, 1829). Valves viii, ventral views. **Fig. 143.** 6.7 mm specimen, same as Fig. 142 (specimen cracked during handling). **Fig. 144.** 13.0 mm specimen, same as Fig. 132. **Fig. 145.** Ex approximately 30.0 mm specimen (curled); West End, Grand Bahama; FSBC I 32546.

recognized as a later name for *Choneplax lata*. Status of *Chiton hastatus* Sowerby, 1840, is less certain; most of the described characters seem to indicate relationship to *Choneplax*, but Carpenter (*In* Pilsbry, 1893) examined the type specimen and reported 2 slits in valve viii, indicating a species of *Acanthochitona*.

Even though valve morphology changes considerably with growth, *Choneplax lata* specimens of all sizes can be recognized readily. Consequently, Kaas' (1972) illustrations of *C. lata* are perplexing. Drawings of a specimen from St. John, Virgin Islands (Kaas figs. 108-112: "9 x 6.5 mm, curled") depict a valve iv considerably wider than long, with short sutural laminae, and a valve viii with a jugum and with lateral margins of relatively short sutural laminae flush with those of the tegmentum, which is posteriorly truncate. Although the unslit insertion plate seems identical to that of *C. lata*, other illustrated features differ markedly from valves iv and viii of the 6.7 and 13.0 mm specimens from Grand Bahama illustrated here (see Figs. 131, 132, 138, 142, 143, 144). I did not illustrate dorsal views of valves from larger specimens because they inevitably were eroded. However, I did dissect a large specimen; most valves were posteriorly truncate but, except for valve ii, the sutural laminae were relatively longer, not shorter, than those of valves illustrated, and the tegmentum was always longer than wide.

Kaas' photograph (1972: pl. 2, fig. 4), reportedly of a 10.5 mm dried specimen of *Choneplax lata* from Spaanse Water, Curaçao, is difficult to interpret but does not much resemble *C. lata*. I did not examine any of the specimens Kaas reported from the Virgin Islands, Tobago, Bonaire, or Piscadera Baai and Spaanse Water, Curaçao. However, I did examine five uncatalogued RMNH lots of small specimens (2.7-7.3 mm) labeled *C. lata* from Aruba and Curaçao, including Piscadera Baai and Spaanse Water. Those lots all contained specimens of *Acanthochitona zebra*, a species which resembles *C. lata* in the number, color, and shape of dorsal tuft spicules and by the underhung insertion plate of valve viii. Kaas also reported only small specimens (4-11 mm), and characters he described on specimens from Bonaire and Curaçao could apply as well to *A. zebra* as to *C. lata*. I am not certain that specimens of both species were not mixed in his account.

Ferreira (1985) ascribed greater morphological variation to small specimens of *Choneplax lata* than actually exists. Inexplicably, he decided that *Acanthochitona andersoni*, *A. balesae*, and *A. interfissa* were juveniles of *C. lata*. That conclusion was incorrect, as demonstrated in preceding treatments of those taxa. A simple proof, in addition to described differences, is obtained by comparing valves viii. All of the above *Acanthochitona* species, regardless of size, have 2 slits and an obvious jugum on valve viii, whereas even very small (6.7 mm length) *C. lata* lack any indications of posterior slits or a jugum.

Ferreira's confusion renders his distributional records of *Choneplax lata* unreliable. Among IRCZM and CAS specimens he identified, I found specimens of *Acanthochitona andersoni*, *A. balesae*, and *A. zebra* as well as true *C. lata*. The illustrated specimen he tentatively labeled *Choneplax cf.*

lata from Barbados appears to be *A. worsfoldi*. Those discrepancies are noted in the appropriate species accounts, but many more lots must be re-examined before all of the records can be corrected.

There seems to be no valid record of *Choneplax lata* from Florida, perhaps because acceptable habitat does not occur there. Specimens I collected at three locations in Grand Bahama and Cuba lived along high energy rocky shores washed by oceanic waves. Pilsbry (1893) described specimens of *C. lata* as vermiform, an apt descriptor considering their tendency to live in small round holes bored into large limestone rocks.

Genus *Cryptoconchus* Burrow, 1815 *Cryptoconchus floridanus* (Dall, 1889)

Figs. 146-149

Notoplax floridanus Dall, 1889b: 416.

Acanthochites (Cryptoconchus) floridanus, Pilsbry, 1893: 37, 38, pl. 3, figs. 63, 64.

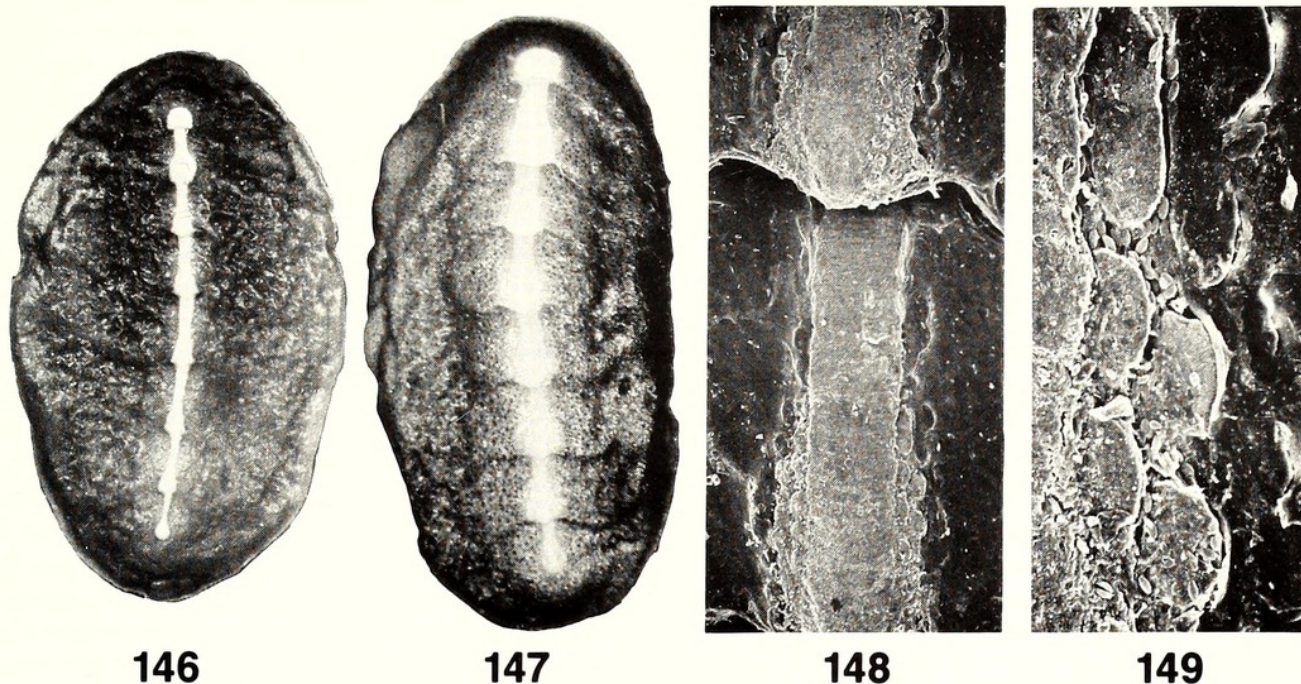
Cryptoconchus floridanus, Thiele, 1910: 110. Kaas, 1972: 34-36, figs. 55-57, pl. 1, figs. 4, 5.

MATERIAL EXAMINED: FLORIDA: 2 spec., 10.8, 13.4 mm, patch reef near Long Key Reef, Dry Tortugas, 1.5-2.5 m, 11-12 May 1979, FSBC I 32074. —3 spec., 10.9-14.7 mm, Long Key Reef, Dry Tortugas, intertidal, 11-12 May 1979, FSBC I 32075. —1 spec., 10.1 mm, Bird Key Reef, Dry Tortugas, 0.5-1.0 m, 4 Oct 1979, FSBC I 32079. —1 spec., 10.7 mm, Bird Key Harbor, Dry Tortugas, 2 m, 21 Aug 1981, FSBC I 32487. —4 spec., 6.1-10.6 mm, Garden Key, Dry Tortugas, 1-2 m, 13 May 1979, FSBC I 32076. —1 spec., 11.3 mm, Garden Key, 1-2 m, 5 Oct 1979, FSBC I 32080. —3 spec., 7.3-12.8 mm, Key West, CAS 063314. —1 spec., 9.5 mm, West Summerland Key, 0-1 m, 27 Sept 1981, FSBC I 32082. —1 spec., 5.4 mm, Missouri Key, 0.5-1.0 m, 25 July 1987, FSBC I 32491. —4 spec., 9.2-14.6 mm, north side Vaca Key, 1 Oct 1979, FSBC I 32077. —5 spec., 4.0-14.9 mm, northeast end Vaca Key, 0-1.5 m, 4 Aug 1980, FSBC I 32081. —1 spec., 9.2 mm, same location, 28 Sept 1981, FSBC I 32083. —5 spec., 7.2-11.1 mm, Bonefish Key, CAS 063313. —1 spec., 14.1 mm, north side Grassy Key, 0.5 m, 1 Oct 1979, FSBC I 32078. —2 spec., 5.0, 9.9 mm, east end Grassy Key, 0-1 m, 18 Mar 1968, FSBC I 6395. —4 spec., all curled, Burnt Point, Crawl Key, 2.5 m, July 1982, FSBC I 32488. —4 spec., all curled, same locality, 4 Aug 1982, FSBC I 32489. BAHAMAS: 1 spec., 13.2 mm, McLeanstown, east end Grand Bahama, 1-2 m, 24 May 1981, FSBC I 32486. —2 spec., 6.0, 13.0 mm, same locality, 27 Aug 1984, FSBC I 32084. —1 spec., curled, Georgetown, Great Exuma, 21 June 1974, FSBC I 32526. TURKS AND CAICOS ISLANDS: 1 spec., 13.6 mm, Providenciales, 0-2 m, 22 Sept 1986, FSBC I 32490. PUERTO RICO: 1 spec., 14.0 mm, 2 km east of La Parguera, 1 m, 17 Aug 1985, FSBC I 32085. —1 spec., 13.0 mm, Cayo Enrique, La Parguera, 1 m, 19 Aug 1985, FSBC I 32086.

DISTRIBUTION: Dry Tortugas and Florida Keys, Bahama Islands to Puerto Rico, Cuba, Jamaica, and the Cayman Islands, Aruba and Bonaire.

DESCRIPTION: Largest specimen 14.9 mm long, 8.9 mm wide including girdle; valves nearly entirely covered by smooth, black, brown, gray (rarely rose or yellow) girdle (Figs. 146, 147). Narrow, white longitudinal bars evident in jugal region.

Exposed parts (jugum) smooth, that of valve i semioval, slightly wider than long; exposed jugal parts of



146

147

148

149

Figs. 146-149. *Cryptoconchus floridanus* (Dall, 1889). **Fig. 146.** Whole specimen, 12.4 mm; Vaca Key, Monroe County, Florida; FSBC I 32081. **Fig. 147.** Whole specimen, 10.7 mm; same lot. **Fig. 148.** Jugum, valves iii-iv, same specimen as 147 (field width = 940 μ m). **Fig. 149.** Rudimentary pustules bordering jugum; same specimen as 147 (field width = 175 μ m).

valves ii-vii narrow, straight-sided for about 60% of length, thereafter expanded to truncate distal end, slightly elevated at central posterior beaks; valve viii narrow, straight-sided, with small, expanded, bulb-like terminus at low mucro. Tegmen-tum virtually absent on valves, only occasionally represented by few ovate, elongate pustules up to 80 μ m long, 50 μ m wide arranged parallel to jugal bars (Figs. 148, 149).

Girdle smooth, appearing granulose or warty under magnification; 18 anterior and sutural dorsal pores situated as in other Acanthochitonidae, bearing about 10 extremely slender, fine-tipped spicules up to 100 μ m long; spicules at peripheral margin sparse, short (40 μ m), with blunt tips; under-side densely covered with short (70-80 μ m), sharp-tipped spicules.

DISCUSSION: Pilsbry (1893) described the disarticulated valves of *Cryptoconchus floridanus* as white, pink or purple; the intermediate valves are rectangular, with a sinus before and behind; there are 5 anterior slits on valve i, single slits on the sides of valves ii-vii, and 2 posterior slits on valve viii. Specimens examined herein, when viewed through the fleshy underside, generally agreed with the standard 5-1-2 slit formula. However, the largest specimen (FSBC I 32081) has 6 unevenly spaced slits on valve i. Tegmental pustules have not been described for *C. floridanus*, but rudimentary pustules sometimes do occur on valves where the girdle does not extend flush with the margin of the jugum.

The Florida range of *Cryptoconchus floridanus* has not been extended since Dall's (1889b) original description of specimens from Cape Florida, Key Largo, Key West, and Dry Tortugas. The species occurs throughout the Bahama Islands and Greater Antilles, including Puerto Rico, Cuba (Jaume and

Sarasúa, 1943), Jamaica (Humfrey, 1975), and the Cayman Islands (Abbott, 1958). In the southern Caribbean, *C. floridanus* has been reported from Aruba and Bonaire (Kaas, 1972). The species has not been reported in the western Caribbean from Mexico to Colombia.

DISCUSSION

More specimens must be examined before definitive conclusions can be made on the composition and relationships of the Acanthochitonidae of the Caribbean region. Of the 14 recognized species, only *Cryptoconchus floridanus* has not been involved in long-term or recent taxonomic confusion. Thus, nearly all published records must be considered questionable, and the specimens upon which those records were based must be re-examined. In addition, more collections of Acanthochitonidae need to be made in the Lesser Antilles and along the Caribbean coasts of Central and South America. I examined far more material from Florida and the northern Caribbean region than from the southern Caribbean. That imbalance also occurs in published literature and probably will be found in the unreported museum collections. To my knowledge, there is no published record of any polyplacophoran from the area between Roatan, Honduras, and Limon, Costa Rica, yet that area contains the vast, shallow Honduras-Nicaragua shelf which exceeds in size the Bahama Banks. Given those cautions, some observations on the Caribbean Sea Acanthochitonidae seem warranted.

Occurrence of species may be limited by distributional barriers, habitat availability, and environmental stress near the northern boundary of the Caribbean region. Only *Acanthochitona pygmaea* occurs at Bermuda. In fact, only six of

approximately fifty known species of shallow-water Caribbean Polyplacophora occur at Bermuda (Jensen and Harasewych, 1986). The paucity of species at Bermuda probably is due to long-term climate fluctuations and geographic isolation.

Seven species of Acanthochitonidae (*Acanthochitona andersoni*, *A. balesae*, *A. hemphilli*, *A. pygmaea*, *A. roseojugum*, *A. zebra*, and *Cryptoconchus floridanus*) are known from Florida, and it is unlikely that many more will be found there. Most of the species are restricted to tropical environments of the Florida Keys and southeast coast and do not occur in the more temperate environments of northeast and west Florida. There are no endemic species. Previous Florida records of *A. astrigera* and *Choneplax lata* are known or suspected to be erroneous; I have collected both species at various Caribbean locations, but I know of no similar habitats where they could occur in Florida.

The northern Caribbean fauna, which extends from Grand Bahama Island to Puerto Rico, the Virgin Islands, and northern Netherlands Antilles (St. Eustatius and Saba Bank) in the east and to Belize and Roatan in the west, is quite diverse. Eleven species are known in that fauna, including all of the Florida species plus *Acanthochitona astrigera*, *A. lineata*, *A. worsfoldi*, and *Choneplax lata*. All eleven species have been collected at Grand Bahama Island, and all except *A. worsfoldi* have been collected at other northern Caribbean sites. It is likely that intensive collecting will reveal similar species richness at other northern Caribbean locations.

Only *Acanthochitona andersoni*, *A. astrigera*, and *Choneplax lata* are known with certainty from the Lesser Antilles south of the northern Netherlands Antilles. However, Ferreira (1985) reported *A. rhodea* from Barbados, so it would appear that a species of the *A. hemphilli* complex occurs there, and Ferreira's Barbados records of *C. lata* seem to be *A. worsfoldi*.

The southern Netherlands Antilles (Aruba, Bonaire and Curaçao) fauna is known to contain *Acanthochitona andersoni*, *A. astrigera*, *A. balesae*, the curiously restricted *A. bonairensis*, *A. rhodea*, *A. zebra*, *Choneplax lata*, and *Cryptoconchus floridanus*. A total of eight species is indicated.

The fauna of southern Caribbean coastal areas is poorest known. Along the entire expanse from Limon, Costa Rica to Trinidad, I have seen only specimens of *Acanthochitona andersoni*, *A. balesae*, *A. rhodea*, *A. venezuelana*, and a single specimen of an unknown *Acanthochitona* species from Galeta Island, Panama.

There is little evident relationship between Brazilian species of Acanthochitonidae and those of the Caribbean fauna. Only three of the seven species of *Acanthochitona* reported from Brazil were described from the Caribbean region, and Brazilian records of each of those three species are questionable. Statements of the Brazilian occurrence of *A. spiculosa* originally derived from E. A. Smith's (1890) report of *A. astrigera* at Fernando Noronha, but Righi (1971) also reported *A. spiculosa* from off São Paulo in 25 m depth, far deeper than the intertidal and shallow subtidal habitat otherwise known for *A. astrigera*. A report of Brazilian specimens of *A. pygmaea* by Righi (1971) was accompanied only by illustrations of spicules and radula and was published when

the identity of that species was poorly understood; verified specimens of *A. pygmaea* have been seen only from Saba Bank northward to Bermuda. Brazilian records of *A. hemphilli* are based on specimens reported from depths of 47-115 m (Righi, 1971), whereas verified specimens have been seen only from Honduras and Puerto Rico northward to Florida and from depths not greater than 18 m.

None of the four species of *Acanthochitona* originally described from Brazil has been encountered in the Caribbean fauna, and each has characters which distinguish it from any Caribbean species. *Acanthochitona brunoi* Righi, 1971, has a broad, strongly furrowed jugum bounded by only small lateral tegmental areas whose anterolateral margins are concave. The jugum of *A. ciroi* Righi, 1971, is very broad, occupying more than half the total width of intermediate valves, but is smooth, not furrowed, and valve i has fine, rib-like rows of pustules (among other pustules) radiating toward the slits from the posteromedial margin of the tegmentum. Pustules of the tegmentum of *A. minuta* (Leloup, 1980) continue fully formed over the entire jugum. The jugum of *A. terezae* Guerra Júnior, 1983, is similarly ill-defined and covered with pustules, but the most distinctive features of that species occur on valve viii, where the forward extension of the small, rudimentary sutural laminae is far exceeded by that of the broad, anterolaterally constricted tegmentum.

Several taxonomic groups are evident among the Caribbean and eastern Pacific Ocean species of *Acanthochitona*. Each group, or species complex, contains two Caribbean and one eastern Pacific species as indicated by morphological similarities. Closely related species complexes recognized here include *Acanthochitona hemphilli* and *A. rhodea* (Caribbean) and *A. ferreirai* (eastern Pacific); *A. pygmaea* and *A. venezuelana* (Caribbean) and *A. avicula* (eastern Pacific); and *A. astrigera* and *A. lineata* (Caribbean) and *A. hirudiniiformis* (eastern Pacific). Watters (1981) proposed another species complex containing *Acanthochitona andersoni* and *A. balesae* (Caribbean) and *A. arragonites* (Carpenter, 1857) (eastern Pacific). I have no study material of *A. arragonites* and so cannot verify that relationship.

Relationships among the other Caribbean species of *Acanthochitona* are less evident. Valve morphology of *A. roseojugum* resembles that of species in the *A. hemphilli* complex, and valves of *A. worsfoldi* resemble those of species in the *A. astrigera* complex. However, girdle spicules of *A. roseojugum* and *A. worsfoldi* hardly resemble spicules of species in those complexes, so only remote relationships to those species are proposed. *A. bonairensis* most resembles the European *A. fascicularis* and does not much resemble any other New World species.

The curious, underhanging posterior insertion plate with two nearly vestigial slits, as well as the form, number, and color of girdle spicules, suggest a relationship between *Acanthochitona zebra* and *Choneplax lata*. However, their resemblance probably represents convergence rather than close phylogenetic relationship. Only single species of *Choneplax* and *Cryptoconchus*, both Caribbean, are known in the New World.

Distributional patterns of taxa in two of the *Acantho-*

chitona species complexes are known sufficiently to allow speculation on their evolutionary history. *A. rhodea* and *A. venezuelana* each occurs only along the southern Caribbean coast, and each has a very similar cognate (*A. ferreirai* and *A. avicula*) in the eastern Pacific region, as well as less similar but still closely related congeners (*A. hemphilli* and *A. pygmaea*) in the northern Caribbean. These distributional patterns suggest at least two isolation-speciation events. In the first event, *A. pygmaea* (and probably *A. hemphilli*) diverged from the still-connected southern Caribbean-Panamic stocks before or during the Pliocene, as evidenced by *A. pygmaea* valves in Tertiary deposits. The valve reported as *A. spiculosa* from the North Carolina Pliocene [Berry, 1940: 213, pl. 10 (not pl. 12), figs. 5, 6] is not of *A. pygmaea*. However, Dall (1903), who previously reported *A. pygmaea* as *A. spiculosa*, listed both *A. pygmaea* and *A. spiculosa* in the Pliocene Caloosahatchie beds of south Florida. The first isolation event left the ancestors of *A. pygmaea* (and probably *A. hemphilli*) in the northern Caloosahatchian fauna and left species resembling *A. avicula* and *A. rhodea* in the southern Gatunian fauna (*sensu* Petuch, 1982). The known southern distributional limits of *A. hemphilli* (Honduras) and *A. pygmaea* (Saba Bank) occur precisely where Petuch (1982) identified areas of abrupt faunal shift between the northern and southern Caribbean fauna. Emergence of the Isthmus of Panama in the late Pliocene provided the barrier which resulted in later speciation among the *avicula*-like and *rhodea*-like progenitors.

Speciation mechanisms in the *Acanthochitona astrigera-lineata-hirudiniformis* species complex are less evident. The Caribbean *A. lineata* and eastern Pacific *A. hirudiniformis* are most similar in valve morphology and thus seem to have diverged most recently. To date, *A. lineata* is known only from the northern Caribbean, whereas *A. astrigera* occurs in both the northern and southeastern Caribbean. Ferreira (1985) reported *A. astrigera* from Caribbean Panama, but he included three species (*A. astrigera*, *A. lineata*, and *A. zebra*) within his concept of *A. astrigera*. Re-examination of his Panama material might provide additional clues to the evolutionary history of this species complex.

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