THOMAS PHELAN

A Field Guide to the Cidaroid Echinoids of the Northwestern Atlantic Ocean, Gulf of Mexico, and the Caribbean Sea

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ABSTRACT

Phelan, Thomas. A Field Guide to the Cidaroid Echinoids of the Northwestern Atlantic Ocean, Gulf of Mexico, and the Caribbean Sea. *Smithsonian Contributions to Zoology,* 40:1–67. 1970.—Twelve species of cidaroid echinoids from the northwestern Atlantic Ocean, Gulf of Mexico, and the Caribbean Sea are described, compared, illustrated, and keyed for identification. The first description of the denuded test of *Histocidaris nuttingi* Mortensen is presented. A lectotype and paralectotype are selected for *Histocidaris sharreri* (A. Agassiz). *Poriocidaris purpurata* (Wyville Thompson), previously known from the eastern Atlantic, is reported for the first time from the Caribbean Sea.

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Introduction

The quest for knowledge of the sea and the study of marine organisms have been attracting an ever increasing number of biologists, students, and serious hobbyists. The primary interest may not be systematics, but the identity of specimens often is essential to other works. Identification is frequently hampered by lack of readily available literature. Indeed, many of the descriptions are scattered through out-of-print publications. This paper is the first of a series to provide researchers who are not echinoid specialists with a field guide to the species of echinoids known to inhabit the northwestern Atlantic Ocean, Gulf of Mexico, and the Caribbean Sea. Twelve species of cidaroid echinoids are compared and keyed for identification.

The differences between some of these species are not as distinct as suggested in the literature. Therefore, in addition to presenting a key for identification, the variations in form that cause difficulty in identification are discussed. This study is based on material in the United States National Museum (USNM) and the Museum of Comparative Zoology (MCZ), Harvard.

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Diagnostic Features of Cidaroid Echinoids

Echinoids are of many forms, each representing adaptation to a particular niche in the marine environment. Some echinoids are almost entirely radially symmetrical; others have strong bilateral features yet retain some radial symmetry. Echinoids with the mouth and anus at opposite poles of a vertical axis and almost exclusively radially symmetrical are commonly called sea urchins or regular echinoids. The cidaroids are sea urchins with distinctive features that readily set them apart from other kinds.

The more or less globular main portion of the skeleton termed the test or corona is composed of twenty vertical columns of calcareous plates. In the cidaroids and most other sea urchins these plates are rigidly joined together. The vertical columns of plates are arranged in similar pairs to form ten distinct sections.

Five sections of the test consist of perforate plates. These alternate with five sections composed of imperforate plates (Plate 1: figure 7; Plate 2: figures 1, 2). Two columns of perforate plates form one ambulacrum. In the cidaroids each ambulacral plate bears one pair of pores to accommodate a tube foot. The pores are arranged in a single vertical sinuate series (Plate 2: figures 1, 2). The single series of pore pairs and simple plates are not restricted to the cidaroids. Other sea urchins commonly have simple plates, but many noncidaroids have compound plates with several pore pairs per plate. The pore pairs of noncidaroids are arranged in single series, multiple series, or in a series of arcs. Toward the ambulacral midline adjacent to each pore pair there is a marginal tubercle on the cidaroid echinoids that also forms a vertical series (Plate 2: figure 6), small inner tubercles are scattered or arranged in series between the two series of marginal tubercles. There are no large primary tubercles with accompanying large primary spines in the ambulacra.

Each of the five sections consisting of two vertical columns of imperforate plates is termed an interambulacrum. Interambulacral plates of cidaroid echinoids have one large primary tubercle per plate which is crenulate (Plate 11: figures 1, 3) or noncrenulate (Plate 17: figure 5). This tubercle commonly bears a large primary spine. The largest spines are at or just above the equator or ambitus of the test (Plate 4: figure 6; Plate 9: figure 2). Noncidaroid echinoids bear one or more large primary spines per interambulacral plate. A large, smooth, somewhat circular area devoid of surface ornamentation is present in the region around each primary tubercle. This consists of the boss or expanded base of the primary tubercle and the surrounding somewhat depressed ring or areole, which serves for primary spine muscle attachment (Plate 2: figure 1). Beyond the areole the plate is covered with small secondary tubercles. Those bordering the areole are slightly larger than the others, commonly forming a distinct scrobicular ring (Plate 6: figures 3, 4). The tubercles of the scrobicular ring carry scrobicular spines, specialized secondary spines (Plate 5: figure 6). Among the noncidaroids only the salenioid echinoids have a similar interambulacral plate. The salenioids are distinguished by other features of the test which are discussed in the following paragraphs.

At the apex of the test is a complex of plates called the apical system (Plate 2: figures 4, 8). There are five ocular plates, one situated at the adapical end of each ambulacrum. Each ocular plate bears an ocular or terminal pore. Five additional plates each with a genital pore are situated at the adapical ends of the interambulacra. The genital plates are larger than the oculars, and the genital pore is also larger than the terminal pore. One of the genital plates has a porous sievelike area, the madreporite, commonly slightly larger than the other genital plates. These ten plates are collectively termed the oculogenital ring.

The oculogenital ring surrounds a flexible membrane, the periproct, in which the anus is located. Periproct outline and plate arrangement are important diagnostic features. The periproct of a cidaroid echinoid is always pentagonal and bears plates decreasing in size toward the centrally located anus (Plate 2: figures 4, 8). This is a distinct feature of the cidaroids.

The salenioids that most closely resemble the cidaroids have the anal opening off-center due to the presence of a large suranal plate absent in the cidaroids.

There is a large opening on the underside or adoral side of the denuded test. Prior to the loss of tissue this opening is covered with plates and a flexible membrane, the peristome (Plate 1: figures 7, 8; Plate 11: figure 2), with the mouth located in the center. In cidaroid echinoids imbricating ambulacral plates,

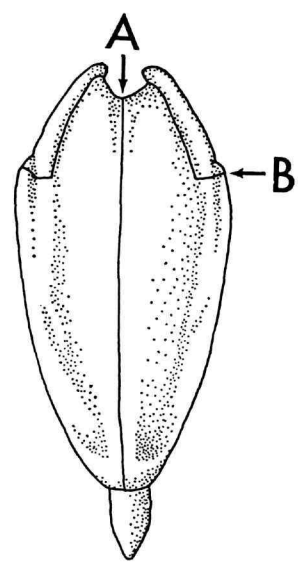

FIGURE 1.—The top of the junction of pyramid halves (A) is higher than the lowest part of the epiphyses (B) in a cidaroid lantern. The reverse is true in noncidaroid lanterns. See PLATE 1: figures 2, 3.

and to some extent interambulacral plates, extend across the peristome to the mouth (Plate 1: figure 7).

Interambulacral plates bordering the peristome of cidaroids internally bear apophyses (Plate 1: figure 5), the main supports for the masticating device commonly called the Aristotle's lantern or simply the lantern (Plate 1: figure 2). Noncidaroid sea urchins have as the main lantern supports auricles that are internal projections from the ambulacral plates (Plate 1: figure 6).

The cidaroid lantern contains five jaws, termed pyramids, each with an unkeeled tooth (Plate 1: figure 1). A keel is a projection on the inner surface of the tooth that extends throughout the length of the hard portion (Plate 1: figure 4). Noncidaroids have unkeeled or keeled teeth.

Each pyramid (Figure 1; Plate 1: figure 2) consists of two demipyramids which join along the dental slide. The junction surface is called the symphysis. A notch on each side of the top of a pyramid accommodates a lantern member termed an epiphysis. In cidaroid echinoids the uppermost part of the junction of pyramid halves (Figure 1A), symphysis, is higher than the upper limit of the lateral wings at the junction with the epiphyses (Figure 1B). The reverse is true on noncidaroid sea urchins (Plate 1: figure 3).

Cidaroids have no gills, but all other rigid-test sea urchins including the salenioids have gills accompanied by a notch in each basicoronal interambulacral plate. The notch opens toward the peristome. Gill notches may be deep, as on *Tripneustes ventricosus* (Lamarck) (Plate 1: figure 8), or very shallow, as in *Arbacia punctulata* (Lamarck). The absence of gill notches is a diagnostic feature of the cidaroids (Plate 1: figure 7).

A list of significant cidaroid and noncidaroid characters is provided for quick reference. Some of the cidaroid features listed are not restricted to cidaroids; Those restricted to cidaroids are in **boldface** type. Only a few significant noncidaroid characters are presented.

List of Significant Characters

	Cidaroid	*Noncidaroid*
Test: (General)	Rigid, regular sea urchin form (periproct within apical system) **lacking gill notches**	Rigid, regular sea urchin form (periproct within apical system) with gill notches Flexible, regular sea urchin form Rigid, irregular echinoid form (periproct outside apical system)
Ambulacra:	Plates simple Pore pairs in single series Sinuate to some extent Marginal tubercle adjacent to each pore pair	Plates compound Pore pairs in multiple series, or in a series of arcs Large primary tubercles and spines Auricles are the prominent lantern supports
Interambulacra:	One primary tubercle and spine per plate Primary tubercles perforate **Apophyses are the prominent lantern supports**	More than one primary tubercle and spine per plate Primary tubercles imperforate
Apical System:	**Periproct pentagonal**	Suranal plate
Peristome:	Covered with a regular series of imbricating plates in the ambulacra, and to some extent in the interambulacra	One pair of perforate plates in line with each ambulacrum
Teeth:	Unkeeled	Keeled
Pyramids:	**Upper limit of symphysis is higher than the top of the lateral wings at the junction with the epiphyses**	The top of the lateral wings at the junction with the epiphyses is higher than the upper limit of the symphysis

The Diagnostic Value of Cidaroid Pedicellariae

Pedicellariae, small pincerlike organs, defend the echinoid from small organisms, especially pelagic larvae seeking a place for attachment. The pedicellariae are scattered all over the test among the spines (Plate 8: figure 8). Most pedicellariae consist of three jawlike valves at the distal end of a flexible stalk which contains a calcareous supporting rod. Pedicellariae with valves containing venomous glands are termed globiferous pedicellariae (Figures 2–6; Plate 19: figures 6, 7) and are recognized by the presence of a chamber within each valve to accommodate the venom gland. This chamber has an opening (Figure 2B) at the distal end of the valve blade. The relative size of the blade opening, its position, and tooth configuration are diagnostically important.

The term tridentate is applied to nonvenomous pedicellariae commonly with three relatively long-bladed valves (Figure 7; Plate 15: figure 1). One species discussed in this paper has only two valves in each of its tridentate pedicellariae (Plate 10: figure 2). Only the large globiferous (Figures 2–6) and large tridentate pedicellariae (Figure 7) are used in this work as aids in identification.

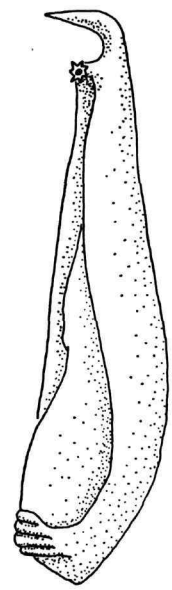

FIGURE 3.—The large globiferous pedicellariae of *Tretocidaris* have a large single end tooth and a very small blade opening. A short closed space is between the blade opening and the end tooth.

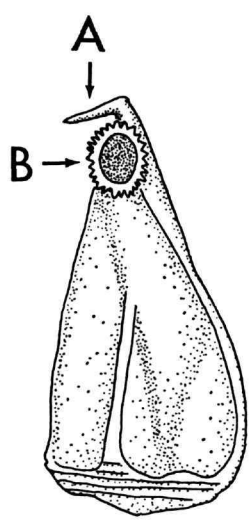

FIGURE 2.—The large globiferous pedicellariae of *Cidaris* and *Calocidaris* have a large single end tooth (A) and a large blade opening (B). A short closed space is between the blade opening and end tooth.

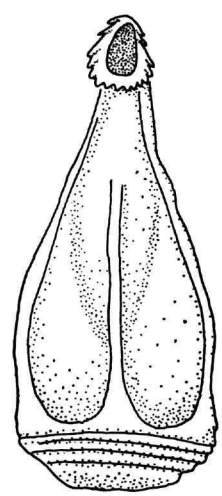

FIGURE 4.—The large globiferous pedicellariae of *Eucidaris* and *Stylocidaris* lack a large single end tooth at the tips of the blades. The blade opening is terminal.

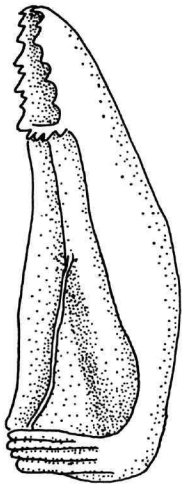

FIGURE 5.—The large globiferous pedicellariae of *Stereocidaris* lack a large single end tooth at the tips of the blades. The blade opening is subterminal. See Figure 6.

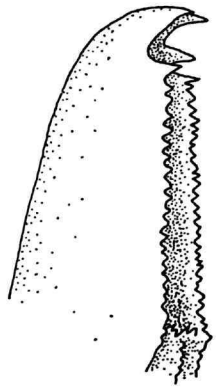

FIGURE 6.—The two uppermost teeth of the blade opening are commonly larger than the other teeth surrounding the blade opening on the large globiferous pedicellariae of *stereocidaris*. These two larger teeth commonly coalesce giving the illusion of a single end tooth, but there is no closed space between these teeth and the blade opening as in *Cidaris* and *Calocidaris*.

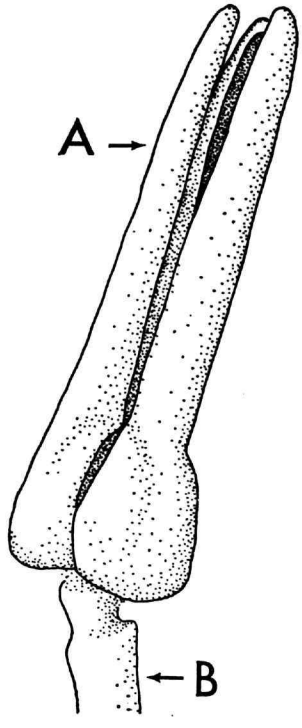

FIGURE 7.—A three-valve tridentate pedicellaria. The blade (A) is the slender upper portion of each valve. The valves lack the venom chambers present in globiferous pedicellariae. The valves of a pedicellaria are attached to a calcareous supporting rod (B).

Diagnostic features of Cidaroid Pedicellariae

No globiferous pedicellariae	Large globiferous pedicellariae have a single large end tooth, closed space between end tooth and blade opening		No large single end tooth	
	Blade opening large, Figure 2	Blade opening very small, Figure 3	Blade opening terminal, Figure 4	Blade opening subterminal, Figures 5, 6
	Cidaris *Calocidaris*	*Tretocidaris*	*Stylocidaris* *Eucidaris*	*Stereocidaris*
	Diagnostic features of the large tridentate pedicellariae on the histocidarids			
	Valves very large and broad, Plate 12: figure 5	Valves very large, long, and slender, Plate 15: figure 1	All pedicellariae composed of two highly compressed valves, Plate 10: figure 2	
Histocidaris *Poriocidaris*	*H. sharreri*	*H. nuttingi*	*Poriocidaris purpurata*	

Techniques

The large globiferous pedicellariae of *Cidaris* and *Calocidaris* are best studied with the valves separated and the tissue removed. This is easily accomplished using a solution of 10 parts water to 1 part household bleach, and the process takes approximately 15 minutes to complete. The valves should then be rinsed in water.

The calcite lattice structure of an echinoid is translucent and therefore does not photograph well in reflected light. In order to overcome this problem, the dry specimens were coated with red ink, but alizarin crimson watercolor or any low-sediment dye can be used. After the ink dried thoroughly, the specimen was lightly coated with ammonium chloride from a "smoke generator" (Teichert, 1948, p. 102). In Plate 1: figure 8, only the area around the edge of the peristome was treated. Notice how vividly the gill slits stand out in the photograph compared to the tubercles in the lower right-hand corner.

Key to the Cidaroid Echinoids of the Northwestern Atlantic Ocean, Gulf of Mexico, and the Caribbean Sea

1a. Tubercles strongly crenulate, crenulation on some or most tubercles even below the ambitus; peristomial ambulacral plates with an internal prolongation (Plate 10: figure 3); globiferous pedicellariae lacking; oral primary spines very strongly serrate, distinctly curving toward mouth ..... ***Histocidaris, Poriocidaris*** 2

b. Not as above 3

2a. All pedicellaria bivalve (Plate 10: figure 2), oral primaries with blunt rounded tips (Plate 11: figure 6). Primary spines white, uppermost primaries of some specimens have a long brown or purple collar, spines cylindrical or gently tapering. Secondary spines brown or purplish brown; ambulacral inner tubercles sparse (Plate 12: figures 6, 7); few interambulacral secondary tubercles (Plate 11: figure 3) ..... ***Poriocidaris purpurata*** (Wyville Thomson)

Key to the Cidaroid Echinoids of the Northwestern Atlantic Ocean, Gulf of Mexico, and the Caribbean Sea—Continued

b. Oral primary spines have a slender tip (Plate 15: figure 6); large tridentate pedicellariae with long slender blades (Plate 15: figure 1); all spines white or nearly so; test commonly white; marginal tubercles of two sizes; larger form distributed in a zigzag pattern with accompanying larger marginal spines (Plate 14: figure 5); ambulacral midzone with an abundance of inner tubercles ..... ***Histocidaris nuttingi*** Mortensen

c. Oral primaries rather short with blunt broadly rounded tips (as in *P. purpurata*, Plate 11: figure 6); primary spines white, secondaries brown (Plate 13: figures 1–3); tridentate pedicellariae with large broad valves (Plate 12: figure 5); ambulacrum with very few inner tubercles (Plate 12: figures 8, 9, 11); interambulacral plate with few secondary tubercles (Plate 14: figures 1, 2) ..... ***Histocidaris sharreri*** (A. Agassiz)

3a. Large globiferous pedicellariae with distinct end tooth (Figures 2, 3) 4

b. Large globiferous pedicellariae without the single end tooth (Figures 4–6) 6

4a. Blades of large globiferous pedicellariae with large opening (Figure 2); areoles usually large, deep; upper tubercles of some specimens weakly crenulate 5

b. Blades of large globiferous pedicellariae with very small opening (Figure 3); areoles shallow, upper side of upper tubercles strongly crenulate (Plate 21: figure 4); primary spine with light and dark bands, spinules larger on upper than underside of primary spines (Plate 21: figures 5–7; Plate 22: figures 1, 2) ..... ***Tretocidaris bartletti*** (A. Agassiz)

5a. Test relatively globular interambulacral midzone slightly sunken (Plate 2: figures 2, 8); extrascrobicular tubercles of upper interambulacral plates in horizontal rows separated by furrows (Plate 2: figures 1, 2); primary spines very long smooth (lacking spinules) and shiny (Plate 2: figures 3, 5; Plate 3: figures 1, 4, 7); scrobicular (Plate 2: figure 7) and marginal spines slender, long, with pointed tips ..... ***Calocidaris micans*** (Mortensen)

b. Test commonly flattened above (Plate 4: figure 6); many uppermost tubercles rudimentary (Plate 5: figures 1, 2); scrobicular ring of tubercles inconspicuous, extrascrobicular tubercles of upper interambulacral plates in horizontal rows separated by furrows (Plate 5: figures 1, 2); primary spines fairly smooth not shiny, usually white, cylindrical or tapering, spinules noticeable on adoral primary spines but commonly reduced or lacking on those of the ambitus and above, large primary spines directed out horizontally, tip commonly slightly flaring to form a small hollow "hoof" (Plate 4: figure 1) ..... ***Cidaris abyssicola*** (A. Agassiz)

c. Test slightly flattened above; few rudimentary tubercles, areoles very large; extrascrobicular area very limited, secondary tubercles very small (Plate 6: figure 3); primary spines with well-developed spinules, those above the ambitus commonly flared to paddle shape (Plate 8: figures 1, 2); oral primaries commonly with moderate serration ..... ***Cidaris blakei*** (A. Agassiz)

d. Test slightly flattened above, few rudimentary tubercles, areoles large, extrascrobicular area with fairly large secondary tubercles (Plate 6: figure 4); sutures not naked; primary spines (Plate 10: figure 1) 2 to 2.5 times the horizontal diameter of the test, commonly swollen beyond the short collar (Plate 8: figure 7), tapering to the tip, rows of spinules well developed; a few of the largest spines on some specimens have a flat widening of the tip (Plate 8: figure 6), oral primary serration slight to lacking ..... ***Cidaris rugosa*** (H. L. Clark)

6a. Test low flattened, very few rudimentary tubercles; ambulacra midline and all interambulacral sutures very naked; 5 to 7 interambulacral plates per row; primary spines 1.5 to 2 times the horizontal diameter of the test, round slender, only very gently tapering toward the tip, almost cylindrical, many directed upward but not vertically; moderately developed rows of spinules 7

b. Test low, adapically flattened (Plate 22: figure 5); midline of ambulacra not naked; interambulacra with 5 to 7 plates in a row, interambulacral transverse sutures not naked, interambulacral midline sutures with only a slight trace of nakedness; primary spines 1.5 to 2 times the horizontal diameter of the test, directed out horizontally, well-developed rows of spinules, uppermost row commonly forming a conspicuous crest (Plate 22: figures 8, 9) ..... ***Stereocidaris ingolfiana*** Mortensen

359-863—69——2

Key to the Cidaroid Echinoids of the Northwestern Atlantic Ocean, Gulf of Mexico, and the Caribbean Sea—Continued

c. Test commonly flattened adapically; ambulacral midline not naked; interambulacra with 9 to 12 plates per column, areoles rather small, shallow (Plate 17: figure 5), interambulacral sutures not naked; primary spines stout, short, slightly longer than the horizontal diameter of the test, but may be less, primary spine spinules are wartlike, a dense covering of hair commonly hides the spine shaft, crownlike tip (Plate 16: figures 2–4; Plate 17: figures 1–3). Scrobicular spines with very broad blunt tip (Plate 16: figure 1). ..... ***Eucidaris tribuloides*** (Lamarck)

7a. Round granules scattered rather uniformly on all apical system plates (Plate 19: figure 1); ambulacral midline and all interambulacral sutures very naked and white (Plate 19: figure 3; Plate 18: figure 6); scrobicular and marginal spines with reddish midline stripe (Plate 19: figure 3); primary spines on some specimens banded (Plate 18: figure 6; Plate 20: figure 4) ..... ***Stylocidaris affinis*** (Philippi)

b. Naked reddish-brown ring in apical system, granules elongate, directed away from both sides of the reddish-brown ring (Plate 19: figures 2, 5); ambulacral midline and all interambulacral sutures very naked and reddish-brown (Plate 19: figure 4); scrobicular spines white without midline stripe (Plate 19: figure 4) ..... ***Stylocidaris lineata*** Mortensen

Distribution

Only a general listing of distribution is provided because collecting has been insufficient and reports have been hampered by inaccuracies due to misidentification of specimens.

Species	*Distribution*	*Depth in meters*
Calocidaris micans	West Indies, Gulf of Mexico	200–330
Cidaris abyssicola	Cape Cod to Florida and West Indies	200–400
Cidaris blakei	Cuba to Barbados	315–420
Cidaris rugosa	32°N off U.S. east coast, south through West Indies	130–540
Eucidaris tribuloides	Throughout the West Indies, Gulf of Mexico, and Bermuda	littoral to 450
Histocidaris nuttingi	Cuba to Antigua	320–415
Histocidaris sharreri	Leeward Islands	?—570—?
Poriocidaris purpurata	South of Ireland to the Canary Islands and Caribbean Sea	750–1800
Stereocidaris ingolfiana	North Atlantic Denmark Strait to Cape Verdes and the Caribbean Sea	300–1750
Stylocidaris affinis	Bermuda, West Indies, Caribbean Sea, and Gulf of Mexico, eastern Atlantic and the Mediterranean Sea	30–1000
Stylocidaris lineata	West Indies	100–500
Tretocidaris bartletti	West Indies, Caribbean	140–625

Calocidaris micans (Mortensen)

PLATE 2: FIGURES 1–8; PLATE 3: FIGURES 1–7

Calocidaris micans.—For a complete synonymy see Mortensen, 1928, p. 312; for an additional description see Mortensen, 1910, p. 2.

The test of *Calocidaris micans* is relatively high, up to 0.75 of the horizontal diameter of the test. It is generally globular in appearance when viewed from the side; the test is not flattened above or below (Plate 2: figure 2). The peristome and apical system maintain the regular curving of the sides. The basicoronal plates are not incurving at the edge of the peristome.

The ambulacral interporiferous zone in the ambital region contains four series of almost equal-size tubercles; an inner tubercle and a slightly larger marginal tubercle on each plate (Plate 3: figure 6). On complete specimens the ambulacral midline is only scarcely naked.

The interambulucral midzone is sunken as there is

a sloping of the extrascrobicular area from the areole to the midline suture. Extrascrobicular tubercles are arranged in almost horizontal rows separated by distinct furrows. Areoles are large, the scrobicular ring reaching the upper and lower edges of all but the uppermost plates. Areole confluence is generally limited to the two lower plates of each column. On some specimens the upper side of the upper tubercules and spines are slightly crenulate (Plate 2: figures 1, 5). The scrobicular ring is somewhat inconspicuous, because the scrobicular tubercles are only slightly larger than the adjacent extrascrobicular tubercles.

The primary spines are without doubt the most diagnostic feature of *C. micans*. They are almost cylindrical, gently tapering at the tip, smooth and shiny, completely lacking hairs and spinules. Primary spines above the ambitus have approximately 16 narrow glassy zones running the length of the shaft. These are so slightly elevated above the rest of the spine that they are not noticeable to the unaided eye. Below the ambitus these glassy zones form inconspicuous glassy ridges completely lacking spinules. All other cidaroids develop rather conspicuous spinules on the primary spines below the ambitus; even those that have rather smooth spines above the ambitus. The most spectacular specimens of *C. micans* have primary spines up to three times the horizontal diameter of the test (Plate 3: figures 1, 7), but on others they are commonly one and a half times the horizontal diameter of the test. The primary spines are almost white, but there is a reddish-brown pigment in the collar, slight olive color in the neck and shaft, and a trace of reddish brown toward the tip. Specimens give the overall appearance of being white, but close observation reveals a slight olive tint.

COMPARISON WITH OTHER SPECIES.—Indentification difficulties would most likely be limited to differentiation between *C. micans* and some specimens of *Cidaris abyssicola*. *Cidaris abyssicola* is noticeably flattened adapically and somewhat adorally as there is a slight incurving of the test at the edge of the peristome. The primary spines are fusiform or cylindrical, white, somewhat chalky in appearance. Spinules are commonly small, even lacking on some spines. The primary spines of some specimens are very smooth and somewhat shiny. The various kinds of spines may be present on a single specimen. Below the ambitus of *C. abyssicola* the primary spines develop rows of spinules even on specimens with smooth shiny upper spines. This contrasts with *C. micans* which lacks spinules even on primary spines below the ambitus. Spines below the ambitus on *C. micans* bear low smooth glassy ridges that extend the length of the shaft.

The form of *C. abyssicola* that Mortensen (1910, p. 13) described as *C. abyssicola* var. *teretispina* (Plate 5: figure 3) has slender, usually cylindrical, smooth, and quite shiny primary spines and a faint olive pigment. The primary spines at and above the ambitus are therefore quite indistinguishable from those of the shorter spine specimens of *C. micans*. Below the ambitus the primary spines bear spinules as on other specimens of *C. abyssicola*. The scrobicular and secondary spines are very similar to the slender pointed ones of *C. micans*. The slender smooth spine specimens of *C. abyssicola* commonly have some primary spines terminating with a "hollow-hoof" tip similar to those found on some spines of the more typical specimens (Plate 4: figure 1).

I have not observed Mortensen's variety *C. abyssicola teretispina* with a globular test similar to that of *C. micans*. The more typical *C. abyssicola* with stouter white spines has been observed with a rather globular test and elevated apical system (Plate 5: figure 2). Rudimentary tubercles occur on fairly large interambulacral plates on *C. abyssicola* (Plate 5: figure 1), but they are apparently limited to smaller plates on *C. micans* (Plate 2: figure 8).

DISTRIBUTION.—West Indies and Gulf of Mexico at depths of 200–330 meters.

Cidaris abyssicola (A. Agassiz)

PLATE 1: FIGURE 7; PLATE 4: FIGURES 1–6; PLATE 5: FIGURES 1–6

Cidaris abyssicola—For a complete synonymy see Mortensen, 1928, p. 301; for additional descriptions see Mortensen, 1910, p. 13, and 1928, p. 301.

The test of *Cidaris abyssicola* is commonly rather low with a flattened apical system and peristome (Plate 4: figure 6). The basicoronal plates are slightly incurving at the edge of the peristome. At the ambitus the periphery is circular with no sunken area in the interambulacra. The flattened test is not a reliable diagnostic feature as some specimens are quite globular with elevated apical system (Plate 5: figure 2) and gently curving sides instead of the strongly arched condition found in the more flattened specimens.

The ambulacra are slightly sinuate, and the marginal

tubercles are in regular series. The inner tubercles are variously arranged on different specimens. There may be one small inner tubercle below center on each ambulacral plate or as many as three inner tubercles are common. The arrangement with three inner tubercles is generally one above the other adjacent to the marginal tubercle and the third below the center of the plate near the midline suture. The lower edge of the plate commonly bears several small granules. The inner tubercles tend to form in uniform series, but in some specimens they are rather irregularly arranged. Specimens with inner tubercles in regular series high on the test may have them in a jumble near the peristome (Plate 5: figures 4, 5). The arrangement of inner tubercles is not a diagnostic one for this species. It is more significant that the interporiferous zone is rather crowded with tubercles, while not obscuring the midline as in *Stereocidaris ingolfiana.*

The upper plates of the interambulacra of most specimens are slightly higher than wide and many bear rudimentary primary tubercles (Plate 5: figure 1). The areoles are moderately large and the scrobicular rings reach the upper and lower edges of the plates everywhere below the ambitus. The areoles are confluent in the two or three lowermost plates of a column. Extrascrobicular tubercles are in more or less horizontal rows separated by furrows and in much greater abundance above than below the ambitus.

The primary spines are directed out horizontally as spokes around the hub of a cartwheel (Plate 4: figure 6). The large primary spines are commonly rather smooth, spinules are small or lacking. These spines are generally white, even chalky in appearance and from 1 to 1.5 times the horizontal diameter of the test, cylindrical or fusiform. A "hollow hoof" is common on spines with unbroken tips (Plate 4: figure 1). Below the ambitus the primary spines develop more prominent spinules.

The test and spines are generally white, but touches of pink and olive are common. The collar of the primary spines is generally the darkest portion of the specimen. Scrobicular spines of some specimens have a slight olive midline, but not a stripe or as distinct as the red midline stripe of *Stylocidaris affinis.*

COMPARISON WITH OTHER SPECIES.—*Cidaris abyssicola* is rather distinct and should not be difficult to identify, but since some specimens bear superficial resemblance to *Calocidaris micans* a comparison is necessary. A more detailed comparison is given under *Calocidaris micans.* The large primary spines of *C. micans* are very smooth and shiny. Most specimens of *Cidaris abyssicola* have fairly smooth but not shiny large primary spines, but there are some specimens of *C. abyssicola* that have more slender rather shiny spines with a slight olive tint. These specimens of *C. abyssicola* can be distinguished from specimens of *C. micans* by examination of the primary spines below the ambitus with a hand lens. Spinules can be observed on these spines of *C. abyssicola,* but only longitudinal glassy ridges are present on the primary spines below the ambitus on *C. micans.* The oral primary spines of *C. abyssicola* generally have distinctly serrate edges. The oral primaries of *C. micans* lack serrations but have well-developed longitudinal ridges and thin edges (Plate 3: figure 3). The midzones of the interambulacra of *C. micans* are sunken. They are not sunken on *C. abyssicola.*

DISTRIBUTION.—East coast of the United States south of Cape Cod, including Florida, and the West Indies at depths of 200 to 400 meters.

Cidaris blakei (A. Agassiz)

PLATE 6: FIGURES 1, 3, 5; PLATE 7: FIGURES 1, 6–8; PLATE 8: FIGURES 1–5, 8; PLATE 9: FIGURES 1, 2

Cidaris blakei.—For a complete synonymy see Mortensen, 1928, p. 307; for additional descriptions see A. Agassiz, 1883, p. 10, and Mortensen, 1928, p. 307.

The test of *Cidaris blakei* is moderately to slightly flattened above and below (Plate 7: figure 1), and its height is approximately two-thirds the horizontal diameter. The test is round at the ambitus, the interambulacral midzones are not sunken. There is a slight incurving of the basicoronal plates at the edge of the peristome.

The ambulacra are distinctly sinuate above the ambitus, less sinuate below. This is apparently due to the very large areoles on the interambulacral plates above the ambitus. The pore pairs are slightly oblique and the ambulacral marginal tubercles are high on each plate, tending to crowd above the inner edge of the inner pore that is low on the plate. Small granules are common on the lower edge of the plates below the marginal tubercles which are in uniform series. Adjacent to the marginal tubercle is an inner tubercle low on the plate. This inner tubercle and the marginal tubercle lie in an oblique position very nearly parallel to the oblique position of the pore pair of the same plate. If an additional inner tubercle is present on the

plate, its position is commonly at random but crowding the midline edge of the plate. Although I have not observed it, Mortensen (1928, p. 307) reported the additional inner tubercles as being in a uniform series. The inner tubercles adjacent to the marginal tubercles are in a uniform series.

The areoles are large and occupy a major portion of the interambulacral plates. Above the ambitus the areoles are very large and only very newly introduced plates have rudimentary tubercles. The areoles of the two or three lowermost plates are commonly confluent. Crenulation is not diagnostic but is weakly present in the uppermost tubercles of some specimens. The scrobicular ring of tubercles is very distinct. These tubercles are considerably larger than the almost granular secondary tubercles (Plate 6: figure 3).

The uppermost primary spines of some specimens resemble the fan-shaped leaves of the ginkgo tree (Plate 8: figures 1, 2; Plate 9: figure 2). On such specimens the great widening of the spine tip is progressively decreased with descending position of the spines toward the adoral side. Spines below the ambitus are quite slender and lack the widened tip. The variation among specimens is remarkable and ranges from those as shown in Plate 8 to specimens possessing only slender-pointed tipped spines. Indeed, specimens with little or no widening of the spine tip are common. Some slender spines bear a very small flared tip, like a funnel cone. The spinules are easily visible but not thorny. The oral primary spines are rather distinctly serrate. The secondary spines are small, slender, and almost pointed, and contrast with the broader more bluntly tipped scrobicular spines.

The slender, only slightly flattened, almost pointed marginal spines of the ambulacra, slender extrascrobicular spines, and the almost granular size of the extrascrobicular tubercles are very diagnostic and are the most significant features of specimens lacking the fan-shaped spines. The very large areoles are important features also, but *C. rugosa* has large areoles and resembles some specimens of *C. blakei.*

The color was reported by A. Agassiz (1883, p. 12) as being brilliant vermilion. Most of the color has been lost from specimens stored in alcohol or dried. The spines may have been white, for they show no trace of color in the shaft.

COMPARISON WITH OTHER SPECIES.—*Cidaris blakei* and *Cidaris rugosa* have been collected together at several localities and can be easily identified when they bear their highly characteristic spines (Plate 8: figures 1, 2, 7), but some specimens of these species have only slender primary spines similar to those of *Stylocidaris affinis* (Plate 20: figure 4). Specimens that lack the distinctive spines may be identified by examining the extrascrobicular area of the interambulacral plates, the granular tubercles of the apical system, and the tips of the marginal spines. The extrascrobicular area of *C. blakei* occupies a smaller percentage of the plate and is covered with more delicate secondary tubercles than on *C. rugosa* (Plate 6: figures 3, 4). The granular tubercles of the apical system of *C. blakei* are also smaller and less prominent than those of *C. rugosa* (Plate 6: figures 5, 6).

The inner tubercles of the ambulacra are commonly in more uniform series in *C. blakei.* On specimens of *C. rugosa* with a single inner tubercle on each ambulacral plate a partial vertical overlap of tubercles occurs and a single zigzag series is formed along the midline (Plate 7: figure 4). Large specimens of *C. rugosa* commonly have inner tubercles of the ambulacra one above the other adjacent to the marginal tubercles of a single plate (Plate 7: figure 9). This condition may exist on a majority of the plates with additional inner tubercles toward the midline. These specimens tend to show a uniform series of inner tubercles. The inner tubercle arrangement is variable and therefore of little help in identification.

The marginal spines of *C. rugosa* are noticeably broader and more bluntly tipped than those of *C. blakei* (Plate 8: figures 8, 9).

DISTRIBUTION.—Cuba to Barbados in the West Indies at depths of 315 to 420 meters.

Cidaris rugosa (H. L. Clark)

PLATE 6: FIGURES 2, 4, 6; PLATE 7: FIGURES 2–5, 9; PLATE 8: FIGURES 6, 7, 9; PLATE 10: FIGURE 1

Cidaris rugosa.—For a complete synonymy see Mortensen, 1928, p. 305; for additional description see H. L. Clark, 1907, p. 210.

The test of *Cidaris rugosa* is moderately to slightly flattened above and below (Plate 7: figure 2). Height of the test is approximately two-thirds the horizontal diameter. Only rarely are the basicoronal plates incurving at the edge of the peristome. The test is round at the ambitus with no sunken interambulacral midzone.

The ambulacra are moderately sinuate; only slightly more noticeably so above than below the ambitus. Pore pairs are in a slightly oblique position on the plates and

the marginal tubercles are higher than center, but the tubercles only tend to crowd above the inner pores adorally. The marginal tubercles form a uniform series and bear fairly broad, noticeably flattened, bluntly tipped spines (Plate 8: figure 9). Small granules are common below the marginal tubercles. There is no naked area in the midzone between the rows of marginal tubercles. When only one inner tubercle is present on each ambulacral plate, it occupies most of the area between the marginal tubercle and the midline suture. The appearance of crowding is evident. In the above condition the inner tubercles partially overlap each other along the midline suture forming a single zigzag series (Plate 7: figure 4). On larger specimens additional inner tubercles are present. Adjacent to the marginal tubercle there are commonly two inner tubercles, one above the other (Plate 7: figure 9). These tend to form into a uniform series. An additional inner tubercle is commonly present on the plate crowding the midline and the vertical pair of inner tubercles. This arrangement on *C. rugosa* gives the appearance of a more uniform series of inner tubercles than on those with a single inner tubercle in a zigzag series. The lack of any naked area in the midzone is the most significant feature of the interporiferous zone. The variability of inner tubercle arrangement exempts their number and position from being a good diagnostic feature.

Each interambulacral plate has a large areole which occupies a major portion of the plate. Rudimentary tubercles are limited to newly introduced plates. The scrobicular rings are prominent and extend to the upper and lower edges of the plates except on the uppermost plates of the test. The two lowermost plates commonly have confluent areoles. The extrascrobicular tubercles are prominent, standing out on the plate as rugged little knobs. This feature markedly distinguishes the interambulacral plates of *C. rugosa* from those of *C. blakei* (Plate 6: figures 3, 4). The small granular tubercles of the apical system are also prominent (Plate 6: figure 6).

Primary spines of the more typical specimens are from 2 to 2.5 times the horizontal diameter of the test, markedly swollen just above the collar, round, and tapered to the tip. The spinules are prominent but not thorny (Plate 8: figure 7). The swollen area above the collar is absent on some specimens, and the spines then have a more slender appearance. Some of the longer spines on some specimens have a flattened slightly expanded tip resembling the less expanded spines of *C. blakei* (Plate 8: figure 6). The oral primaries vary from nonserrated to moderately serrated. The marginal, scrobicular, and extrascrobicular spines are flattened, rather broad and blunt tipped (Plate 8: figure 9). The scrobicular spines may be so blunt as to appear truncated.

The color is lost from most dried or alcohol specimens but was reported as more or less rose red or brick red adapically by H. L. Clark (1907, p. 210).

COMPARISON WITH OTHER SPECIES—*Cidaris rugosa* is compared with *C. blakei* in detail following the description of that species. *Cidaris rugosa* is readily distinguished from *Stylocidaris affinis, Stylocidaris lineata,* and *Tretocidaris bartletti* by the lack of naked sutures, especially along the ambulacral midline. The large globiferous pedicellariae differ also. *Cidaris rugosa* has a large opening below the large end tooth, *S. affinis* and *S. lineata* lack an end tooth. *Tretocidaris bartletti* has a large end tooth but below it is a very small opening. Neither *C. rugosa* nor *Stereocidaris ingolfiana* has naked ambulacral sutures; *S. ingolfiana* lacks the large single end tooth on the large globiferous pedicellariae, commonly has a crest or wing on the upper side of the primary spines, and a more jumbled arrangement of ambulacral inner tubercles. *Cidaris rugosa* is readily distinguished from *C. abyssicola* by the large number of rudimentary tubercles and smoother primary spines of *C. abyssicola.*

DISTRIBUTION.—From 32 degrees off the United States east coast through the Greater Antilles and Lesser Antilles as far as Barbados. It is known from depths of 130–540 meters.

Eucidaris tribuloides (Lamarck)

PLATE 1: FIGURES 1, 2, 5; PLATE 16: FIGURES 1–5; PLATE 17: FIGURES 1–7; PLATE 18: FIGURES 1–3

Eucidaris tribuloides.—For a complete synonymy and additional description see Mortensen, 1928, p. 400.

The test of *Eucidaris tribuloides* is moderately flattened above and below (Plate 17: figure 5). There is a moderate incurving of the basicoronal plates at the edge of the peristome. The test at the ambitus is commonly circular, but numerous specimens are subpentagonal and a small percentage pentagonal. The radius in the pen-

tagonal specimens is greatest in the interambulacral midzone and shortest in the ambulacra. The flattening of the test above and below is relatively more prominent on small specimens than on large ones of 50 mm or more. The apical system is commonly slightly larger than one-third of the horizontal diameter of the test and approximately the same size as the peristome. On small to medium-size specimens the apical system may be noticeably smaller than the peristome. The madreporite is commonly enlarged and prominent on denuded specimens.

The ambulacra are only slightly sinuate (Plate 17: figures 4, 5). Marginal tubercles are prominent, the bosses on some specimens contiguous and transversely oval, arranged in uniform series. Inner tubercles crowd the interporiferous zone and the crowding exists regardless of the presence of one, two, or three inner tubercles per plate. Two inner tubercles per plate are the most common, but there is only a very slight tendency for the inner tubercles to form in series.

Interambulacral plates in the region of the ambitus are approximately twice as wide as high and have shallow small areoles. The tubercles of the scrobicular ring are noticeably more prominent than the extrascrobicular tubercles of the interambulacral midzone (Plate 17: figure 5). There is less difference in size between the scrobicular tubercles and the extrascrobicular tubercles bordering the ambulacra (Plate 17: figures 4, 5). In the interambulacral midzone the extrascrobicular tubercles are in somewhat horizontal rows separated by furrows. The large number of primary tubercles in vertical series is an important diagnostic feature (Plate 17: figure 5). A specimen 35 mm in diameter commonly has 9 to 10 primary tubercles in a vertical series.

The primary spines are short, from about half the horizontal diameter of the test to only slightly larger than the horizontal diameter (Plate 16: figures 2–4). They are fairly stout, either cylindrical or noticeably tapered. The tip of the spine (Plate 17: figure 1) has a crown formed by lamellae, each of which is at the tip end of a row of warts (Plate 17: figures 1, 2). At the center of the crown is a small prominence. Except when very small, specimens lack pointed spinules. The shaft of each spine is covered by a dense spongy covering of anastomosing hairs. The extent of development of this covering varies between individuals. Under water those with a very dense covering appear to have a coat of fur (Plate 17: figure 3). The neck of the primary spines is very short and very difficult to observe on nondenuded specimens. Oral primaries are oval in transverse outline, only slightly different from transitional and ambital primaries. The scrobicular spines are broad, straight sided. The tips are very blunt and concave, almost shovellike on some specimens (Plate 16: figure 1).

The large globiferous pedicellariae lack an end tooth and are similar to the kind shown in figure 4.

The specimens are brown, commonly darkest at the collar and tips of the marginal and scrobicular spines. The brown pigment of the primary spines is commonly obscured by the gray or white covering of anastomosing hairs. The denuded test is olive; the areoles white or almost so.

Eucidaris tribuloides is usually found in fairly shallow water, but its depth range extends into the upper limits of the distribution of *Stylocidaris affinis*. The two species are commonly collected at the same station, especially off the west coast of Florida. Very small specimens of both species are strikingly similar but can be differentiated by the following features.

Both species have light and dark banding of the primary spines with well-developed thorns. Close examination of the dark bands of *E. tribuloides* will reveal that some of the thorns have already developed into typical warts (Plate 18: figure 3). Observe the dark bands nearest the base of the spines as this is where the first warts appear. As the individual grows, wart development progresses more rapidly in the dark bands than the light ones, and a stage is reached where the thorns remain only in the light bands (Plate 18: figures 1–3). These also change to warts and the color banding usually leaves. The crownlike tip develops on at least one primary spine even on extremely small individuals of *E. tribuloides* (Plate 18: figures 1–3). One or two very broad tipped large scrobicular spines will be present even on the very small specimens (Plate 18: figure 2).

The thorns on the primary spines of *S. affinis* remain and, as the spines grow, simply become the spinules. The scrobicular spines of even the smallest specimens of *S. affinis* have the prominent reddish midline stripe (Plate 18: figure 5).

DISTRIBUTION.—West Indies, Gulf of Mexico, and Bermuda. Littoral to 450 meters.

Histocidaris nuttingi Mortensen

PLATE 14: FIGURES 3–5; PLATE 15: FIGURES 1–7

Histocidaris nuttingi.—For a complete synonymy see Mortensen, 1928, p. 98; for additional descriptions see Mortensen, 1926, and 1928, p. 98.

The test is broad and quite flattened adapically (Plate 15: figure 7), widest high on the test, well rounded above the ambitus, more tapering adorally with slight to no incurving of the basicoronal plates. The horizontal outline is round.

The marginal tubercles are in series but not of the normal size gradient. Size and arrangement of these tubercles and the attached spines are important diagnostic features. A denuded ambulacrum viewed from the horizontal position shows larger tubercles alternating down the two marginal series in a zigzag pattern among smaller tubercles of the series (Plate 14: figure 5). This zigzag pattern is present on all four specimens available for study. The larger marginal tubercles bear proportionately longer slender spines. The smaller marginal tubercles are very nearly equal in size to the inner tubercles. So abundant are the inner tubercles that they and their slender spines obscure the midline suture.

Ambulacral plates of the peristome bear the internal prolongation common among the histocidarids (Plate 10: figure 3).

The widest interambulacral plates are approximately twice as wide as high. Crenulation is strong even on tubercles below the ambitus. At the ambitus and above, the large shallow areoles crowd the adoral transverse plate sutures distorting the curvature of the lower side of the areole and scrobicular ring (Plate 14: figure 4). So severe is the crowding that some of the scrobicular tubercles are actually projections of the lower edge of the plate situated in line with the suture. The extrascrobicular area on each side of the scrobicular ring bears numerous secondary tubercles. Those on the midline suture side of the plates are noticeably arranged in nearly horizontal rows (Plate 14: figure 4).

The apical system is quite flat and has an abundance of tubercles scattered over its surface. Tubercles on the genital plates are most dense around the genital pores. The very large genital pores of the MCZ specimen in Plate 14: figure 3 suggest that it is a female. This specimen (MCZ 7729a) is approximately 75 mm in diameter and is almost the same size as the USNM specimen collected by RV *Oregon* at station 6699. The USNM specimen has much smaller genital pores which are difficult to observe due to the density of secondary spines. A few very small plates are on the genital pore membranes of the female MCZ 9927a. Most of the small plates bear tubercles the same size as the tubercles on the genital plates.

The primary spines are quite varied on each individual as can be seen in Plate 15: figures 2–6. Some of the spines are remarkably long. A medium-size specimen 35 mm in horizontal diameter (MCZ 7731) bears a spine 150 mm in length. The ratio of spine length to test diameter is greater in medium-size specimens than in large ones. The shaft of the spines is smooth, shiny and white, cylindrical to gently tapering to the tip. Thorns are commonly scattered along the shaft at intervals of about 5 mm (Plate 15: figures 2, 3) and arranged in three or four rows which are not easily recognized unless viewed from the end of the spine. The spines may terminate in a rather blunt tip or especially on the larger specimens the tips may be swollen or flared due to the growth of narrow expanded longitudinal ridges limited to the tip region (Plate 15: figure 4). Transitional spines are strongly serrate and curve adorally (Plate 15: figure 5). Oral spines of the basicoronal plates taper to a relatively slender tip, curve adorally, and are markedly serrate (Plate 15: figure 6).

The large tridentate pedicellariae are diagnostic. They are very large and easily seen with the unaided eye and have long slender blades (Plate 15: figure 1). The tips of the blades commonly terminate with slightly different lengths (Plate 15: figure 1). Mortensen (1926, p. 6) suggested that this is probably due to the tips breaking and regrowth. As with other histocidarids, *H. nuttingi* possesses no globiferous pedicellariae.

The medium-size specimens are all white, but the larger specimens have white spines and some yellowish to brownish pigment in the test.

The three histocidarids are compared and discussed following the description of *Poriocidaris purpurata* (Wyville Thomson).

Mortensen (1926) wrote his original description of *H. nuttingi* without actual observation of the single specimen available at the time. Dr. Nutting of the University of Iowa furnished Mortensen with photographs, spines, pedicellariae, and a description of the specimen. The holotype is presumed lost, as I have been informed by Dr. Jerry J. Kollros, Chairman of the Department of Zoology, University of Iowa, that

the specimen is not at the Museum. Fortunately specimens identified as *Histocidaris nuttingi* Mortensen are in the collections—three in MCZ and one in USNM. All four were studied and the identification as *H. nuttingi* is correct. The very long slender blades of the large tridentate pedicellariae, the slender oral spines, white test and spines, very long thorny primary spines, and the abundance of ambulacral inner tubercles and spines agree with Mortensen's description.

One discrepancy exists in the illustrated oral spine of Mortensen's original description and the oral spines observed on the basicoronal plates of the specimens studied. The spine illustrated by Mortensen (1926, pl. 1: figs. 1, 2) is relatively longer and is identical to the transitional spine of the third interambulacral plate from the peristome. A spine from this position is shown in Plate 15: figure 5, and an oral spine from a basicoronal plate is shown in Plate 15: figure 6. The width of the base end of the shaft is quite variable, but all have a slender tip.

I believe that Nutting sent a transitional spine to Mortensen and not a true basicoronal oral spine. A close look at Mortensen's illustration of the full adoral view (Mortensen, 1926, Plate 4: figure 11), shows transitional and oral spines with the same shape as those on the specimens at the Museum of Comparative Zoology and the United States National Museum.

DISTRIBUTION.—Cuba to near Antigua at a depth of 328 to 411 meters. So few specimens are available that the distribution of *Histocidaris nuttingi* is very inadequately known.

Histocidaris sharreri (A. Agassiz)

PLATE 12: FIGURES 1–5, 8–11; PLATE 13: FIGURES 1–3; PLATE 14: FIGURES 1, 2

Histocidaris sharreri.—For a complete synonymy and additional description see Mortensen, 1928, p. 86.

The test is almost globular, moderately elevated at the apical system (Plate 13: figure 1; Plate 14: figure 1), and only very slightly flattened adorally.

The ambulacra are moderately sinuate, and have large marginal tubercles in uniform series. The most significant feature of the ambulacra is the near naked interporiferous zones (Plate 12: figures 9, 11). Many plates lack even a single inner tubercle. I believe that the deep ambulacral midline suture which Mortensen (1929, p. 87) suggests as being diagnostic of this species is only an irregularity or growth deformity of the specimen he studied as it is not continuous on the specimen. The upper portion of Plate 12: figure 11 shows the region of the ambulacrum illustrated by Mortensen (1928, pl. 68: fig. 4). Peristomial ambulacral plates bear an internal prolongation as in other histocidarids (Plate 10: figure 3).

Each large intermediately deep areole of the interambulacral plates is surrounded by a prominent scrobicular ring which crowds the plate sutures. The extrascrobicular area is therefore very limited, with few secondary tubercles and spines (Plate 14: figure 1). The primary tubercles are strongly crenulate even on tubercles below the ambitus (Plate 14: figures 1, 2).

There is a marked difference in the relative size of the genital pores of the two specimens studied. The very large genital pores of the smaller specimen, MCZ 253 (Plate 12: figure 1), indicate that it is a female. The smaller genital pores of MCZ 362 (Plate 12: figure 10) suggest that it is a male. Tubercles of the genital plates are most abundant around the genital pores, and on the female form a distinct ring around the large pores. Small tubercles are also scattered along the periproctal edge of the genital plates.

The two specimens were too few to permit determination of the normal variation in primary spine form and only the lower portion of two large primary spines remain attached to MCZ 253. The length of the uppermost primary spines is approximately 1.5 times the horizontal diameter of the test. These spines lack or rarely possess thorns. The tips flare out (Plate 12: figure 4) due to radial expansion of the longitudinal ridges. At the ambitus the tips differ in that the ridges expand to form an elongate swollen tip (Plate 12: figures 2, 3). At or just below the ambitus the primary spines develop two rows of serrations which become progressively larger on transitional spines approaching the peristome (Plate 13: figures 1, 3). Below the ambitus the spines curve adorally. The curvature increases with adoral position. The oral primaries are broadly rounded at the tip, transversely flat adorally, and convex adapically. The spines are strongly serrate and curve longitudinally toward the mouth. Specimen MCZ 362 has suffered considerable loss of spines but a drawing in Agassiz (1883, pl. 3) shows the spine forms and position. The tips of spines from this specimen are shown in Plate 12: figures 2–4. Only the lower portion of two primary spines remain attached to MCZ 253. Well-developed thorns (Plate 12: figure 1) occur on the shafts of these broken spines. There

are no thorns on the primary spines of MCZ 362. The presence or absence of thorns is a normal variant in the histocidarids and their absence on MCZ 362 is not significant.

The large tridentate pedicellariae are the most diagnostic feature. They are very large, and easily observed with the unaided eye, and have three rather long broad blades (Plate 12: figure 5). No globiferious pedicellariae occur in any species of the histocidarids.

The specimens are brown with a small amount of yellow pigment. The primary spines are white with a yellow-brown collar.

The three histocidarids are compared and discussed in detail following the description of *Poriocidaris purpurata* (Wyville Thomson).

COMMENTS ON THE HISTORY AND CONFUSION ASSOCIATED WITH *Histocidaris sharreri*.—The echinoid that is currently recognized as *Histocidaris sharreri* was named *Porocidaris sharreri* in the original description (A. Agassiz, 1880, p. 71). Three specimens, two large males and a small female, were mentioned in this description, but it was not until the more complete description (A. Agassiz, 1883, p. 12, pl. 3; pl. 4: figs. 1, 2), again only mentioning the three specimens, that drawings of this species were published. Mortensen (1903, pp. 23, 28) recognized that more than one species was represented in the descriptions and illustrations of A. Agassiz (1880, 1883). The current name of the species that Mortensen separated from *H. sharreri* is *Calocidaris micans*. In A. Agassiz (1883) only the illustration in Plate 3 and a portion of the description on pages 12 and 13 represent the species currently recognized as *H. sharreri*. The specimen that A. Agassiz (1883) illustrated on plate 3 is MCZ 362.

Following the listing of MCZ 362 in the catalog of recent echinoid type specimens (Downey, 1968, p. 62) is the entry "(= *Calocidaris micans*)." Downey in personal communication stated that it was not intended to indicate that this specimen (MCZ 362) was a specimen of *Calocidaris micans*. Specimen MCZ 362 is herein selected as the lectotype of *H. sharreri*, and specimen MCZ 253 is designated a paralectotype.

The two specimens in the Museum of Comparative Zoology (MCZ 362 and MCZ 253) are the large male and small female mentioned by A. Agassiz (1880, 1883). The third specimen mentioned by Agassiz was later renamed *Calocidaris micans*.

DISTRIBUTION.—Leeward Islands: Nevis and St. Kitts. The distribution of all histocidarids of the northwestern Atlantic, Caribbean, and Gulf of Mexico is inadequately known.

Poriocidaris purpurata (Wyville Thomson)

PLATE 10: FIGURES 2–8; PLATE 11: FIGURES 1–6; PLATE 12: FIGURES 6, 7

Poriocidaris purpurata.—For a complete synonymy and additional description see Mortensen, 1928, p. 104.

The test is noticeably flattened adapically and adorally (Plate 11: figure 3), with well-rounded sides. Some specimens are widest high on the test, others widest at the midpoint. Commonly there is no incurving of the basicoronal plates at the edge of the peristome. A few specimens exhibit a slight tendency toward incurving.

The ambulacra are moderately sinuate, marginal tubercles in a uniform series, inner tubercles lacking or very scattered in the upper portion of the ambulacra (Plate 12: figures 6, 7). Below the ambitus the tubercles are more abundant but normally only one or rarely two per plate. Plates lacking inner tubercles are common throughout the ambulacra. *Poriocidaris purpurata* possesses the internal prolongation (Plate 10: figure 3) on the peristomial ambulacral plates common to the histocidarids.

The shallow areoles are very large, the scrobicular ring circling near all the plate sutures on plates at and above the ambitus (Plate 11: figures 1, 3). Only a few extra scrobicular secondary tubercles occur on these plates. Below the ambitus the extrascrobicular areas at each side of the areoles are relatively larger and are accompanied by a proportionate increase in secondary tubercles (Plate 11: figure 2). Primary tubercles are crenulate even below the ambitus but strongly crenulate on the uppermost two or three of each series.

Primary spines are 2 to 2.5 times the horizontal diameter of the test, are cylindrical or slightly tapering. A few specimens with a few well-developed thorns on some spines have been collected from the eastern Atlantic. Normally numerous very small ridges of spinules run the length of the shaft. The spinules are directed strongly toward the tip of the spine. The collar on the uppermost primary spines of some specimens extends for a considerable distance up the spine. Some spines with long collars have a swelling in the collar. Purple to brownish pigment is common in the collar but the shaft is usually white.

The oral primary spines are strongly serrated, broadly rounded at the tip (Plate 11: figure 6) transversely convex on the adapical side flat on the adoral side. Longitudinally, these spines curve toward the mouth.

The most important diagnostic feature of *P. purpurata* is that its tridentate pedicellariae are bivalved and very strongly compressed (Plate 10: figure 2).

The color is quite varied. Specimens range from white to dark brownish purple test and secondary spines. The primary spine shaft is white, but the collar is the color of the test and secondary spines.

DISTRIBUTION.—South of Ireland to the Canary Islands. It was not previously known to occur in the western Atlantic. I discovered two specimens, one at the United States National Museum, the other at the Museum of Comparative Zoology at Harvard University. The specimen in the USNM (E–8244) was collected by RV *Oregon* at station 1909, 11 September 1957, 12°35′N, 82°19′W in the Caribbean Sea at 350 fms. The other specimen (MCZ 7732) was collected at Nicholas Channel off Bahia de Santa Clara at 500 fms, *Atlantis* station 3459.

COMPARISON WITH OTHER SPECIES.—The three histocidarids, *Histocidaris nuttingi, H. sharreri,* and *Poriocidaris purpurata,* can readily be distinguished from the other cidaroids of the northwestern Atlantic, Caribbean, and Gulf of Mexico by the lack of globiferous pedicellariae. Internally all three of the histocidarids have a prolongation on the peristomial ambulacral plates (Plate 10: figure 3) lacking in the other cidaroids of this region. Crenulation is strong all around the upper primary tubercles and present on tubercles well below the ambitus on the histocidarids. There is varied development of crenulation among the other cidaroids of the region but on none of them does it extend below the ambitus.

The naked tests of *H. sharreri* and *P. purpurata* are similar. Both have very large areoles, scrobicular rings that crowd their plate sutures especially at and above the ambitus, and very few extrascobicular secondary spines and tubercles. There are only a few inner tubercles in the ambulacral midzone of each species; possibly slightly more on *P. purpurata* than on *H. sharreri.*

The ambulacral midzones of *H. sharreri* and *P. purpurata* have few inner tubercles, but the midline suture is almost hidden by the abundant inner tubercles on *H. nuttingi.* The marginal tubercles of *H. sharreri* and *P. purpurata* are arranged in a uniform size gradient throughout the ambulacra; small adapically on small plates larger at the ambitus. *Histocidaris nuttingi* has large marginal tubercles separated by smaller ones approximately the same size as the inner tubercles. The large marginal tubercles in each series of an ambulacrum form a zigzag pattern.

The large tridentate pedicellariae are a diagnostic feature on each of these species. *Histocidaris sharreri* has three very broad large valves on each of its large tridentate pedicellariae (Plate 12: figure 5), whereas those of *H. nuttingi* are very long and slender (Plate 15: figure 1). All the pedicellariae on *P. purpurata* have two highly compressed valves. The small tridentate pedicellariae of *H. sharreri* and *H. nuttingi* are similar.

The collar on the uppermost primary spines of all three of these histocidarids commonly extends far up the shaft. This feature was previously considered diagnostic for *P. purpurata.* Thorns are uncommon on the primary spines of *P. purpurata,* common on those of *H. nuttingi,* of uncertain occurrence on *H. sharreri.* Thorn occurrence on *H. sharreri* is discussed in the description of the primary spines of that species.

Poriocidaris purpurata is distributed from south of Ireland to the Canary Islands and in the Caribbean Sea at depths of approximately 750–1,800 meters.

Stereocidaris ingolfiana Mortensen

PLATE 22: FIGURES 3–9

***Stereocidaris ingolfiana.*—For a complete synonymy see Mortensen, 1928, p. 267; for additional descriptions see Mortensen, 1903, p. 38, and 1928, p. 267.**

The test is flattened above and below, sides well rounded (Plate 22: figure 5). There is a very slight incurving of the basicoronal plates at the edge of the peristome. The height is commonly about 0.55 of the horizontal diameter, but a few specimens with relatively globular tests have been observed (Mortensen, 1903, p. 38; 1928, p. 268). The horizontal outline of the test is round.

The ambulacra are moderately sinuate, marginal tubercules in a uniform series. The ambulacral midzone is a jumble of inner tubercles which obscure the midline suture even on a denuded test (Plate 22: figure 6).

The interambulacral midline suture commonly has a dimplelike depression at each corner of the interambulacral plates (Plate 22: figure 7). These are not

true pits as in the temnopleurids, but they are readily observed on the denuded test. There are only a few rudimentary tubercles (Plate 22: figure 3), areoles are large and deep, the lower two in a series commonly confluent (Plate 22: figure 4). The scrobicular ring of tubercles is only slightly conspicuous, extrascrobicular area very limited. Mortensen (1903, p. 38) reported the secondary tubercles arranged in horizontal rows on large specimens. His largest specimens were 32 and 38 mm in diameter. I did not study any specimens that large, but on specimens 21 to 26 mm I did not see any tendency of alignment into rows. The extrascobicular area is so narrow on these specimens that there is insufficient space for rows to develop (Plate 22: figure 7). None of the interambulacral sutures appear naked.

The spinules of the uppermost longitudinal series on the primary spines grow longer than the other spinules and are fused together. Where this condition is highly developed, the spinule series forms a wing (Plate 22: figures 8, 9). The wing is common on the upper side of the spine, but a few spines may have an additional wing or two. The second wing most commonly develops on the underside of the spine. The spinules of the uppermost row are enlarged and united as if melted together on primary spines when a wing is not apparent. A row of numerous small serrations is on each edge of the oral spines and on the lowermost one or two transitional spines.

The apical system lacks features significant enough to aid readily in identification.

The large globiferous pedicellariae lack the single large end tooth of *Calocidaris* and *Cidaris*. The closed space between the end tooth and the blade opening is also lacking in *S. ingolfiana*. The opening is subterminal, rather large, narrower above than below, surrounded by teeth. The top of the opening is near the tip of the blade. The two uppermost teeth are larger than the others. These tend to fuse on some valves, giving the superficial appearance of a single end tooth. The two larger teeth fused or unfused are at the upper edge of the opening and not separated from the opening by a closed space as in *Cidaris* and *Calocidaris*.

The specimens are almost white, but a slight pink tint occurs in the primary spines of some specimens.

COMPARISON WITH OTHER SPECIES.—*Stereocidaris ingolfiana* can be distinguished readily from *Stylocidaris affinis* and *S. lineata* by the lack of naked sutures, and especially by the jumble of inner tubercles in the midzone of *Stereocidaris ingolfiana* obscuring the midzone suture. *Stereocidaris ingolfiana* can readily be distinguished from *Histocidaris* and *Poriocidaris purpurata* by the lack of distinct crenulation and possession of globiferous pedicellariae. *Histocidaris sharreri* and *P. purpurata* have very few inner tubercles in the ambulacra, only *H. nuttingi* has a cluttered ambulacral midzone, but it has large and small marginal tubercles. *Stereocidaris ingolfiana* has uniform marginal tubercles. *Tretocidaris bartletti* has strong crenulation on the upper side of the upper tubercles, naked sutures, and an uncluttered ambulacral midzone. *Cidaris* and *Calocidaris micans* have a well-developed single end tooth on the large globiferous pedicellariae, but *S. ingolfiana* lacks the single large end tooth. The very obscure ambulacral midline suture of *S. ingolfiana* and the "wing" on the primary spines also distinguishes *S. ingolfiana* from *Cidaris* and *Calocidaris micans*.

Stereocidaris is noted for the abundance of rudimentary tubercles, and interambulacral plates higher than wide on its adapical side. Some species from the Pacific and also some fossils have few fully developed tubercles visible when viewed from above.

Stereocidaris ingolfiana has far fewer rudimentary tubercles than one would expect in this genus (Plate 22: figures 3, 5). The absence of the single end tooth on the large globiferous pedicellariae offers the strongest evidence that it is a *Stereocidaris*.

Cidaris abyssicola has many rudimentary tubercles (Plate 5: figure 1), and indeed a fossil so well endowed could easily be assigned to the genus *Stereocidaris*. This feature distinctly distinguishes it from all the other species of *Cidaris* in the northwestern Atlantic and the Gulf of Mexico. Neither species has a markedly higher-than-wide ratio of upper interambulacral plates so characteristic of some *Stereocidaris* species. The ambulacral interporiferous zones of both species are crowded with inner tubercles. Those of *C. abyssicola* tend to be more organized into a series (Plate 5: figure 4). Those of *S. ingolfiana* are jumbled, the midline often difficult to distinguish (Plate 22: figure 6).

Specimens of *C. abyssicola* with two inner tubercles, one above the other adjacent to the marginal tubercles (Plate 5: figure 4), have a very crowded interporiferous zone but the series of tubercles is quite pronounced.

DISTRIBUTION.—Northern Atlantic from the Denmark Strait to Cape Verdes on the eastern side and into the Caribbean on the western side at depths of 300 to 1,745 meters.

Stylocidaris affinis (Philippi)

PLATE 18: FIGURES 4–6; PLATE 19: FIGURES 1, 3, 7; PLATE 20: FIGURES 4, 5

Stylocidaris affinis.—For a complete synonymy and additional description see Mortensen, 1928, p. 336.

Test flattened above and below, circumference round, basicoronal plates slightly incurving at the edge of the peristome.

Ambulacra are moderately sinuate; marginal tubercles in uniform series. Commonly there is only one inner tubercle per plate, located on the lower portion. A very small granule is commonly found just above it. Two additional granules are on the lower edge of the plate just below the marginal tubercle (Plate 20: figure 5). All these granules may be indistinguishable without special preparation of the test. The midline suture is white and very naked (Plate 19: figure 3).

The areoles of the interambulacra are quite large, well separated, even the lowermost two in a column are commonly not confluent. Areoles in the ambital region are moderately deep. Large specimens lack crenulation on the tubercles. I have observed crenulation on very small specimens up to 5 mm in diameter, but found it absent on specimens 10 mm and larger. The scrobicular ring of tubercles is rather inconspicuous. Interambulacral and ambulacral midline sutures are naked and white.

The apical system is covered with coarse round granular tubercles (Plate 19: figure 1) except on very small specimens only a few millimeters in horizontal diameter, which have radially elongate tubercles. Specimens large enough to be easily studied with the unaided eye have developed the round tubercles.

The length of the primary spines is from 1 to 1.5 times the horizontal diameter of the test. Some young specimens have spines up to twice the horizontal diameter of the test. The spines are rather slender tapering toward the tip, rows of rather coarse spinules can be observed by the unaided eye. There is a short naked neck between the collar and the rows of spinules. The scrobicular spines are very diagnostic. The most important feature is the dense reddish to reddish brown stripe of pigment running through the midline on the exposed side of the spine. The edges of these spines are white or white with a slight greenish tint. These spines taper in the distal portion toward a cutoff or blunt tip (plate 18: figure 4). The oral spines have rows of blunted spinules and lack serrate edges, are only slightly flattened and terminate in a blunt tip.

The large globiferous pedicellariae lack an end tooth.

The test is white to slightly olive. Red to reddish-brown pigment is abundant in the apical system and in a midline stripe on the scrobicular and marginal spines. The collar and neck of primary spines commonly have the reddish pigment, especially on specimens with reddish-brown banded spines. Some specimens have white or slightly olive spines without color bands. Color banding is most prevalent on small specimens.

COMPARISON WITH OTHER SPECIES.—The tests of *Tretocidaris bartletti* and *Stylocidaris affinis* are quite similar, but the strong crenulation on the upper side of the upper tubercles on *Tretocidaris bartletti* (Plate 21: figure 4) distinguishes it from *Stylocidaris affinis*, which lacks crenulation except on very small specimens.

The granules around the periphery of the apical system tend to elongate in a radial direction on *T. bartletti* (Plate 21: figure 2) while those of *S. affinis* are round (Plate 19: figure 1).

The ambulacra of the two species are very similar (Plate 20: figure 5; Plate 21: figure 1).

The spinules on the upper side of the primary spines are more fully developed than those on the underside on *T. bartletti* (Plate 21: figures 5, 6; Plate 22: figures 1, 2). This feature is helpful also in identifying very small specimens only a few millimeters in diameter. The white scrobicular spines are an added identifying feature. *Stylocidaris affinis* has spinules of uniform size around the primary spines and a reddish midline stripe on the scrobicular and marginal spines.

Stylocidaris affinis and *Stylocidaris lineata* are superficially similar but are easily distinguished. The more colorful is *S. affinis* (Plate 20: figure 4), with reddish pigment throughout the plates of the apical system, reddish stripe down the midline of the scrobicular and marginal spines (Plate 19: figure 3), and commonly especially in small specimens reddish to brown banding of the primary spines (Plate 18: figures 5, 6). The rest of the echinoid is white to slightly olive. *Stylocidaris lineata* is white or almost so. The only noticeable color is the reddish-brown naked midline sutures of the ambulacra (Plate 19: figure 4), the sutures of the interambulacra, and the reddish-brown ring in the apical system (Plate 19: figure 5). These reddish-brown sutures and ring in the apical system are the most distinguishing features. The sutures of *S. affinis* are white (Plate 19: figure 3).

The apical system of *S. affinis* is covered with round granules (Plate 19: figure 1), whereas *S. lineata* lacks granules in the region of the naked reddish ring. The granules on either side of the ring are radially elongate (Plate 19: figure 2).

Many specimens of these species were studied at the U.S. National Museum and at the Museum of Comparative Zoology. Only one specimen of *S. affinis* was found with an apical system similar to *S. lineata.* All specimens of *S. lineata* have the apical system here described. Collections commonly have both of these species identified as *S. affinis,* and the worker must be careful to identify specimens himself rather than to rely on existing labels.

The primary spines of *S. lineata* are somewhat longer than those of *S. affinis.* The length of the naked neck and number of spinule rows are too variable to distinguish the species.

The large globiferous and large tridentate pedicellariae of *S. lineata* have longer more slender valves (Plate 19: figure 6) than those of *S. affinis* (Plate 19: figure 7).

Eucidaris tribuloides is usually found in fairly shallow water, but it extends into the upper limits of the distribution of *S. affinis.* The two species are commonly collected at the same station especially off the west coast of Florida. Specimens of both species only a few millimeters in diameter are strikingly similar, both having light and dark banding of the primary spines with well-developed thornlike spinules (Plate 18: figures 1–3, 5). The wartlike spinules of *E. tribuloides* first appear in the dark bands nearest the base of the primary spines. Wart development progresses more rapidly in the dark bands as the individual grows. The thorns remain only in the light bands on slightly larger specimens (Plate 18: figures 2, 3). These also change to warts and the color banding is commonly lost. The spinules do not develop into warts on *S. affinis.* A crownlike tip commonly develops on at least one primary spine even on extremely small individuals of *E. tribuloides* (Plate 18: figure 3). A distinguishing feature is that one or two very broad tipped large scrobicular spines (Plate 18: figure 2) are commonly present even in the smallest specimens of *E. tribuloides. Stylocidaris affinis* has a reddish midline stripe on the scrobicular and marginal spines even when very small (Plate 18: figure 5).

DISTRIBUTION.—Bermuda, the West Indies, Caribbean Sea, Gulf of Mexico, eastern Atlantic, and the Mediterranean Sea at depths of 30 to 1,000 meters.

Stylocidaris lineata Mortensen

PLATE 19: FIGURES 2, 4–6; PLATE 20: FIGURES 1–3

Stylocidaris lineata.—For a complete synonymy see Mortensen, 1928, p. 342; for an additional description see Mortensen, 1910, p. 10.

The naked test of *S. lineata* is indistinguishable from that of *S. affinis* except for the apical system and suture color. Only these features are discussed here.

The apical system has a reddish nearly naked ring lacking granular tubercles crossing all genital plates (Plate 19: figures 2, 5). The granules on either side of the naked ring are radially elongate. The ambulacral midline suture and all interambulacral sutures are reddish brown (Plate 19: figures 4, 5), even on specimens only a few millimeters in diameter. This is a very important diagnostic feature of *S. lineata* and probably the least variable, because the color is almost always the same and withstands years of alcohol and dry storage with great durability. The primary spines are white with delicate spinules, visible to the naked eye. Length of the spines is from 1.5 to slightly more than 2 times the horizontal diameter of the test. The scrobicular and marginal spines are white and lack a midzone stripe.

COMPARISON WITH *S. affinis.*—Three significant features distinguish *S. lineata* from *S. affinis.* The scrobicular and marginal spines of *S. lineata* are white and without a midline stripe, whereas those of *S. affinis* have a prominent reddish-midline stripe with a white to greenish edge (Plate 18: figure 4; Plate 19: figure 3). The apical system of *S. lineata* has a naked reddish ring lacking small granular tubercles. The tubercles are radially elongated on each side of the ring. No naked ring is present in the apical system of *S. affinis.* The tubercles are round and scattered over the apical system (Plate 19: figure 1), which is commonly reddish to reddish brown. The midline sutures of the ambulacra and all interambulacral sutures of *S. lineata* are reddish brown (Plate 19: figure 4). Whereas those of *S. affinis* are white (Plate 19: figure 3). Additional comparisons follow the description of *S. affinis.*

The description of the naked test of *S. affinis* applies to *S. lineata* with the exception of the apical system and the suture color.

DISTRIBUTION.—West Indies, at depths of 100–500 meters. It may be frequently found living with *S. affinis*.

Tretocidaris bartletti (A. Agassiz)

PLATE 21: FIGURES 1–7; PLATE 22: FIGURES 1, 2

Tretocidaris bartletti.—For a complete synonymy see Mortensen, 1928, p. 315; for additional description see Mortensen, 1910, p. 5.

The test of *Tretocidaris bartletti* is rather low, approximately .55 of the horizontal diameter, flattened above and below. The apical system is very slightly elevated, highest point is in the periproct. The basicoronal plates have a very slight tendency to incurving at the edge of the peristome. Ambulacra are moderately sinuate, marginal tubercles in a uniform series. There is one small inner tubercle low on each ambulacral plate (Plate 21: figure 1) except on newly introduced plates at the adapical end of the column. The inner tubercles are in series. The interambulacral areoles are large and shallow, two lowermost confluent. The upper side of the uppermost tubercles are crenulate. Crenulation commonly extends all the way around a few of these tubercles, but it is more prominent on the uppermost portion (Plate 21: figure 4). The scrobicular rings of tubercles are fairly prominent. They circle close to all plate sutures limiting the extrascrobicular area which bears few secondary tubercles. The interambulacral midline suture is naked. Granules on the periphery of the apical system are elongated radially (Plate 21: figure 2).

The primary spines are cylindrical to very gently tapering, with their length approximately 1.5 times the horizontal diameter of the test. The spinules of the upper side are larger than those of the underside. These upper spinules of some specimens are very large and very conspicuous (Plate 22: figures 1, 2). A hand lens may be required to observe the difference in spinule size on other specimens (Plate 21: figure 7). A spine between these two extremes is shown in Plate 21: figures 5, 6. Regardless of the degree of development, the upper side spinules are larger than those on the underside.

The primary spines are color banded, but this is less important because some other cidaroids also commonly have color-banded spines. The reddish-brown bands range from very wide to very narrow. Regardless of the pattern, banding is a constant feature. The underside of the spine has greatly reduced pigment and is almost white (Plate 22: figure 2).

The oral primary spines have a thin ridge on each side which commonly has inconspicuous closed serrations. The large globiferous pedicellariae of this species are very significant, being quite different from those of any other species. The single end tooth is quite long and prominent, and the blade opening is very small (Figure 3) commonly surrounded by a ring of very small teeth. Above the opening is a short closed space separating the long slender end tooth from the blade opening. This very small blade opening is the most significant diagnostic feature of *T. bartletti*.

The specimens are quite white except for the brown to brownish-red color banding of the primary spines. The same color is commonly found to varying extents in the apical system and areoles. Naked sutures are white. Scrobicular spines are white or white with a weak greenish-brown midline.

COMPARISON WITH OTHER SPECIES.—*Tretocidaris bartletti* has a large single end tooth and a very small opening in the blades of the large globiferous pedicellariae. The large globiferous pedicellariae of *S. Affinis* and *S. lineata* lack a large single tooth. *Cidaris* and *Calocidaris micans* have a large end tooth, and a large blade opening on the valves of their large globiferous pedicellariae.

The crenulation on the upper side of the uppermost primary tubercles always present in *T. bartletti* also occurs on some specimens of other species which commonly lack crenulation. The tests of *Stylocidaris affinis* and *S. lineata* are very similar to the test of *T. bartletti*, but lack crenulation except when only a few millimeters in diameter. The reddish-brown sutures of *S. lineata* distinguish it from *T. bartletti* which has white sutures.

The scrobicular spines of *S. lineata* are very similar to those of *T. bartletti*, but the scrobicular spines of *S. affinis* bear a strong reddish to reddish-brown midline stripe. The scrobicular spines of *T. bartletti* are white or bear a weak greenish to greenish-brown midline, not as distinct as that of *S. affinis*. The spinules on the upper side of the primary spines of *T. bartletti* are markedly larger than those of the underside. This is a distinct feature of this species.

DISTRIBUTION.—West Indies and Caribbean Sea at depths of 140 to 625 meters.

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Index

PLATES

PLATE 1

Diagnostic features common to all cidaroids:

1. The tooth lacks a keel.
2. The top of the junction of pyramid halves is higher than the lowest part of the epiphyses (see Figure 1). The compasses have been removed from the figured lantern.
5. The prominent lantern supports are interambulacral apophyses.
7. The series of ambulacral plates continues across the peristome to the mouth. There are no gill notches on the peristomial edge of the test as on noncidaroid rigid test sea urchins (Plate 1: figure 8) *Cidaris abyssicola* (A. Agassiz), × 1.5.

Noncidaroid features:

3. The top of the junction of pyramid halves is lower than the lowest part of the epiphyses (see Figure 1).
4. The tooth has a keel.
6. The prominent lantern supports are ambulacral auricles.
8. Gill notches on the peristomial edge of the test.

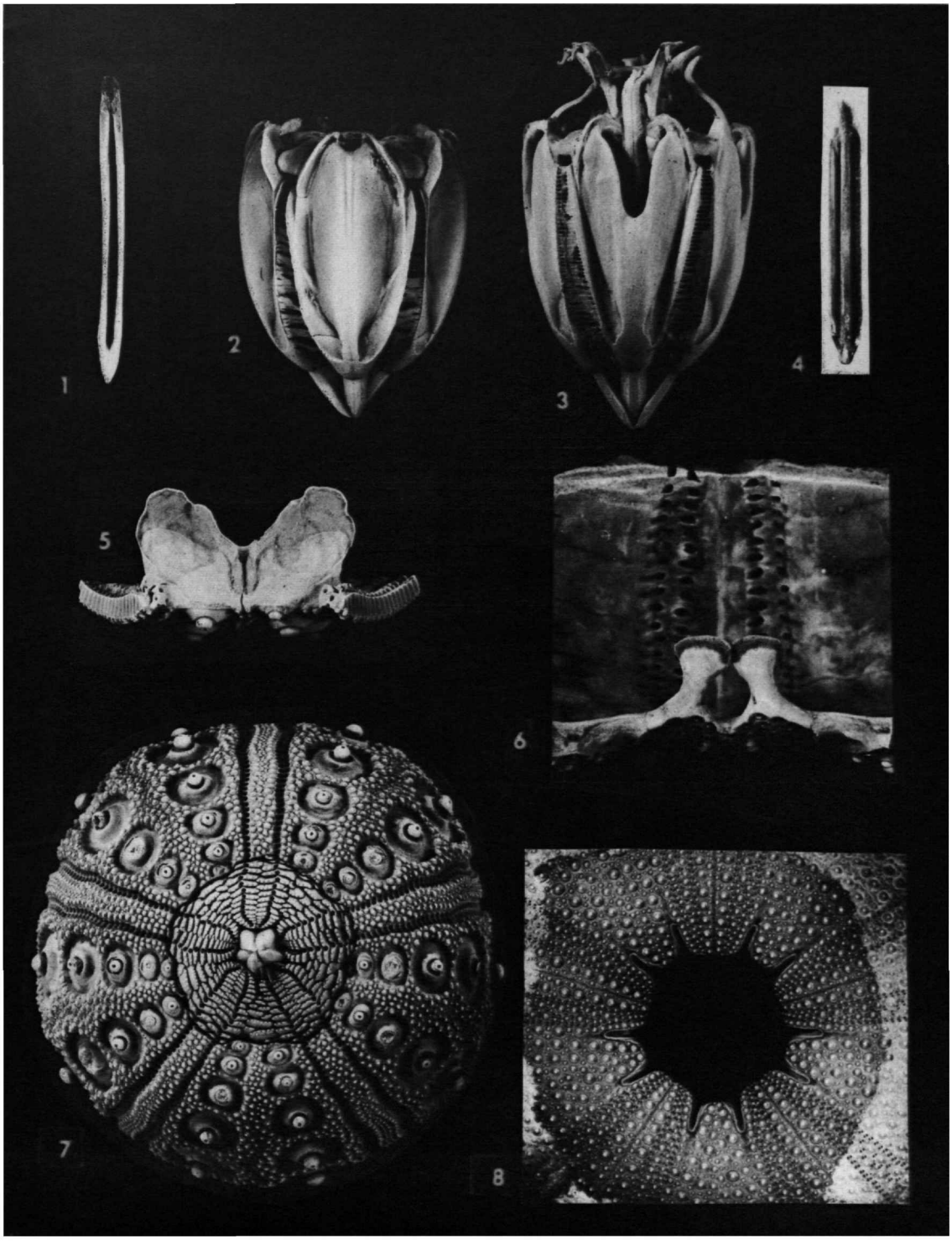
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PLATE 2

Calocidaris micans (Mortensen), USNM 10717:

1. Details of an interambulacral plate and a portion of an ambulacrum, × 4.
2. Side view of test, note slightly sunken interambulacral midzone, × 1.5.
3. Adoral side of the base of a large primary spine, note shiny surface and absence of crenulation, × 7.
4. Apical system, note pentagonal periproct common to the cidaroids, × 4.
5. Adapical side of primary spine in figure 3 showing crenulation matching that of a tubercle such as in figure 1, × 7.
6. Portion of an ambulacrum showing typical arrangement of pore pairs, marginal tubercles, and inner tubercles, × 6.
7. Scrobicular spine, × 6.
8. Adapical view of test, × 6.

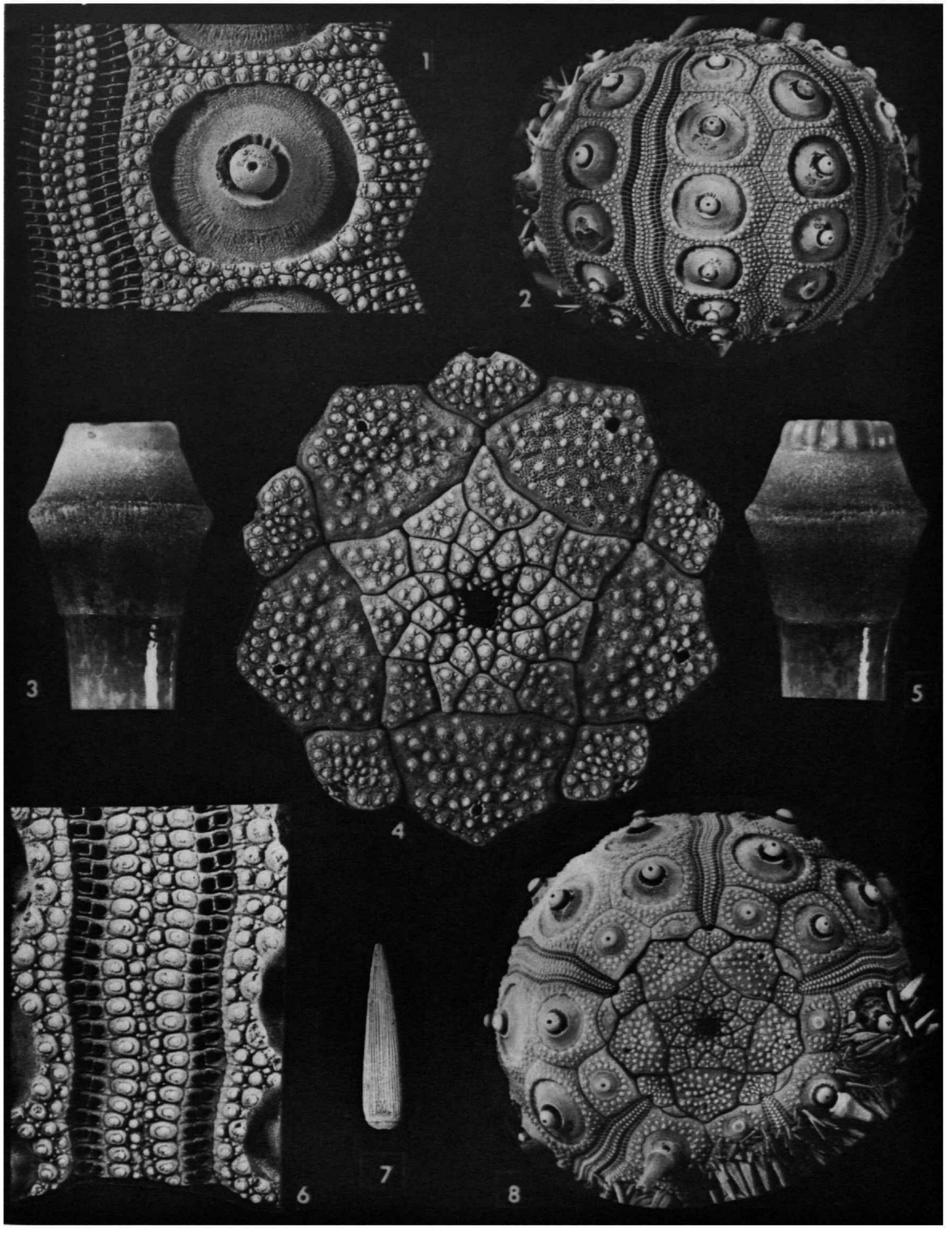
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PLATE 3

Calocidaris micans (Mortensen), USNM 10717:
1, 7. Adapical and adoral views, × 0.5.
2, 5, 6. Adapical, adoral, and ambital portions of an ambulacrum, × 6.
3. Oral primary spine, × 9.
4. Primary spine, × 0.9.

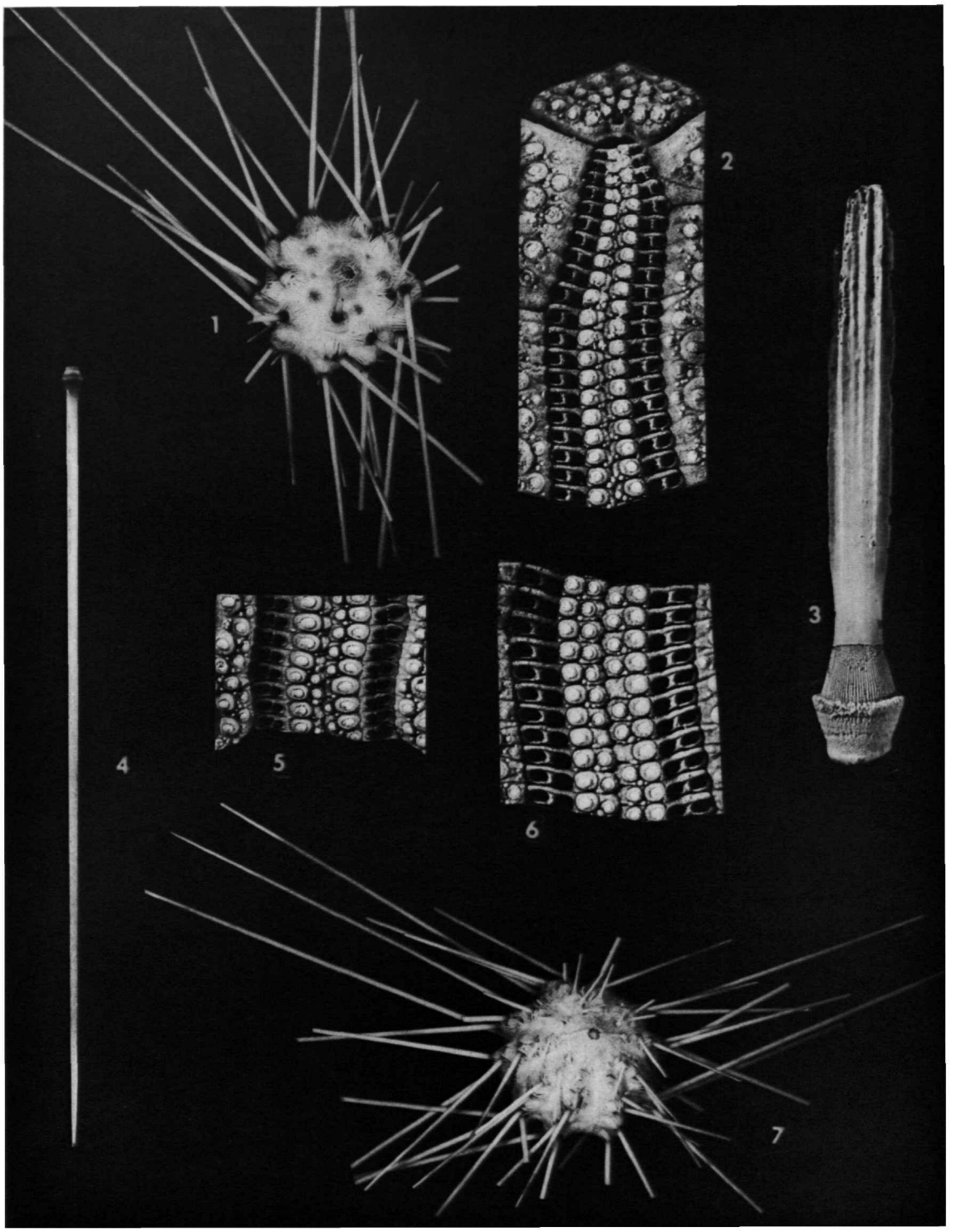
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PLATE 4

Cidaris abyssicola (A. Agassiz):

1. Tip of primary spine showing hollow "hoof," × 6, USNM 7615.
2, 6. Adapical and side views showing flattened adapical area and horizontally directed primary spines, × 1, USNM 7615.
3. Adapical end of an ambulacrum, × 4.
4. A fairly smooth chalky white primary spine, × 1.2.
5. A transitional primary spine from the adoral side of the test, × 2.

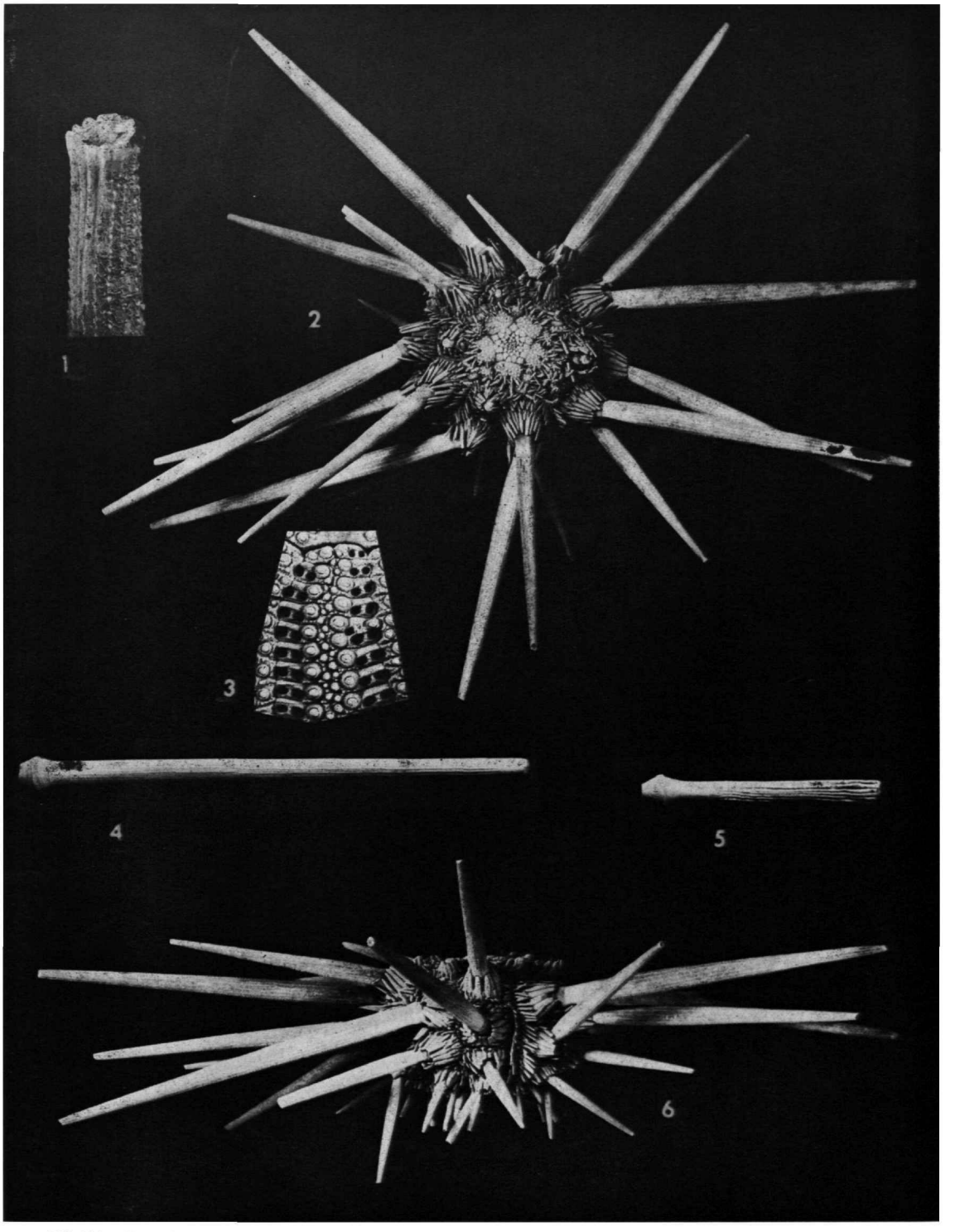

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PLATE 5

Cidaris abyssicola (A. Agassiz):

1, 2. Adapical and side views of denuded test, × 1.5.
3. Slender spine form which Mortensen referred to as *C. abyssicola* var. *teretespina,* × 1.
4, 5. Ambital and adoral views of an ambulacrum, × 4.
6. Scrobicular spines covering the muscles of a primary spine, × 5, USNM 7615.

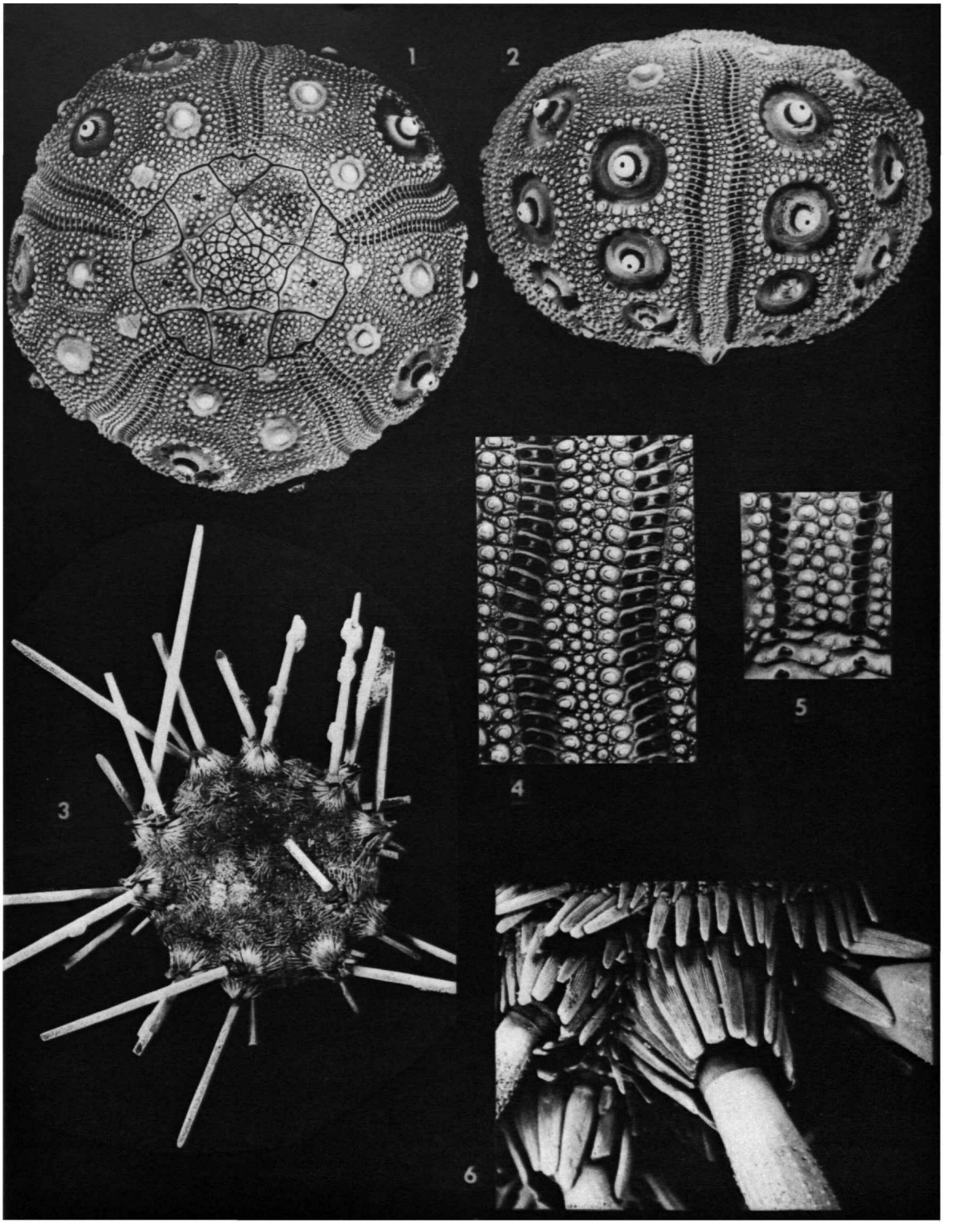
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PLATE 6

Cidaris blakei (A. Agassiz):

1. Adapical view of test, × 2, USNM E3933.
3. Portion of an interambulacrum showing very large areoles and sparsity of very fine extrascrobicular tubercles, × 4, MCZ 155.
5. Apical system showing fine granular tubercles, × 4, MCZ 155.

Cidaris rugosa (H. L. Clark):

2. Adapical view of test, × 1.5, USNM E10329.
4. Portion of an interambulacrum of a paratype showing relatively larger extrascrobicular area and tubercles than those of *C. blakei* in figure 3, × 4, MCZ 167.
6. Apical system of a paratype showing relatively coarse granular tubercles, × 4, MCZ 167.

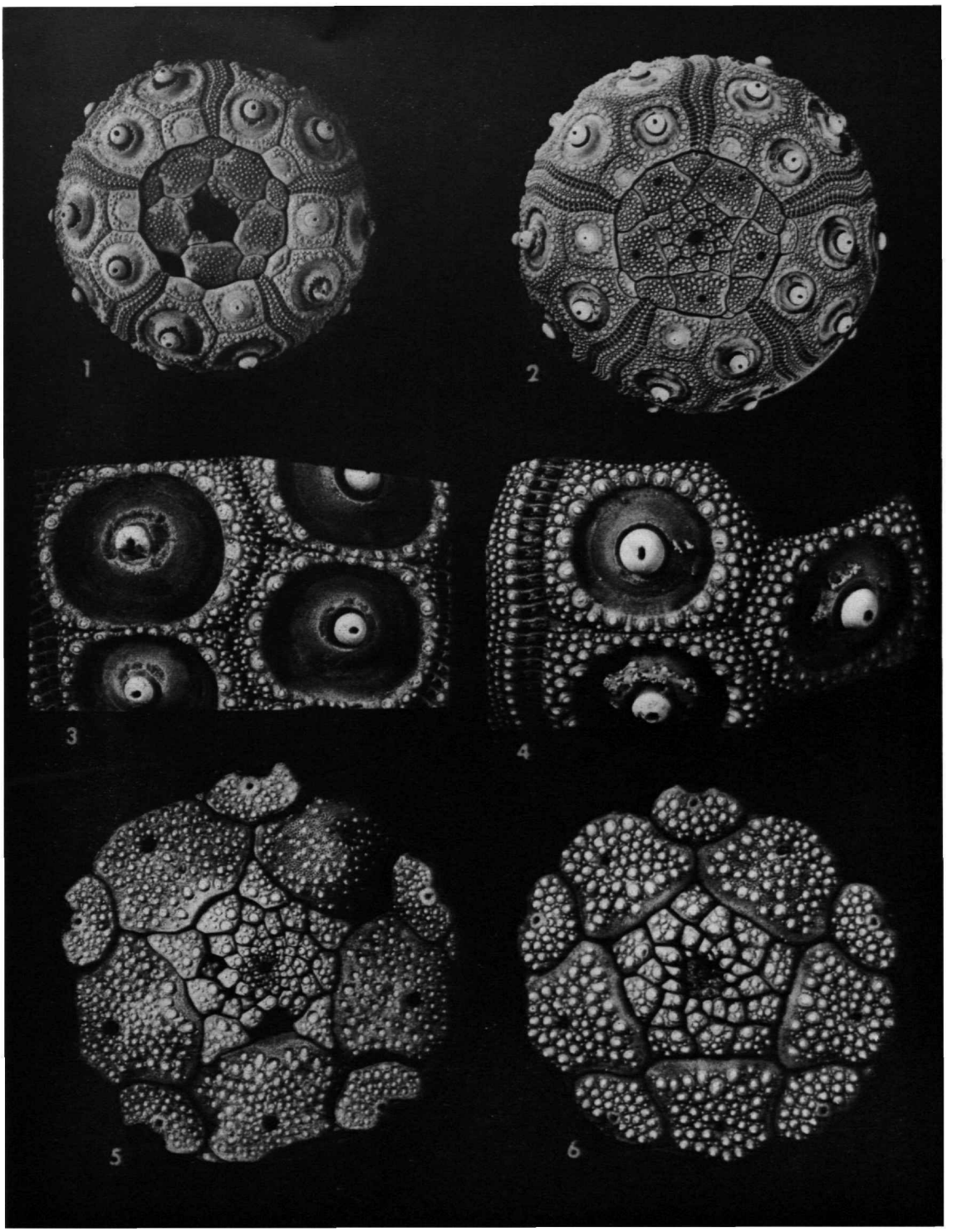
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PLATE 7

Cidaris blakei (A. Agassiz), USNM E3933:
1. Side view of test, × 2.
6, 7, 8. Adapical, ambital, and adoral views of an ambulacrum, × 6.
Cidaris rugosa (H. L. Clark):
2. Side view × 1.5, USNM E10329.
3, 4, 5. Adapical, ambital, and adoral views of an ambulacrum, × 4.5, USNM 21444.
9. Ambital view of an ambulacrum, × 4.5, USNM E10329.

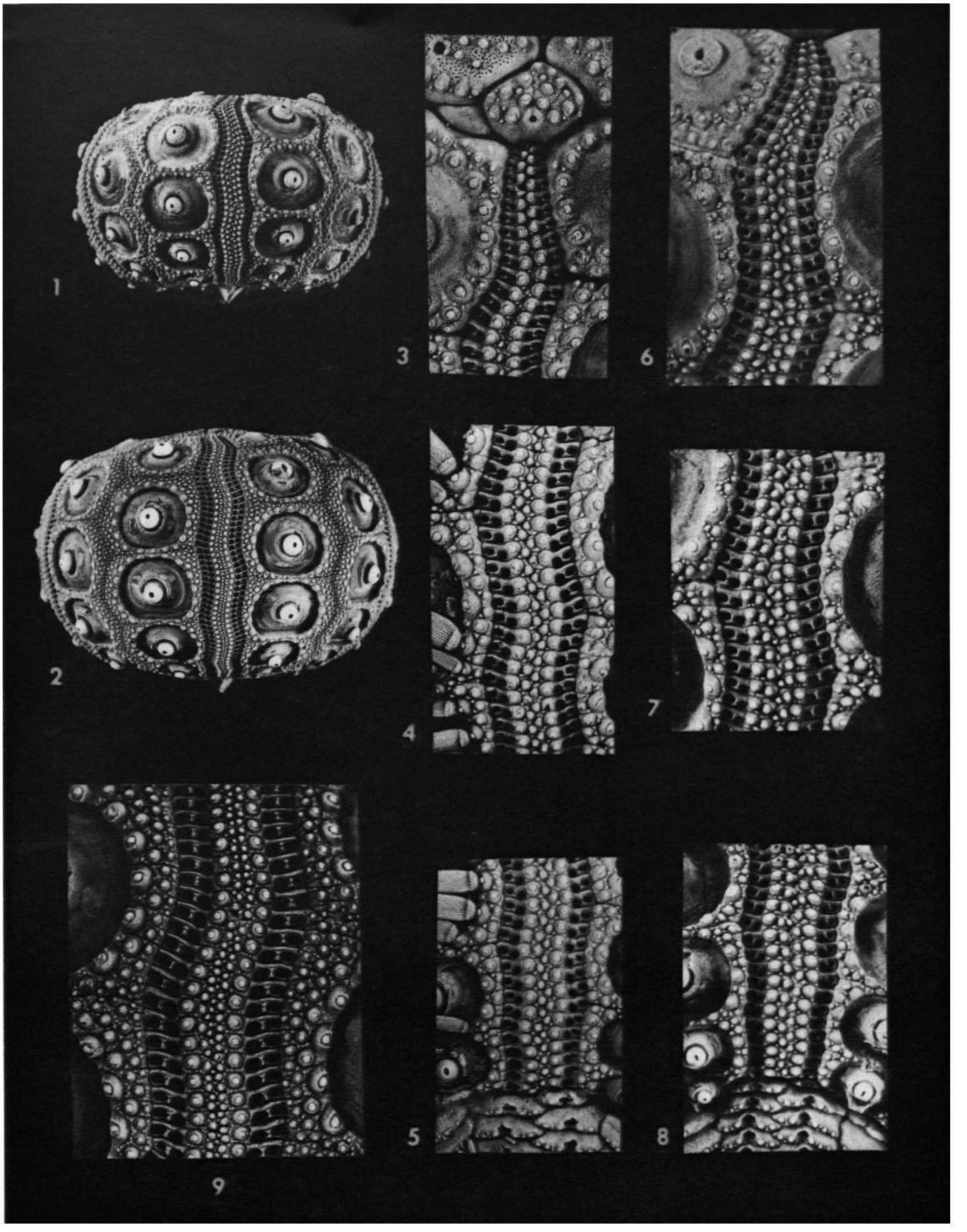
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PLATE 8

Cidaris blakei (A. Agassiz):

1, 2. Fan-shaped adapical primary spines of an exceptionally well-developed specimen, × 1.5, USNM E3933.

3, 4. Slightly flattened ambital primary spines similar to the adapical spines of some specimens, × 1.5, USNM E3933.

5. Primary spine from below the ambitus without flattened tip, × 1.5, USNM E3933.

8. Close-up view showing the more pointed slim marginal spines of *C. blakei* as compared with *C. rugosa* in figure 9, × 8, USNM E8697.

Cidaris rugosa (H. L. Clark):

6. Primary spine with flattened tip, × 1.5, USNM E10329.

7. Primary spine with swollen area near collar, × 1.5, USNM 21444.

9. Close-up view showing broader blunter marginal spines of *C. rugosa* as compared with *C. blakei* in figure 8, × 7, USNM 21463.

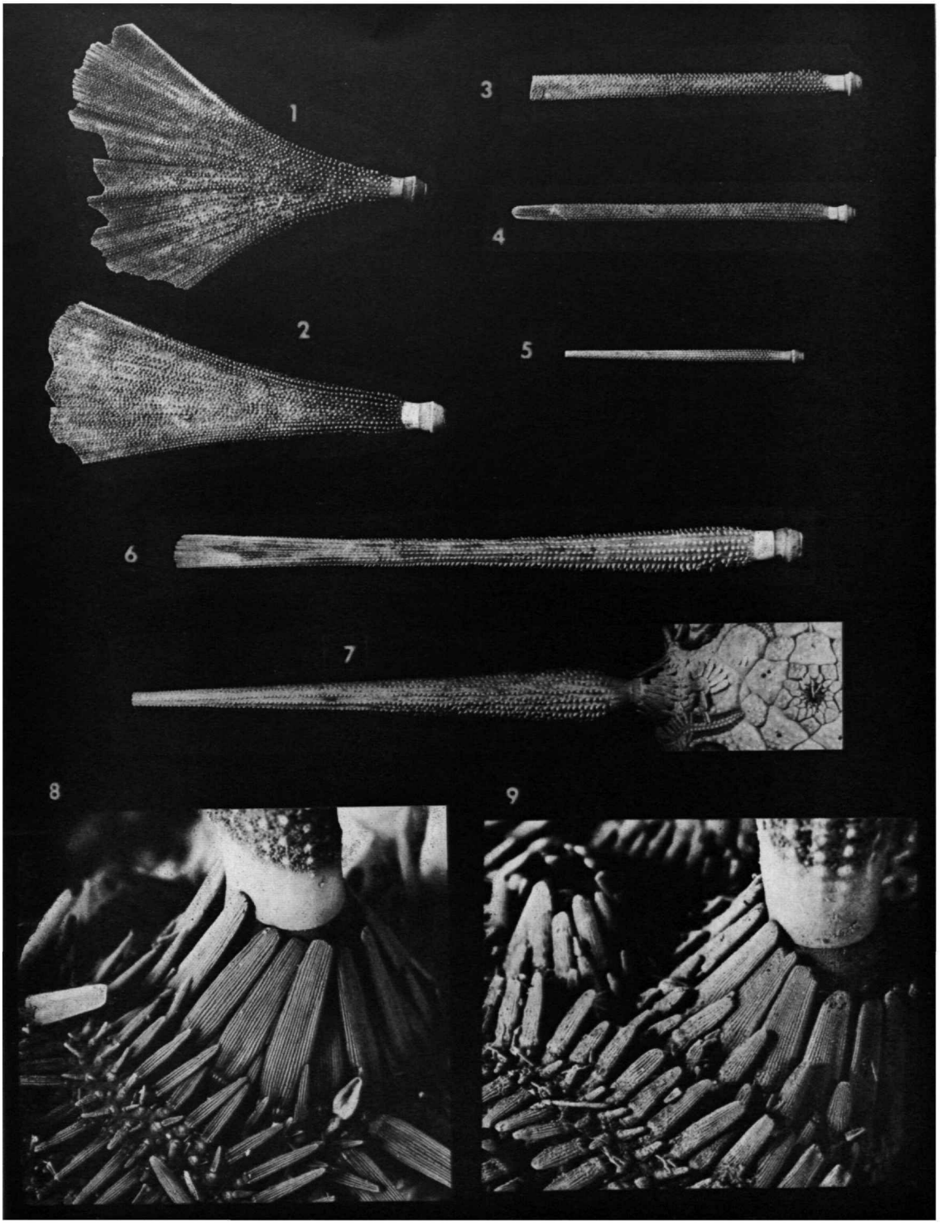
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PLATE 9

Cidaris blakei (A. Agassiz):

1, 2. Adapical and side views of a specimen with exceptionally well-developed fanlike adapical primary spines, × 1, USNM E8697.

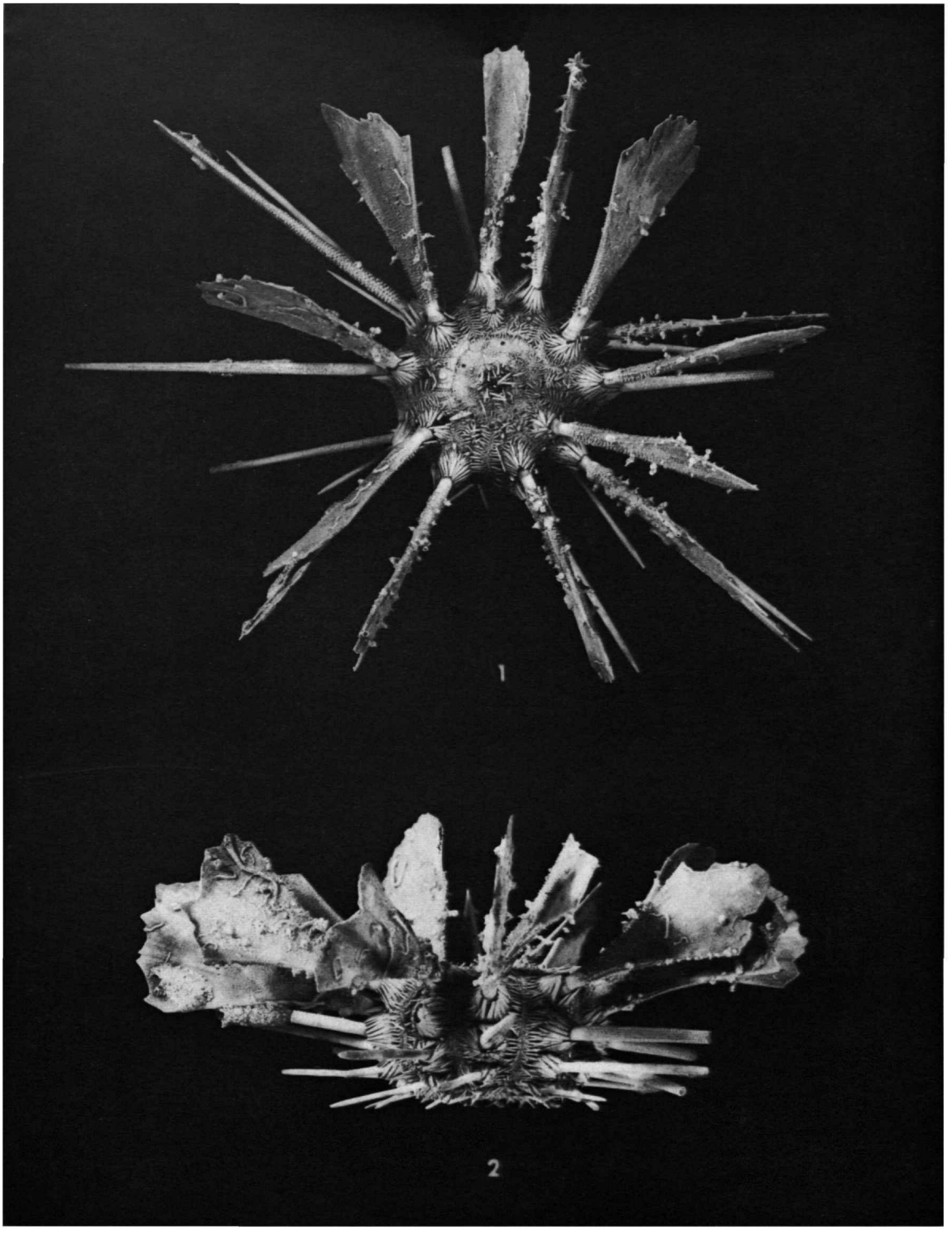
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PLATE 10

Cidaris rugosa (H. L. Clark):

1. Adapical view, × 1, USNM 21463.

Poriocidaris purpurata (Wyville Thompson):

2. Bivalve tridentate pedicellaria, × 20, USNM E8244.
3. Internal view of a portion of the peristome showing the prolongations on the ambulacral plates, a diagnostic feature of all histocidarids, × 9, USNM E8244.
4, 5, 6. Tip of cylindrical, tapered, and slightly tapered cylindrical primary spines, × 4, USNM E8244.
7. Crenulation on adapical side of primary spine base, × 4, USNM E8244.
8. Adoral side of primary spine base showing absence of crenulation, × 4, USNM E8244.

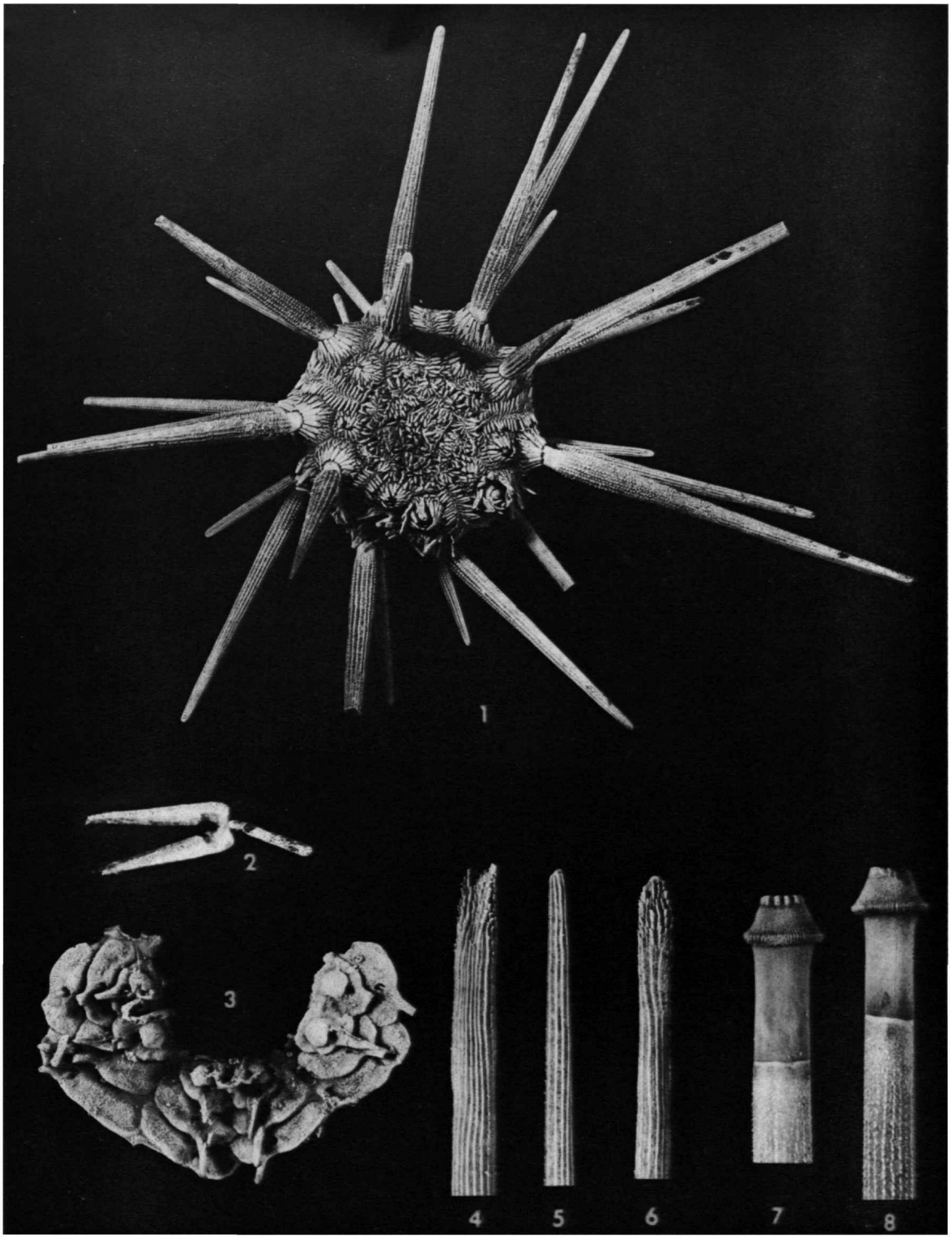
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PLATE 11

Poriocidaris purpurata (Wyville Thompson):

1, 2, 3. Adapical, adoral, and side views, × 2.5, USNM E8244.
4. Adapical view partially denuded, × 1, USNM E8244.
5. Adapical view of eastern Atlantic specimen, × 1, USNM 27675.
6. Oral primary spines, notice the blunt rounded tips and prominent serration, × 6, USNM E8244.

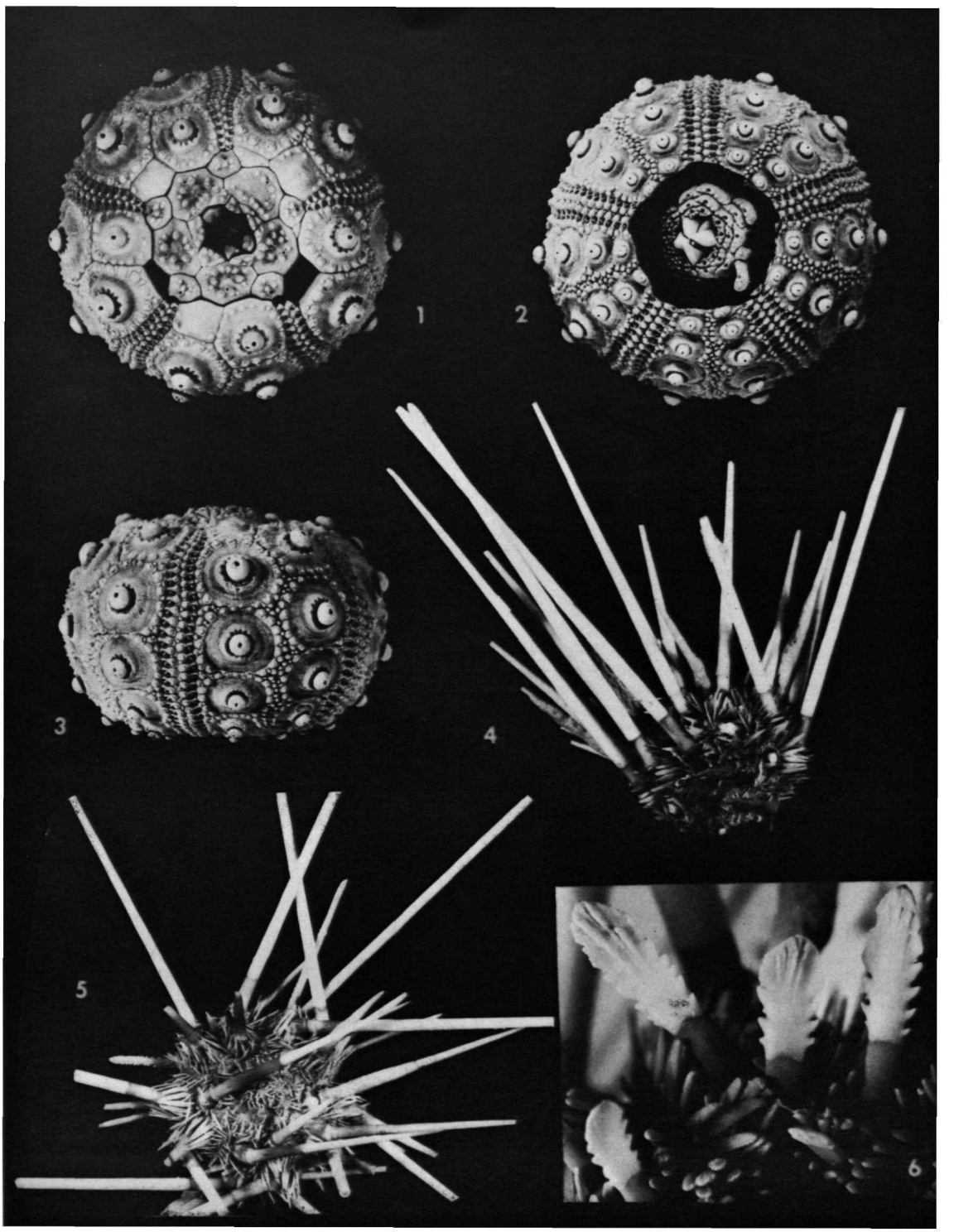
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PLATE 12

Histocidaris sharreri (A. Agassiz).

Paralectotype, MCZ 253:

1. Adapical view of the test, notice the large female genital pores, × 1.5.
8, 9. Adapical and ambital views of an ambulacrum, × 5.

Lectotype, MCZ 362:

2, 3, 4. Tips of primary spines, × 2.
5. Large tridentate pedicellaria, × 6.
10. Apical system, × 2.
11. Ambital view of denuded portion of an ambulacrum, note that the deeply sunken suture, a deformity, is limited to a small area in the upper portion of the figure, × 6.

Poriocidaris purpurata (Wyville Thomson), USNM E8244.

6, 7. Adapical and ambital view of an ambulacrum, × 7.

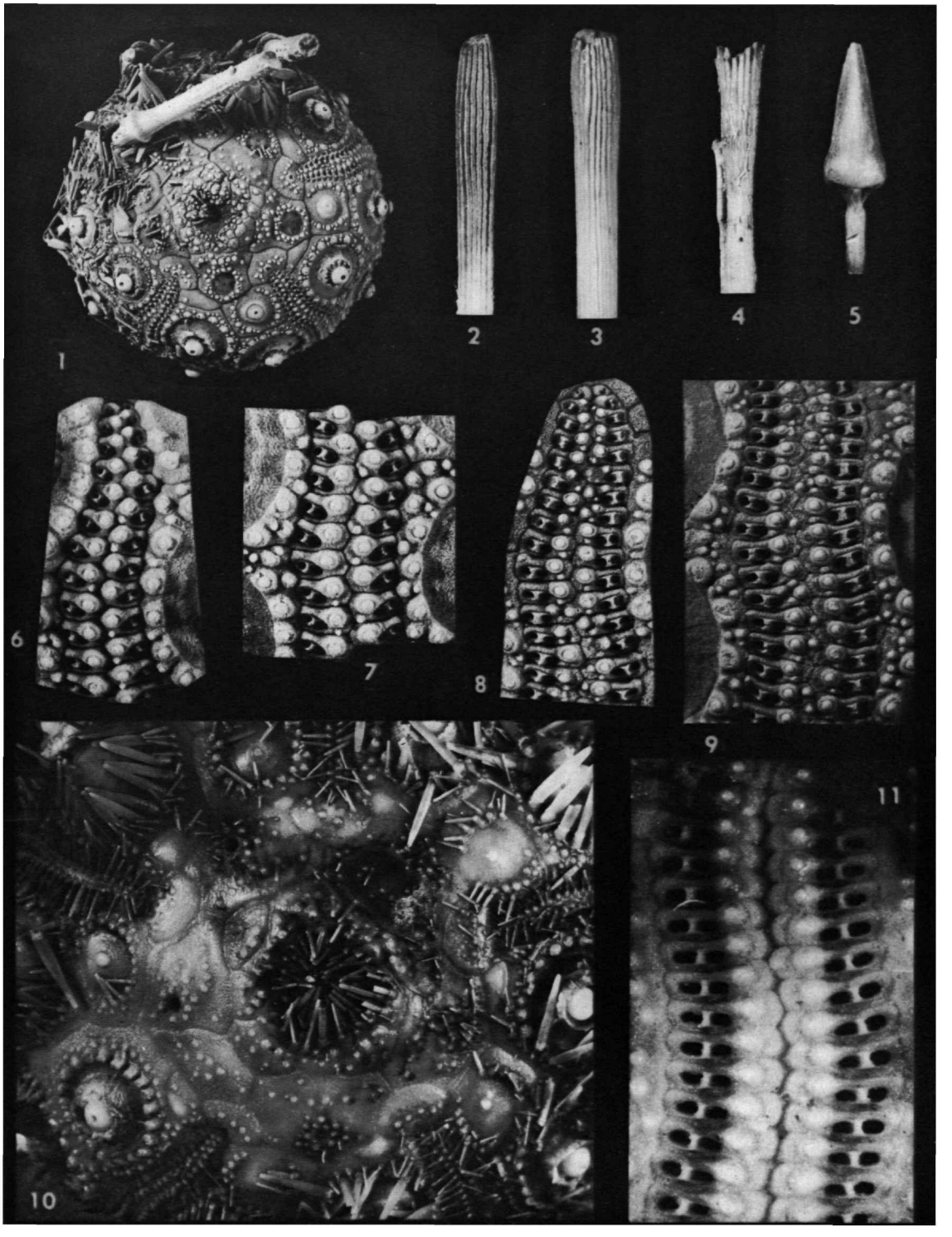
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PLATE 13

Histocidaris sharreri (A. Agassiz), lectotype, MCZ 362:
1, 2, 3. Side, adapical, and adoral views, × 0.75.

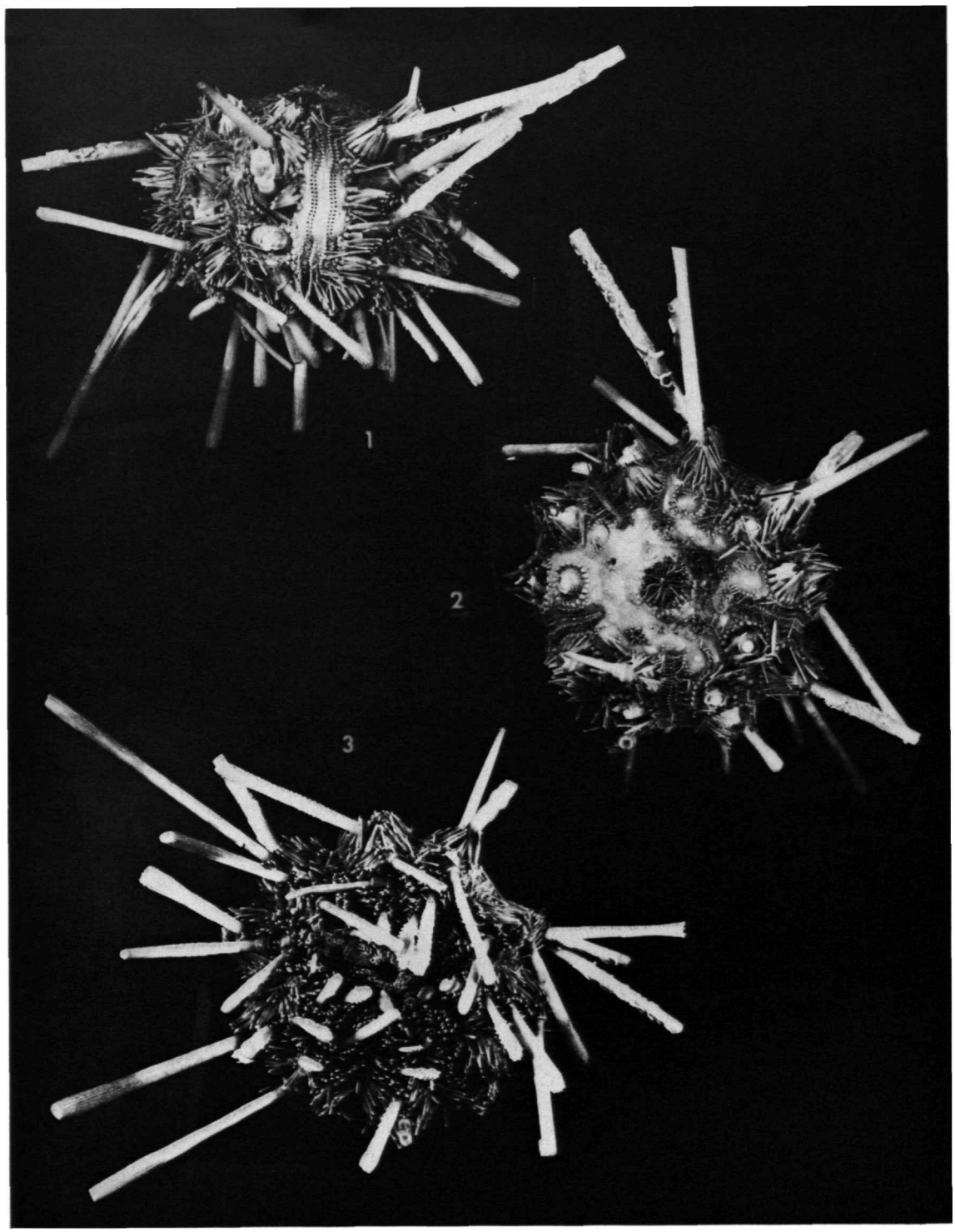
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PLATE 14

Histocidaris sharreri (A. Agassiz), paralectotype, MCZ 253:
1, 2. Side and adoral views, × 1.5.
Histocidaris nuttingi Mortensen, MCZ 7729A:
3. Apical system showing large female genital pores, × 2.
4. Ambital view of test, note how the scrobicular ring crowds the lower plate suture, × 2.
5. Ambulacrum showing the zigzag pattern of large marginal tubercles, × 4.

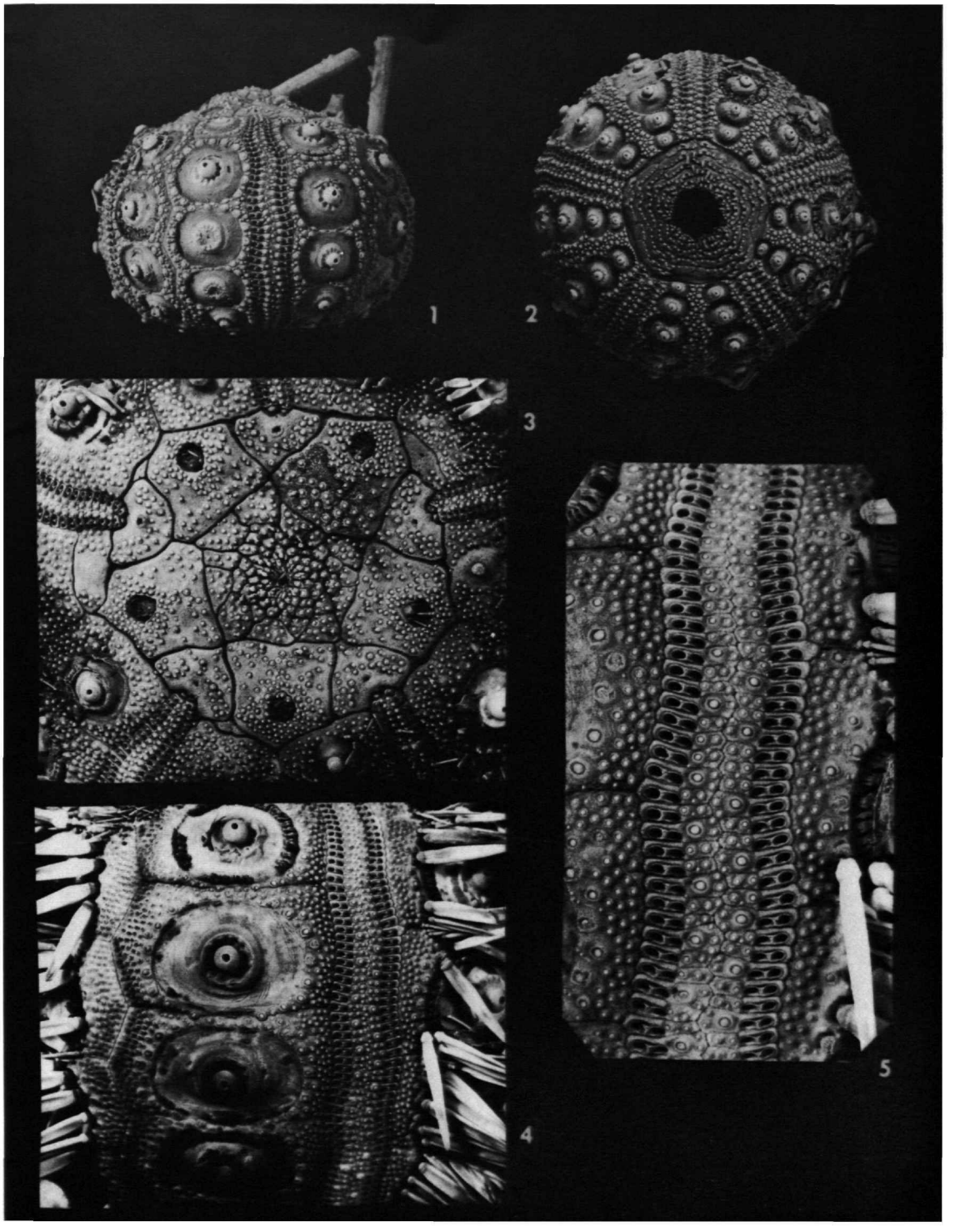
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PLATE 15

Histocidaris nuttingi Mortensen, MCZ 7729A:

1. Tridentate pedicellaria, note the uneven length of the long narrow blades, × 12.
2, 3. Large shiny thorny primary spine, × 2.
4. Curved primary spine lacking thorns, × 1.5.
5. Transitional primary spine, × 2.
6. Oral primary spine, × 2.
7. Side view, × 1.

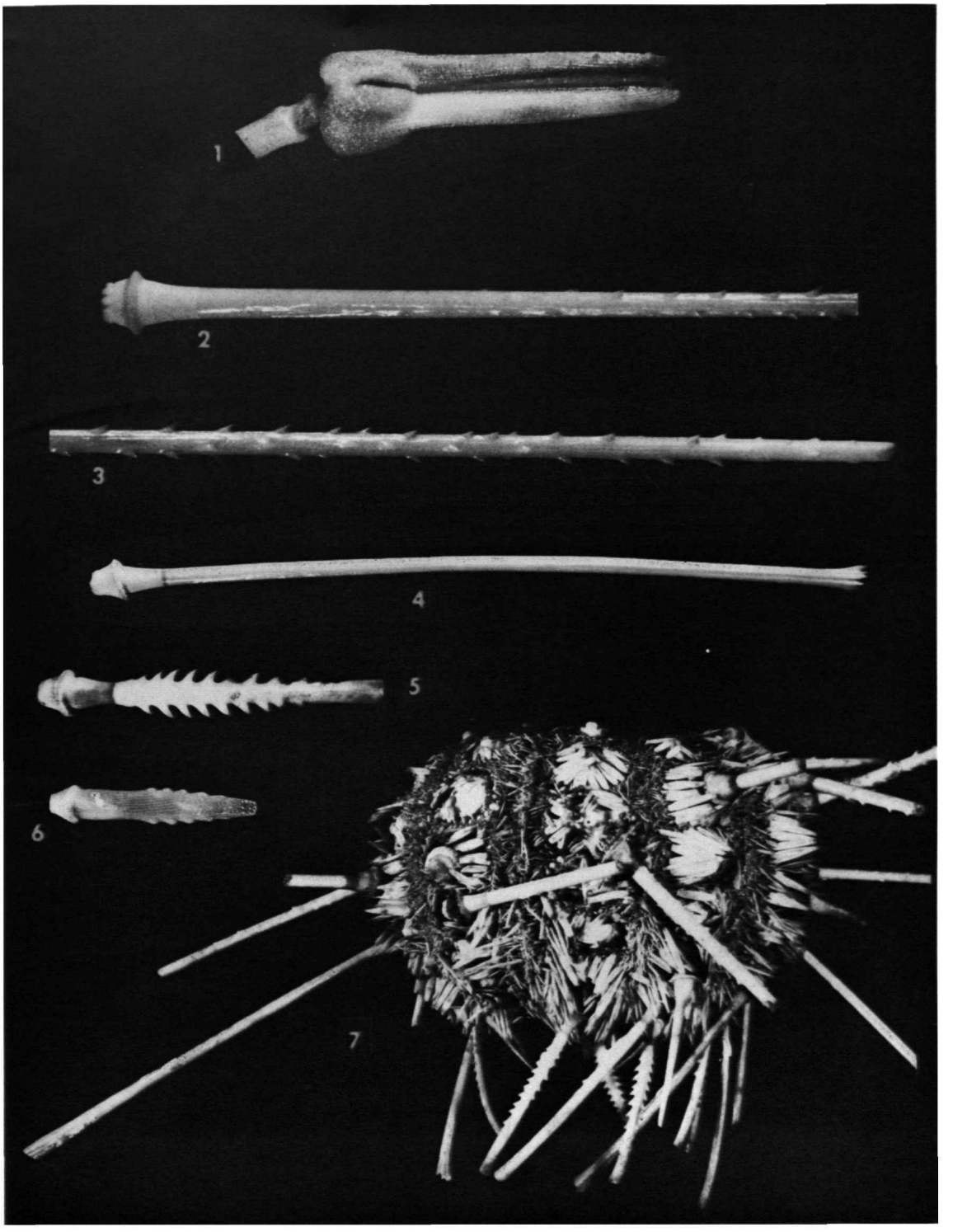
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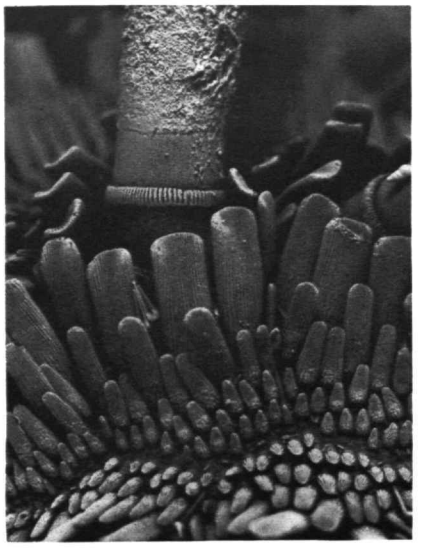
PLATE 16

Eucidaris tribuloides (Lamarck):

1. Close-up of broad shovellike tips of scrobicular spines, × 8.
2, 3, 4. Adapical, adoral, and side views, × 1.
5. Close-up of ambulacrum showing broad tipped marginal spines, × 8.



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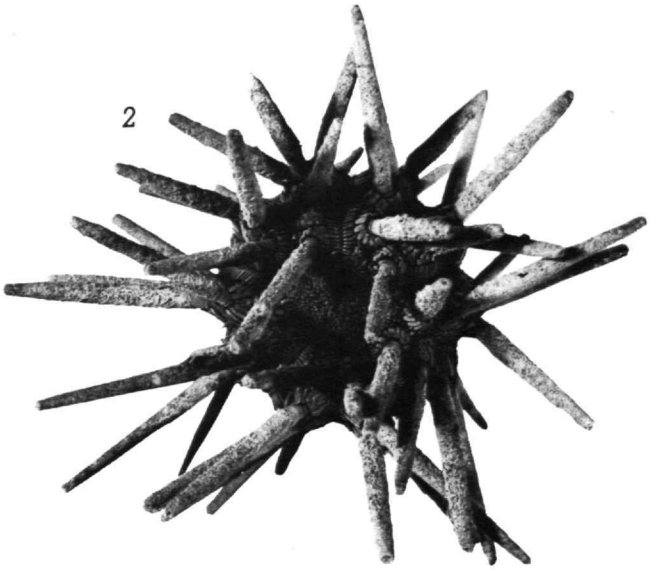

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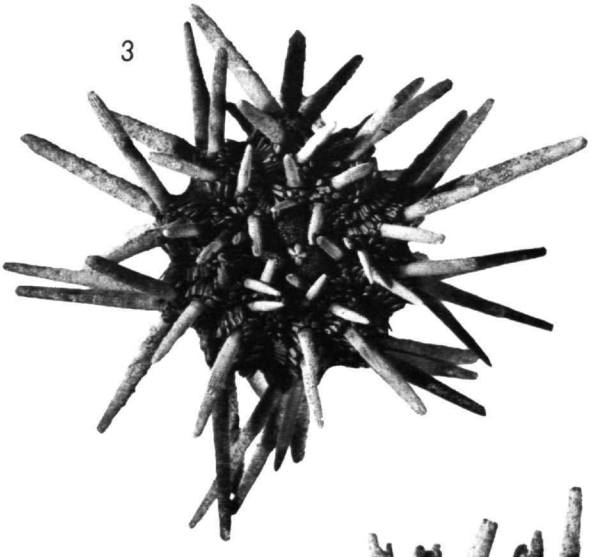

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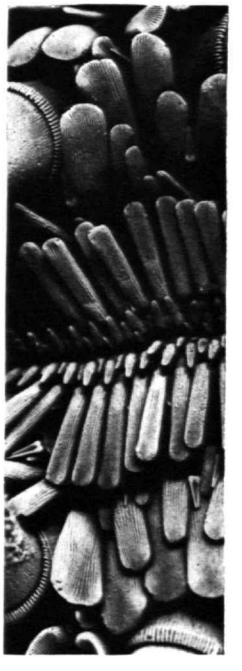

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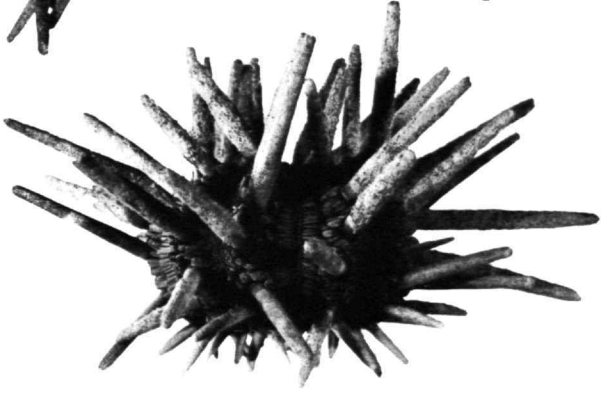

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PLATE 17

Eucidaris tribuloides (Lamarck):

1. Crown at tip of primary spine, × 9.
2. Denuded primary spine, × 3.
3. Wet uncleaned primary spine showing the common furlike covering, × 3.
4. Ambital view of an ambulacrum, × 6.
5, 6, 7. Side, adapical, and adoral views, × 2.

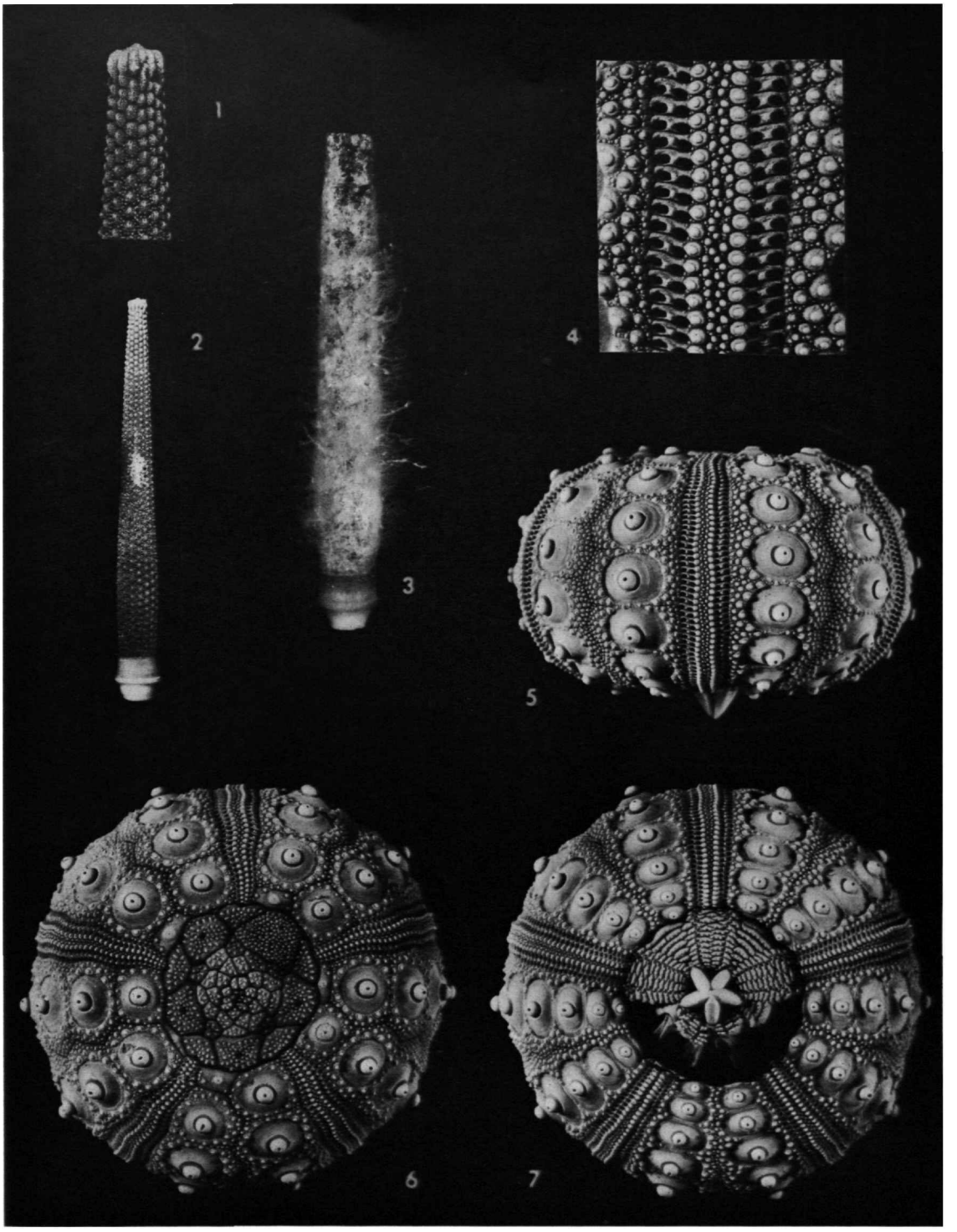
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PLATE 18

Eucidaris tribuloides (Lamarck), very small specimen:

1. Adapical view, × 4.
2, 3. Close-up view, note broad tipped scrobicular spines, thorny spinules in light bands, and warty spinules in dark bands near base of primary spines. Crowns are well developed at tips of primary spines, × 6.

Stylocidaris affinis (Philippi):

4. Scrobicular spine showing reddish midline stripe, × 10.
5. Adapical view of very small specimen, not that thorny spinules occur in light and dark primary spine bands, reddish stripe on scrobicular and marginal spines, × 4.
6. Larger specimen than in figure 5, note naked sutures, side view, × 1.

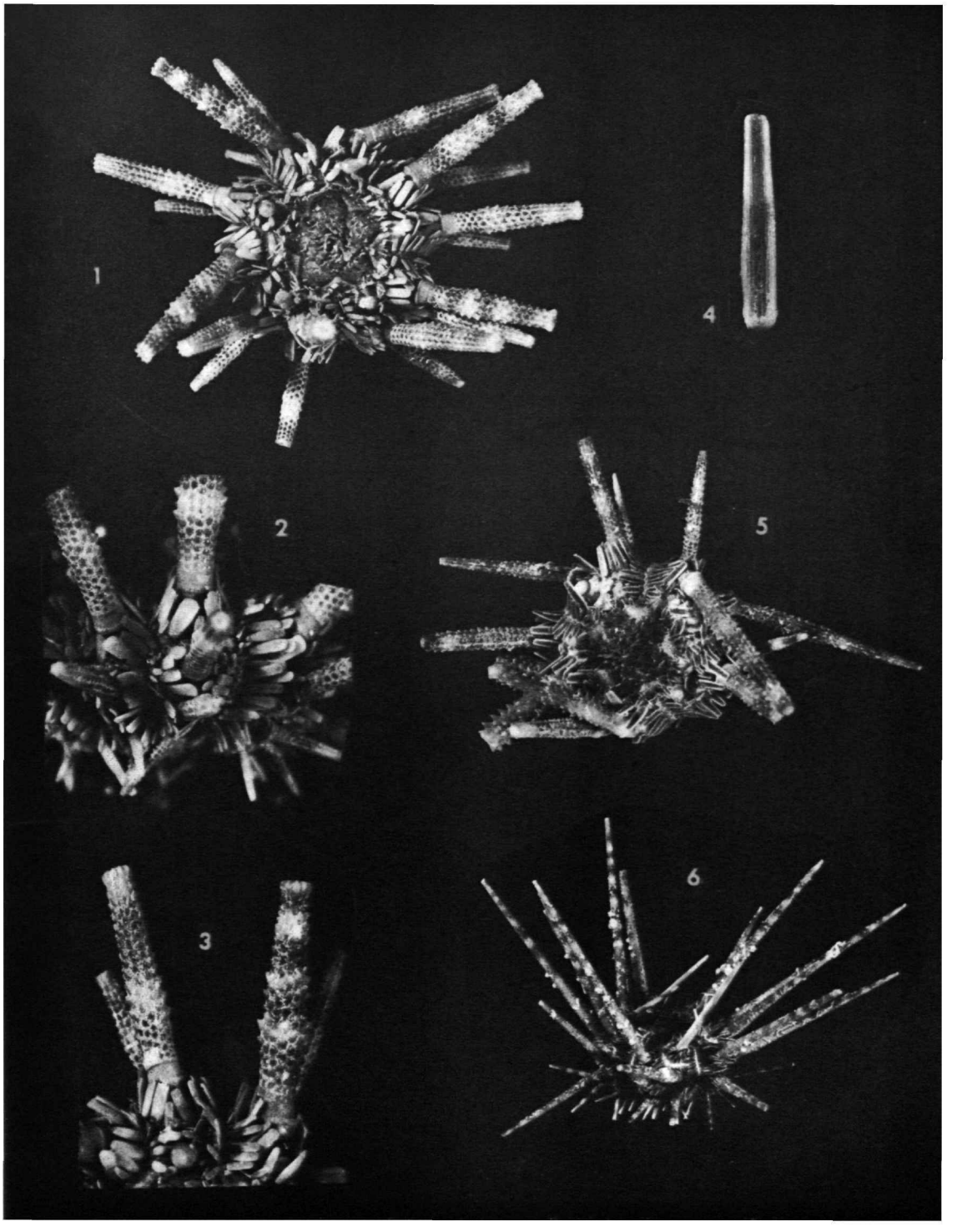
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PLATE 19

Stylocidaris affinis (Philippi):

1. Apical system, note the even distribution of round granular tubercles, × 4.
3. Close-up, note naked white sutures, midline stripe on marginal and scrobicular spines, × 4.
7. Large globiferous pedicellariae, × 40.

Stylocidaris lineata Mortensen:

2. Apical system, note radially elongate tubercles and naked ring, × 4.5.
4. Close-up, note naked reddish ambulacral suture and white unstriped marginal and scrobicular spines, × 3.
5. Adapical view, note reddish naked ring in apical system, × 3.
6. Large globiferous pedicellaria, notice the longer narrower valves when compared to *S. affinis* in figure 7, × 40.

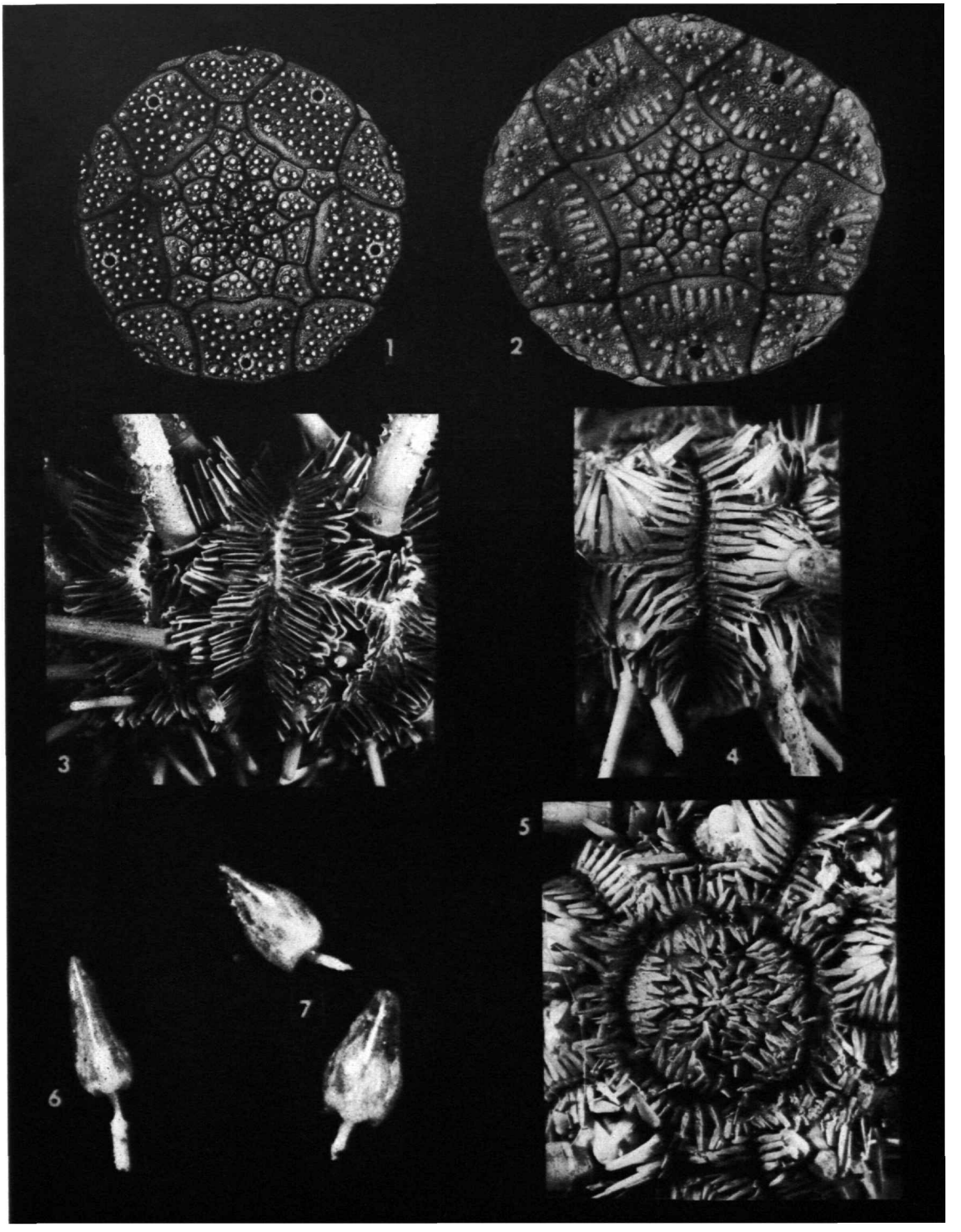
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PLATE 20

Stylocidaris lineata Mortensen:
1, 3. Adapical and side views, × 1.
2. Ambital portion of an ambulacrum, note the similarity to figure 5 and Plate 21: figure 1, × 10.
Stylocidaris affinis (Philippi):
4. Adapical view, × 1.25.
5. Ambital portion of an ambulacrum, × 7.

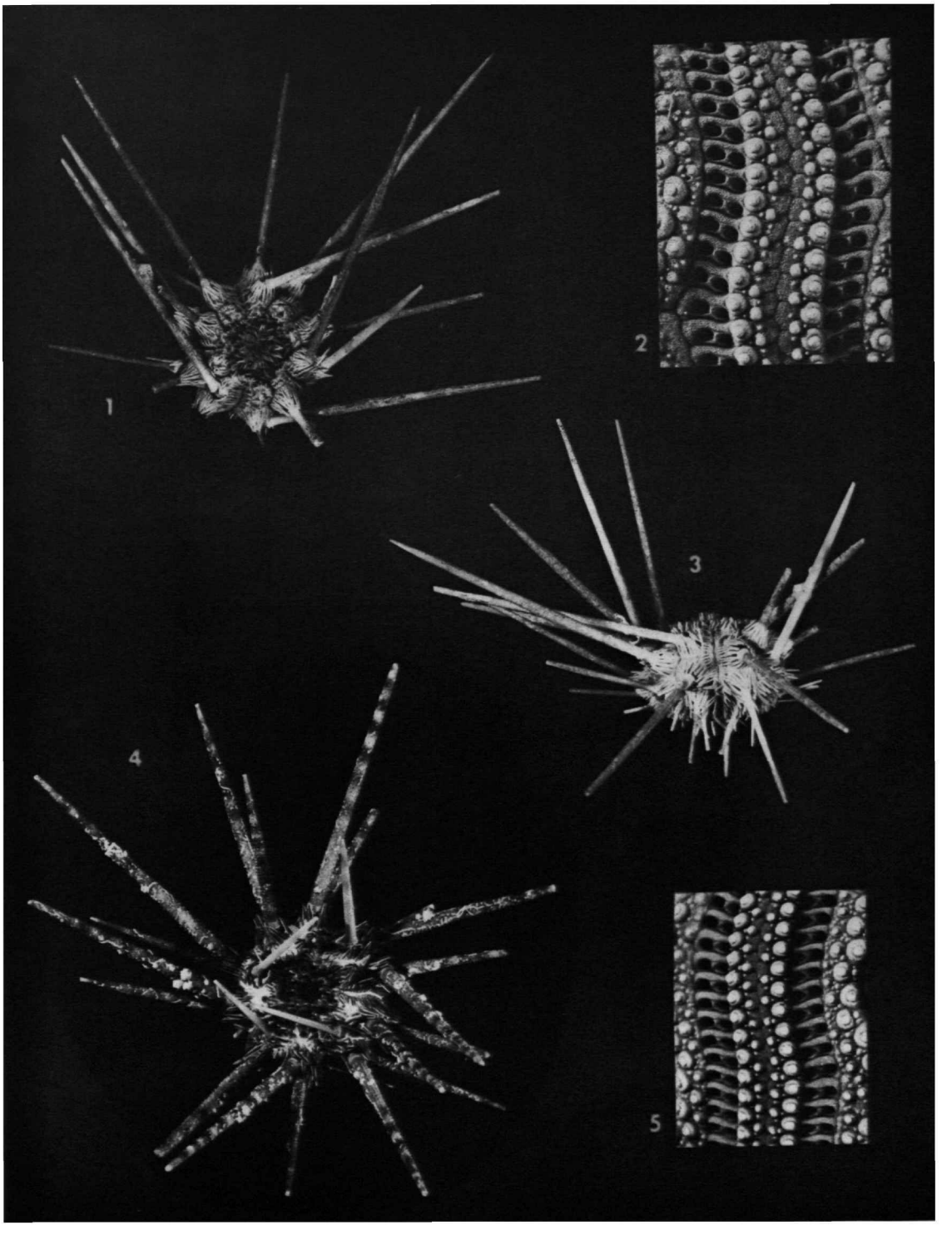
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PLATE 21

Tretocidaris bartletti (A. Agassiz), USNM 6836:

1. Ambital portion of an ambulacrum, × 3.
2. Apical system, × 5.
3. Side view, × 3.
4. Oblique view of adapical side showing crenulation on upper side of upper primary tubercles, × 5.
5. Primary spine, adapical side, note large spinules, × 2.
6. Adoral side of primary spine in figure 5, note small spinules and lighter color, × 2.
7. Adapical side of small spinule form of primary spine, × 2.

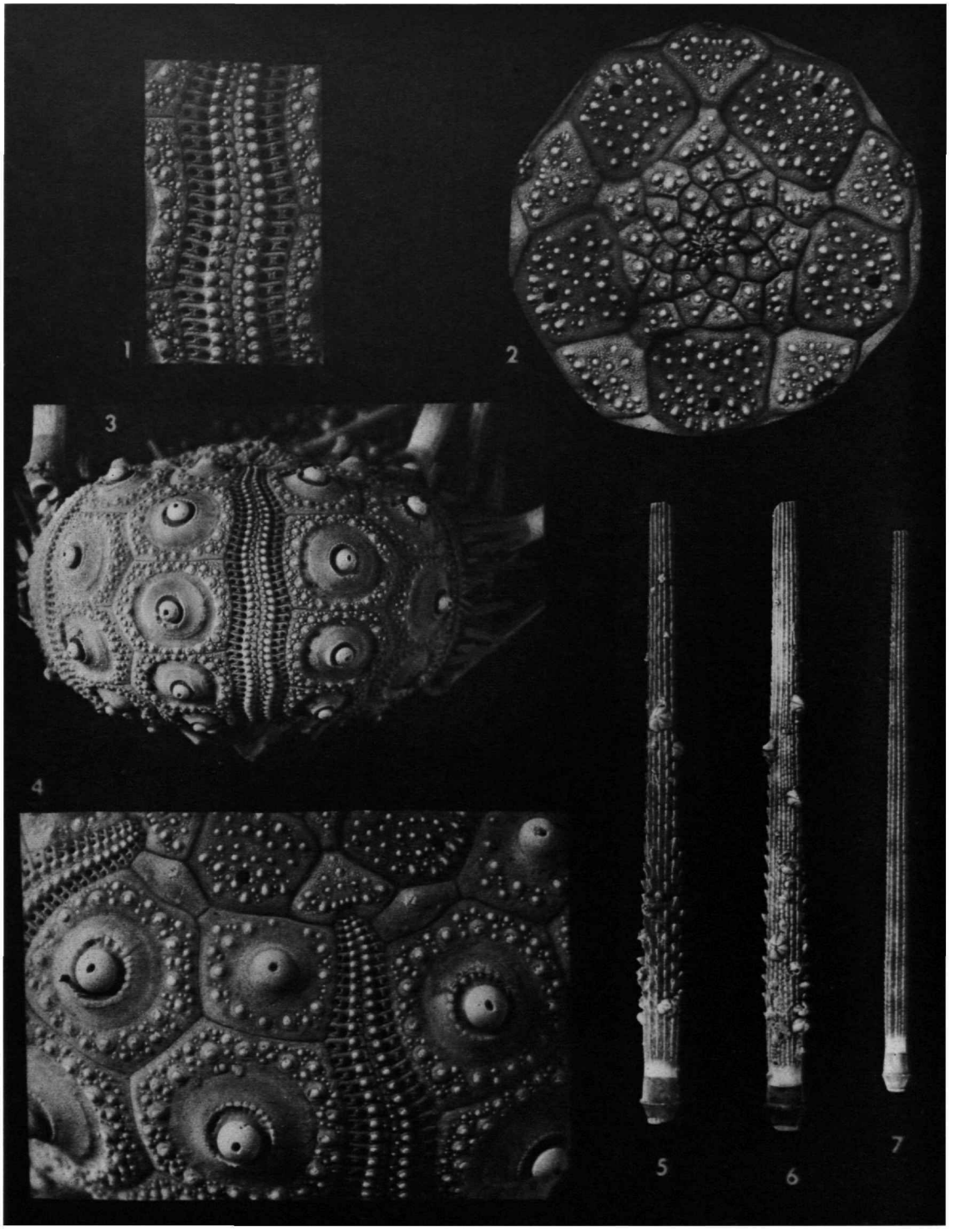
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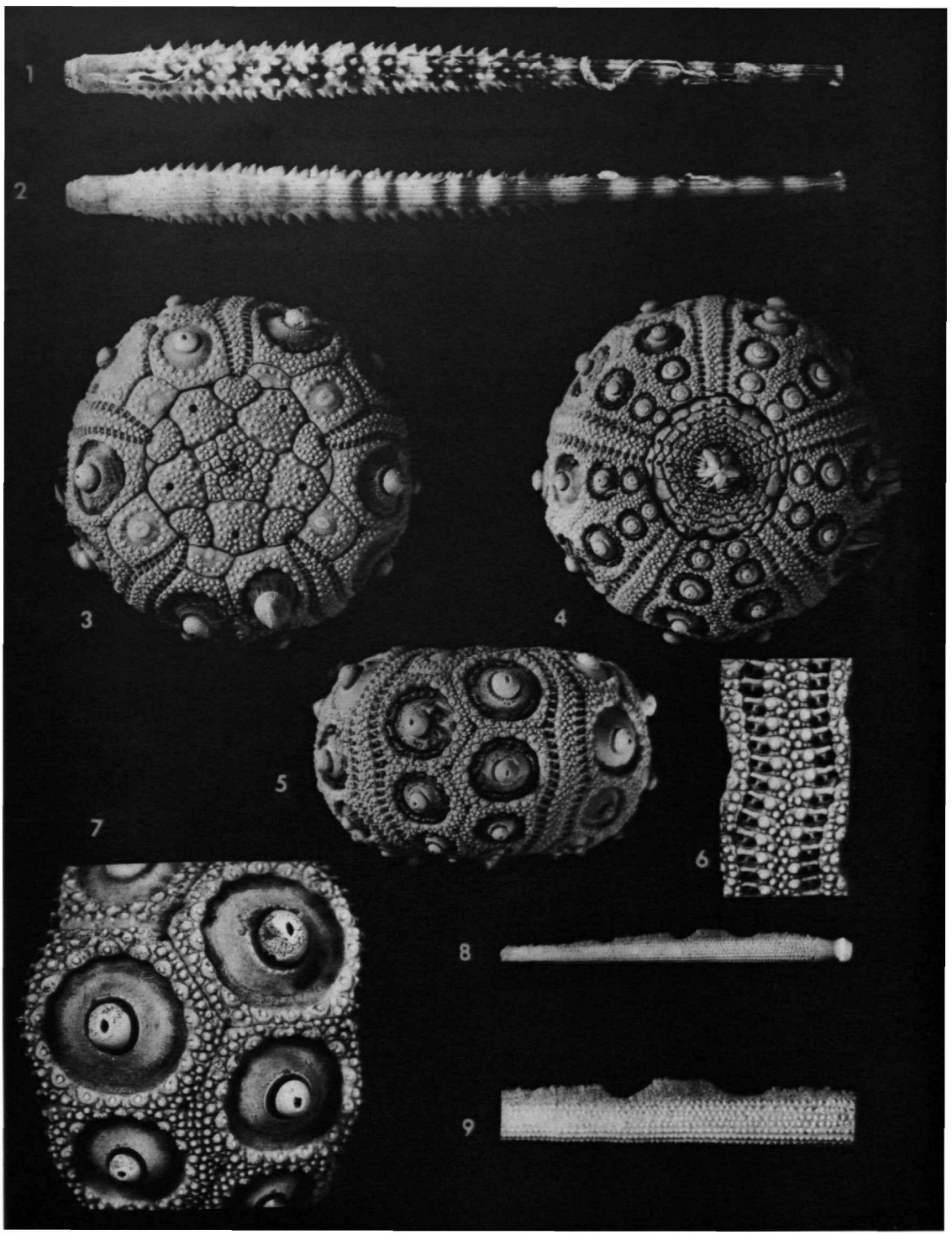
PLATE 22

Tretocidaris bartletti (A. Agassiz):

1. Primary spine with very thorny spicules, adapical side, × 1.5, MCZ 159.
2. Adoral side of primary spine in figure 1, note greatly reduced size of spinules, × 1.5. MCZ159.

Stereocidaris ingolfiana Mortensen:

3, 4, 5. Adapical, adoral, and side views, × 3.
6. Ambulacrum, ambital portion, × 6.
7. Interambulacrum, ambital portion, × 6.
8. Primary spine, × 1.5.
9. Close-up of the primary spine in figure 8 showing the features of the "wing," × 3.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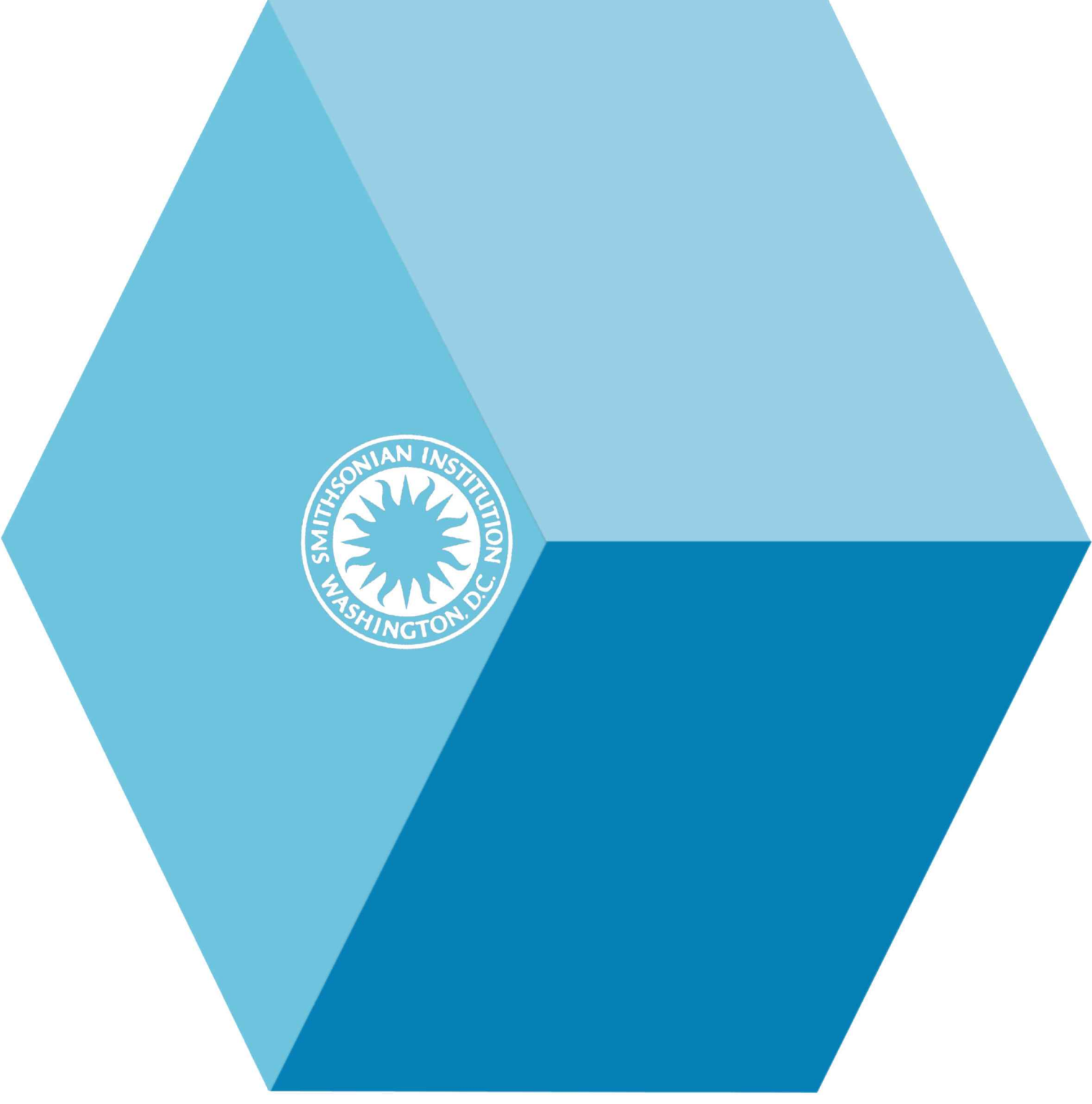
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