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VOLUME 8  
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1948

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REPORTS ON THE COLLECTIONS OBTAINED BY ALLAN HANCOCK PACIFIC EXPEDITIONS OF  
VELERO III OFF THE COAST OF MEXICO, CENTRAL AMERICA, SOUTH AMERICA, AND GALA-  
PAGOS ISLANDS IN 1932, IN 1933, IN 1934, IN 1935, IN 1936, IN 1937, AND IN 1938.

A NEW GENUS OF BRITTLE STARS,  
*AMPHICONTUS*

(PLATE 1)

By ALEX HILL

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# A NEW GENUS OF BRITTLE STARS, *AMPHICONTUS*

(PLATE 1)

ALEX HILL

*Research Associate, Allan Hancock Foundation*

Among the several vials of minute brittle stars from the Hancock Collections given me for identification, one contained a small specimen from Velero Station 384 collected in 5 fms., three fourths of a mile off shore, on the east side of Independencia Bay, Peru. The conclusion was finally reached that the species was new and that it did not belong to any genus in the collection. However, the shape of the disk, the outline of the plates, and the small size indicated the Amphiuridae. A sketch and a preliminary description were forwarded to Dr. Hubert Lyman Clark of the Museum of Comparative Zoölogy, Cambridge, Mass.

While waiting to hear from Dr. Clark, the author found another lot of brittle stars, from Velero Station 330-35. Careful examination of these showed that they were essentially like the specimen from Peru, and one was then forwarded to Dr. Clark. Station 330-35 is on the south side of Albemarle Island, Tagus Cove, Galapagos, in 12 fms. This stop had been made by *Velero III*, December 12, 1935, on her way to Peru.

Further study confirmed earlier conclusions, and Dr. Clark suggested that the new genus be named *Amphicontus* (Amphi—in accordance with the related genera—plus  $\kappa\omicron\upsilon\tau\omicron\varsigma$ —a pole, in reference to the polelike spines on the disk).

The generic diagnosis is as follows:

## AMPHICONTUS, new genus

Amphiuridae with a thick disk covered by a large central plate surrounded by five primary plates of equal size, accompanied by a number of small scales. Radial shields large, somewhat irregularly oval, smooth, in close contact with each other. Interradial areas each covered by 8-10 (or more) small plates and scales, three of which carry relatively big, blunt, polelike spines; one of these lies close to the primary radial plates, while the other two are on the interradial margin. Side armplates large, bearing stout, blunt, not flattened spines of nearly equal length. Dorsal and ventral armplates large, more or less pentagonal, notably similar



to each other. Ventral interradial areas covered with scales. Genital slits very small. No tentacle scales or pores. Three pairs of oral papillae; two outer pairs more or less vertical to the jaw.

This new genus resembles some of the small species of *Amphiura* in the contour of the disk, in the superficial appearance of the disk-plates, and in the shortness of the arms. It differs, however, in having 3 pairs of oral papillae as in *Amphiodia* and in the presence of 15-20 polelike spines on the disk. It also lacks tentacle pores and scales; presumably the tentacles are themselves wanting.

### ***Amphicontus minutus* Hill, new species**

*Description*.—Disk diameter, 2 mm.; arm length, 6 mm. Disk rather thick and heavy, covered with swollen plates. The central plate slightly pentagonal with rounded angles, surrounded by five rounded plates of equal size separated from one another by minute interstitial plates or scales. Interradial plates, 8-10 or more, the most proximal bearing a strong, blunt, vertical, polelike spine which marks the proximal, median point of the interradial space; the other plates, more or less symmetrically arranged; of the two outermost each has a blunt, polelike spine, making 10 polelike spines along the complete margin of the disk. Two young paratypes have a small spine adjoining the longer spine on its radial side, making 10 long, inner spines and 10 short, outer spines in the interradial areas of the disk-margin. No other important differences have been noted in the study of the 6 paratypes.

Radial shields prominent, less than half the disk radius in length, longer than wide, irregularly oval, in close contact along the straight radial margins; interradial margins convex but irregular; distal margins convex.

Dorsal armplates somewhat pentagonal with rounded corners, broader than long, with a concave proximal and a convex distal surface to the plate.

Ventral interradii covered with small, overlapping scales. Oral papillae, three pairs: innermost, thick, blunt, rounded triangular, not closely in contact with each other; the middle and distal pairs are erect, flattened, bluntly pointed, the width at the base about half the height, the distal pair wider. Two blunt and rounded teeth on each jaw. Oral shields pentagonal or diamond shaped, approximately as wide as long, with proximal angle most acute, distal angles rounded. Adoral shields

longer than broad, meeting fully within, but well separated radially by the first under armplate, which is rounded pentagonal, approximately as broad as long with a nearly straight distal margin; subsequent plates pentagonal, broader than long, with a proximal angle; lateral angles rounded, distal margin scarcely concave. No tentacle scales or pores. Lateral armplates with prominent spine-ridges, bearing 3 heavy, subequal, blunt spines; spines longer than arm segment.

*Color*.—Cream white, with the following exceptions: some of the primary plates of the disk and some of the dorsal armplates have splotches of brown or nearly black.

*Types*.—Holotype, AHF no. 3; 6 paratypes, one in the Museum of Comparative Zoölogy, Cambridge, Mass., No. 5861.

*Type locality*.—South side of Tagus Cove, Albemarle Island, Galapagos, in 12 fms.

*Remarks*.—At the type locality, on the south side of Tagus Cove, Albemarle Island, Galapagos, the records indicate that the bottom is composed of coarse, black sand. Records also indicate that the dredge contained one other echinoderm, *Paulia horrida* (Gray), and two species of crabs, *Stenorhynchus debilis* (Smith) and *Portunus* (Achelous) *angustus* Rathbun.

At Station 384-35, three fourths of a mile off the east shore of Independencia Bay, Peru, the bottom was coarse white sand with an abundance of sea weeds and red algae. This haul was rich in spider crabs, *Pyromaia tuberculata* (Lockington) and *Inachoides microrhynchus* Milne Edwards and Lucas. In addition to the crabs a number of worms were in the same haul.



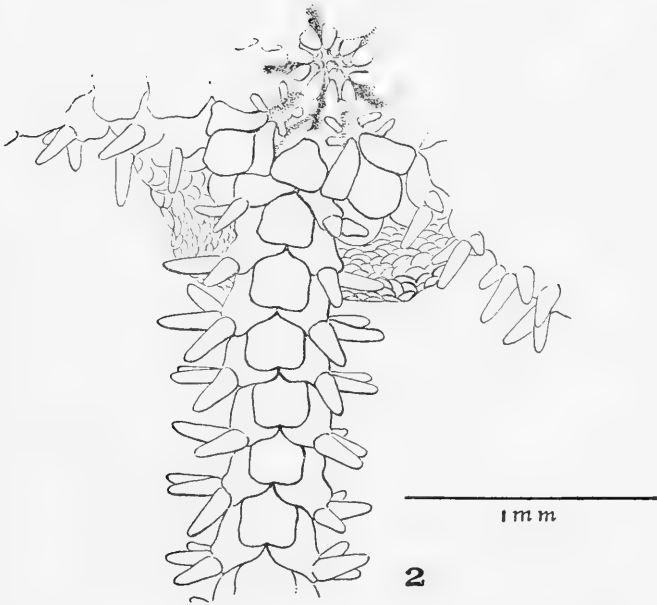
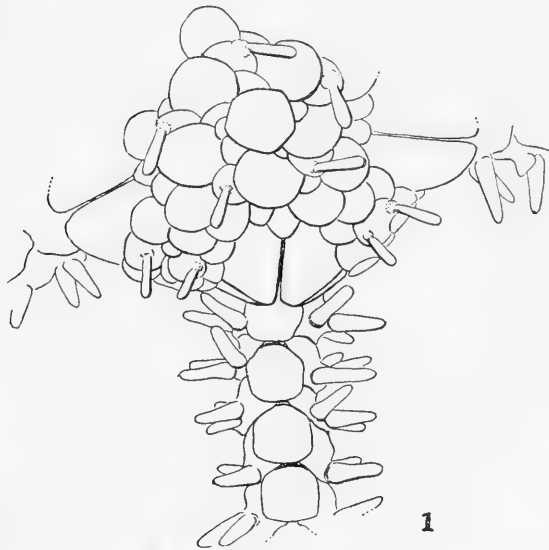
## EXPLANATION OF PLATE 1

## FIGS.

1. *Amphicontus minutus* Hill, new species, upper surface of most of disk and part of one arm.
2. Lower surface of part of disk and base of one arm.
3. Two arm segments seen from side.

*All drawings by Anker Petersen, staff artist,  
Allan Hancock Pacific Expeditions.*







REPORTS ON THE COLLECTIONS OBTAINED BY ALLAN HANCOCK PACIFIC EXPEDITIONS OF  
VELERO III OFF THE COAST OF MEXICO, CENTRAL AMERICA, SOUTH AMERICA,  
AND GALAPAGOS ISLANDS IN 1932, IN 1933, IN 1934, IN 1935,  
IN 1936, IN 1937, IN 1938, AND IN 1939.

NEW OPHIURANS OF THE ALLAN HANCOCK  
PACIFIC EXPEDITIONS

(PLATES 2-9)

*By* FRED C. ZIESENHENNE

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# NEW OPHIURANS OF THE ALLAN HANCOCK PACIFIC EXPEDITIONS

(PLATES 2-9)

FRED C. ZIESENHENNE

*Research Associate*  
*Allan Hancock Foundation*

In the study thus far of the ophiurans, which have been collected on the eight *Velero III* cruises to the Eastern Tropical Pacific, nineteen additional new species have been noted, twelve of which were collected on the 1938 cruise when the new dredging apparatus of the *Velero III* was used.

It was the writer's good fortune to work with Dr. H. L. Clark, Museum of Comparative Zoölogy, during the ten weeks of the 1938 cruise, and he wishes to express his indebtedness to Dr. Clark for his invaluable advice and opinions and also for certain field and color notes used in the preparation of this paper.

Thanks are also due to Mr. Anker Petersen, staff artist of the Allan Hancock Foundation, for the preparation of the illustrations.

## Hemieuryalidae

Genus SIGSBEIA Lyman

*Sigsbeia laevis*, new species

Plate 2, Figs. 1-3

*Description.*—Disk diameter, 7.5 mm.; arms, about 38 mm. long. Disk small, swollen, and elevated; disk plates swollen, of various sizes, irregularly arranged with no central plate or rosette. Interbrachial scales arranged in 3 rows, a median row of 3 to 5 large, irregular plates separated from the radial shields by a series of small plates. Radial shields triangular, longer than wide, interbrachial margin longest, angles within widely separated by 2 or more large and several smaller disk plates. Between the distal margins of the radial shields and the arm base are 7 disk plates arranged in a triangle, transversely to the arm. The disk of the specimen seems to have been crushed at one time, as the radial shields at one arm base have fused into an equilateral triangle with concave sides.

First upper arm plate oval, twice as wide as long. Succeeding plates

swollen, pentagonal, about as wide as long, with proximal margins slightly concave, and lateral and distal margins convex; plates barely in contact. Side arm plates narrow, bearing 3 blunt arm spines, the upper one rectangular, very large, not twice as broad as long, resembling a supplementary upper arm plate. Under and median spines of equal size, short, flat, rounded, and longer than broad. Side arm plates meeting above but not below.

Oral shields, except the madreporite, rectangular, almost 3 times as broad as long, distal margin only slightly convex. Adoral plates rectangular, meeting fully within, separated distally by a smaller triangular plate. Jaws prominent, almost twice as long as wide. Three or 4 oral papillae on each side and a triangular-shaped papilla on the apex of the jaw. Outer papillae longest, broader than long; median peg shaped, blunt, forming a straight line with the margins of the outer and apical papillae. Five bluntly pointed teeth.

Interbrachial spaces below covered with elongated, irregular disk plates, 2 or 3 elongated plates bordering the base of the arms. Two small, oval genital slits in each interradius in contact with the oral shield. First under arm plate trapezoidal, about as wide as long, with a broad, slightly convex distal margin. Succeeding plates rectangular with concave proximal and side margins and a slightly broader distal margin. The distal portion of the plate overlaps the proximal margin of the succeeding plate. One flat, rounded tentacle scale, about  $\frac{1}{2}$  the length of the under arm plate, attached to the side arm plate.

*Color.*—Dried specimen, disk white centrally with a brownish tinge on the margins. An irregular oval brown ring at the base of each arm and one radiating out from the center of the disk to the interbrachial area. Each of the larger disk plates bears a brown marking. The upper arms bear a brown median stripe the width of the upper arm plate, including the portions of the side arm plates that come within that width. Bordering the brown median band is a white band, lateral to which is a narrow brown line that disappears distally. The remainder of the side arm plates and the median and lower arm spines are pink. The broad upper arm spine is half white and half brown. The arms are uniformly white at the tips, and the under arm plates are white; tentacle scales white with a tinge of pink now and then. In life the disk was pale, its sides really coral red and the lower surface quite red; no distinct marks on the disk; a deep yellow stripe (longitudinal) on upper surface of the arm.



*Types*.—Holotype, AHF no. 9; 7 paratypes, one in M.C.Z.

*Type locality*.—Station 863-38, clinging to red coral, 30-50 fms., off Bahia Honda, Panama, March 1, 1938. Five additional paratypes from Station 948-39, 30-35 fms., off Bahia Honda, Panama, March 28, 1939.

*Remarks*.—This species is closely related to *S. lineata* L. & M. of Cocos Island and the Galapagos Islands but differs in the flat disk scales, less swollen arm plates, and the very different color pattern. From *S. murrhina* Lyman of the West Indies, it differs markedly in the same characters and in its much smaller size and more slender form. Its distinctive characteristics besides the color pattern are: irregular disk scales with no rosette, knobs, or noticeable convexities; uppermost arm spine, at least on basal segments, flat, longest at the upper margin, not quite so large as the other two spines together, and not twice so wide as long. The name *laevis* has reference to the smooth disk scales.

## Ophiacanthidae

Genus OPHIACANTHA Müller and Troschel

*Ophiacantha phragma*, new species

Plate 2, Figs. 4-6

*Description*.—Disk diameter, 8 mm.; arms, about 38 mm. long. Disk pentagonal, rather thick, covered with closely compacted, short, rounded granules. Irregularly placed are some long, stout, pointed disk spines,  $\frac{1}{2}$  mm. in length. Radial shields concealed. Disk granulations extend out on the first few upper arm plates.

First upper arm plate small, partially concealed by granules. Succeeding plates longer than broad, somewhat hexagonal, proximal margins straight, distal lateral and proximal lateral margins nearly straight, distal margins slightly concave; distally the plates become triangular, longer than broad, with a convex distal margin. Upper plates in contact basally, separated by the side arm plates distally. Side arm plates broad, in contact distally. Arm-spine ridge prominent, bearing 7 long, slender, tapering arm spines, the uppermost longest, more than 2 arm segments in length, gradually reducing in length to the lowermost, which is shortest.

Oral shields triangular, acute inner angle and rounded outer angles with conspicuous granules on the distal margin, like those of the disk. Adoral plates broad and narrow, slightly enlarged distally, meeting fully within. Jaws long and narrow, bearing medially a pair of granules about the size of those on the disk. Five to 7 oral papillae on a side. Outermost

largest, broad, slightly longer than broad with a rounded cutting edge. Next papillae broad, flat, twice as long as broad. Inner 3 to 5 narrow, acutely pointed, apical pair slightly largest.

Interbrachial spaces below covered with a dense granulation and bearing spines centrally but not along the large genital slits. First under arm plate diamond shaped, twice as broad as long. Succeeding plates triangular, about as long as broad, with a broadly rounded distal margin. Basally the plates are in contact; distally they are separated by the side arm plates. Two and sometimes 3 erect, flat, oval tentacle scales on the first arm segment. Two broad, oval, flat tentacle scales on the next 5 to 8 arm segments, inner scale slightly the longest. Only one flat, oval, appressed tentacle scale on the remaining arm segments.

*Color*.—Dried specimen, disk granulations brown, disk spines pale cream color. Arms light purple with a dark band every 2 to 5 segments. Under arms and mouth parts are creamy white. A smaller dried specimen had brown and white markings on the disk with white disk spines. Arms show longitudinal purplish lines in addition to the bands.

*Types*.—Holotype, AHF no. 15; 34 paratypes.

*Type locality*.—Station 529-36, 165 fms., off San Francisquito Bay, Lower California, Mexico, March 1, 1936. There are 34 paratypes as follows: 2 from Station 431-35, 45 fms., north of Octavia Bay, Colombia, January 27, 1935; one from Station 534-36, 125 fms., off San Francisquito Bay, Lower California, Mexico, March 2, 1936; one from Station 780-38, 47 fms., Chatham Bay, Cocos Island, Costa Rica, January 14, 1938; 2, one in the Museum of Comparative Zoölogy, from Station 795-38, 55 fms., Sulivan Bay, James Island, Galapagos, January 21, 1938; 5 from Station 948-39, 30-35 fms., outside Medidor Island, Bahia Honda, Panama, March 28, 1939; 10 from Station 874-38, 45 fms., N.E. of Anacapa Island, California, August 1, 1938; one from Station 909-39, 60-90 fms., 2 miles off Emerald Bay, Catalina Island, California, January 29, 1939; 3 from Station 750-37, 60 fms., Outer Gorda Banks, Lower California, Mexico, April 4, 1937; 4 from Station 875-38, 50 fms., N.E. of Anacapa Island, California, August 1, 1938; 2 from Station 900-38, 40 fms., Long's Point, Catalina Island, California, November 18, 1938; 2 from Station 213-34, 7-10 fms., La Plata Island, Ecuador, February 10, 1934; and one from Station 201-34, 25-35 fms., Gardner Bay, Hood Island, Galapagos, January 31, 1934.

*Remarks*.—These specimens have a habit of rupturing the upper surface of the disk upon being brought to the surface. The paratypes from

Station 750-37 had intact disks, and on the disk margins were several compact groups of 3, 4, or 5 large conical, blunt-tipped spines, heavier and twice as long as the disk spines. The distinctive character is the wide oral shields with thin marginal granules. This species is closely related to *O. bairdi* Lyman but differs in having a triangular oral shield, 2 or 3 tentacle scales on the 8 to 10 basal arm segments, and a distinct series of enlarged granules on the distal margin of the oral shields. It is because of this palisade or fence on the oral shields that the name *phragma* was chosen.

Genus **OPHIOMYCES** Lyman

**Ophiomyces multispinus**, new species

Plate 3, Figs. 1-4

*Description*.—Disk diameter, 5 mm.; disk height, 4.5 mm.; arms, 23 mm. long. Disk conical, almost as high as wide; interradius produced to form a pronounced ridge, while the area directly above the arm base is concave. Disk scales numerous, circular, and overlapping; many of them are beset with short, delicate, finely tapering, pointed spines. At the apex of the disk are 5 heavy, long, gradually tapering spines, about 1 mm. in length and longitudinally ribbed. No radial shields can be seen, but the spine-bearing scales are fewer in the region of the arm base.

Arms short, heavy, and rapidly tapering. First 3 upper arm plates overlapping, small, oval, broader than long, with convex distal margins. Fourth plate triangular, broader than long with the peak within. Fifth plate triangular, broader than long, proximal margins concave, distal margin convex. The 1st to 5th upper arm plates separate the side arm plates, from which point the side arm plates are in contact above. Succeeding plates broader than long, proximal margin slightly convex, distal margin deeply convex. Plates reduce in size distally to the arm extremities, where they are barely visible. Side arm plates broad with a prominent spine ridge, separated from each other by a naked membrane. They meet above and below except the 3 basal segments above, where the upper arm plates separate them. Arm spines, 9, covering the upper side of the arm. Uppermost fine, delicate, and shortest; gradually they become longer below, to the 3rd upper spine, which is the longest, more than  $1\frac{1}{2}$  arm segments in length. Undermost 4 spines heavy, curved, longitudinally striated, undermost 2 slightly shorter; spines become fewer and relatively shorter distally.

Oral shields and adoral plates completely concealed by the broad and numerous oral papillae. By removing the papillae the oral shield is found to be triangular, acutely pointed within, with slightly concave margins, distal margin truncated and raised to a median, rounded ridge that bears one short, heavy, rounded, tapering, blunt spine. Adoral plates large, roughly triangular, larger than the oral shields, barely meeting within; a proximal swollen ridge bears the 2 exceedingly wide, fan-shaped, distal oral papillae. Jaw plates long and rounded, meeting only proximally and bearing 2 rows of oral papillae, outer and inner rows; outermost papilla on the jaw plate is the 3rd and last fanlike mouth papilla. Twelve oval oral papillae on each side, arranged in 2 distinct rows, one on the margin of the jaw and the other within the margin of the jaw plate. The marginal row of papillae from the outer to the apical is as follows: outermost very broad, flat, fan shaped, longer than broad, largest of the row; next 3 fan shaped, flat, longer than wide, diminishing in size to the apex of the jaw; next 3 short, rounded, tapering to a blunt point. Apical papillae short, rounded, and bluntly pointed. Inner row of oral papillae 6; the distalmost exceedingly broad and fan shaped, only slightly longer than wide; next 3 flat, spatulate, 3 times as long as broad. Proximal 2 narrow, rounded at the tips, short, only slightly longer than the corresponding outer row of papillae. Four flat, broad, rounded teeth, widely spaced. No tooth papillae.

Interbrachial spaces below densely covered with scales, some bearing spines. Two long, narrow, genital slits bordered by long, wide, genital plates, parallel to each other, obliquely set at arm base. Under arm plates hourglass shaped, longer than wide, lateral margins concaved by the large tentacle pores; produced median ridge bearing tentacle scales. Tentacle scales, 3 pairs on 1st 3 arm segments. One long, narrow tentacle scale on the side arm plate and 2 median flat, oval, fan-shaped tentacle scales attached to the under arm plate. Next 4 arm segments with 4 pairs of tentacle scales, attached to the under arm plate, outer 2 oval and fan shaped, inner 2 long, paddle shaped, narrow, and pointed. Three pairs of tentacle scales on succeeding 7 arm segments, inner 2 pairs long and narrow, outer one oval and acutely pointed; succeeding 12 segments bear 2 tentacle scales, an oval outer and a long thin inner scale; near the extremities only one narrow, pointed, tentacle scale.

*Color.*—In life, disk grayish blue with a dull yellow stripe in each interradius; arms pale orange, lighter at base and orally. Dried specimens are nearly white, but the disk has an evident bluish tinge.

*Types*.—Holotype, AHF no. 5; 5 paratypes, one in M.C.Z.

*Type locality*.—Station 810-38, 73 fms., off Barrington Island, Galapagos, January 26, 1938. Six diskless specimens from Station 810-38 in the Museum of Comparative Zoölogy and 2 diskless specimens from Station 786-38, 392 fms., N.E. of Indefatigable Island, Galapagos, January 18, 1938.

*Remarks*.—This species is readily distinguished from the other known members of the genus by the numerous tentacle scales, particularly the long paddle-shaped ones. The numerous short and fine spines of the disk and the numerous slender arm spines are also important characters. This species has therefore been named *multispinus* with reference to the numerous spines.

## Amphiuridae

Genus **OPHIOPHRAGMUS** Lyman

**Ophiophragmus disacanthus**, new species

Plate 9, Figs. 1-3

*Description*.—Disk diameter, 4 mm.; arms, 33 mm. long. Disk pentagonal, swollen, covered by numerous, overlapping disk scales; a large central plate and 10 slightly smaller radiating plates. There are from 7 to 9 irregular series of scales in each interradius. The median series overlaps the adjoining series, and they in turn overlap the adjacent series. The side and upper disk scales meet to form a distinct disk margin. In each interradius are 2 long, stout, flattened, marginal papillae. The length of the papillae is 3 to 4 times its diameter. In comparison, the papillae exceed the largest arm spine in length, but they are not so broad or so heavy. Radial shields are about twice as long as wide, length less than half the disk radius, in contact without, separated within by one disk scale. Interradial edges covered by overlapping disk scales.

Upper arm plates quadrangular, wider than long, side margins broadly convex, proximal and distal margins slightly convex. Arm plates fully in contact with each other. Side arm plates very narrow, separated from each other by a membrane, not in contact above and barely in contact below. Spine ridge large and prominent, bearing 3 short, heavy, blunt-tipped spatulate arm spines. The spines are less than an arm segment in length; median spine narrow and short; upper and lower spines heavy and broad, length 2 to 3 times the diameter of the spine.

Oral shields elongated, almost twice as long as broad. An acute angle within and a lobe without, outer side margins slightly concave. Adoral plates triangular, broader than long, widest without. All margins slightly concave; not quite meeting within. Jaws very small, triangular, broader than long. Three oral papillae on a side, outermost triangular, about as long as wide; median bluntly rounded, slightly longer than wide; inner rectangular, blocklike, longer than wide, widely separated. Four teeth, ventralmost short and triangular, next 3 broad and rectangular, increasing in length to the uppermost, which is the longest.

Interbrachial spaces below covered with large overlapping disk scales, as large as those on the upper surface. Genital slits inconspicuous, concealed by the arm spines. First under arm plate small, rectangular, wider than long, margins straight. Succeeding plates pentagonal, about as wide as long, angle within, proximal lateral and lateral margins almost straight, distal margins concave. Plates barely in contact or separated by the side arm plates. Two small oval tentacle scales placed at right angles to each other, innermost slightly the longer.

*Color.*—Dried from alcohol, the holotype was a dark olive buff on both upper and under surfaces without any special markings.

*Types.*—Holotype, AHF no. 21; 4 paratypes.

*Type locality.*—Station 177-34, 5-20 fms., Sullivan Bay, James Island, Galapagos, January 23, 1934. Four paratypes from Station 337-35, 2-5 fms., Sullivan Bay, James Island, Galapagos, December 12, 1934.

*Remarks.*—This species seems to be confined to the Galapagos Islands. It can readily be distinguished from all known species of the genus by the 10 large marginal papillae, longer than the arm spines. The papillae are well spaced, 2 in each interradius. In the 5 specimens examined, not more than 2 papillae were found in any interradius. In dredging, several papillae were crushed and broken, but prominent scars remained to mark their location. The name *disacanthus* has reference to the 2 marginal disk papillae in each interradius.

### **Ophiophragmus lonchophorus**, new species

Plate 4, Figs. 4-6

*Description.*—Disk diameter, 3 mm.; arms, 23 mm. long. Disk circular and swollen, covered with large, polygonal, overlapping disk scales. There are several conspicuous disk scales but no central disk plate or rosette arrangement. In the interbrachial areas are 5 rows of disk scales;

the median row overlaps the adjoining rows. There are from 11 to 18 stout, cylindrical marginal papillae in each interradius. Radial shields longer than wide, length equal to half the disk radius, in contact except inner ends, where a small scale separates them.

Upper arm plates transversely oval, proximal margin broadly convex, distal margin straight overlapping the margin of the succeeding plate. Side arm plates not meeting above or below. Spine ridge bears 3 somewhat flattened, bluntly pointed arm spines, about an arm segment in length; middle arm spine slightly the longest.

Oral shields diamond shaped, about as long as wide, with rounded angles. Adoral plates swollen, broader than long, meeting within. Jaws small and triangular, a deep depression between them. Three oral papillae on a side, outermost largest, somewhat triangular, about as broad as long; median small, flat, peglike, longer than broad; apical blocklike, heavy, slightly longer than broad. Four broad teeth, uppermost longest.

Interbrachial spaces below covered with minute overlapping scales. The scales are so fine and crowded that they can only be taken for granules under low magnification; only under high magnification can the scales be distinctly seen. Genital slits long, extending from the oral shield to the disk margin; the edge bears a row of overlapping scales, larger than the under disk scales. First under arm plates small, triangular, angle within, distal margin straight. Second and succeeding plates pentagonal, about as broad as long basally, and becoming longer than broad distally. Lateral, proximal lateral, and distal margins slightly concave. The basal 7 or 8 plates have a notable raised median ridge. Tentacle scales 2, a small, narrow, oval outer scale attached to the side arm plate and a relatively huge spearhead-shaped inner scale, almost twice as long as broad, attached to the under arm plate. The smaller scale is not present on the distal third of the arm. The large scale is not present on the last 15 arm segments, nor is it conspicuous on newly regenerated segments.

*Color*.—Dried from alcohol, disk and arms light gray, with irregular brownish drab arm bands on distal third of arms. Marginal papillae and arm spines pale gray. Under disk surface light gray, mouth parts and under arm lighter. The paratype, dried from alcohol, is dark brownish drab; under disk surface, marginal papillae, and arm spines gray. The median ridge of the basal under arm plates is also pale gray.

*Types*.—Holotype, AHF no. 19; one paratype.

*Type locality*.—Holotype and paratype from Station 964-39, 2-8 fms., Tenacatita Bay, Mexico, May 8, 1939.

*Remarks.*—This species can be readily distinguished from other known members of the genus by the unique inner tentacle scale. It is strange that after dredging in Tenacatita Bay on seven different occasions this notable new species should now be taken for the first time. The name *lonchophorus* has reference to the unique spear-shaped inner tentacle scale.

### **Ophiophragmus ophiactoides, new species**

Plate 3, Figs. 5-7

*Description.*—Disk diameter, 7 mm.; arms, about 38 mm. long. Disk covered with small scales; only a few specimens had a large central plate; scales enlarged about the interradial margins and radial shields. Interradial fence is composed of small, blunt, rounded marginal papillae, varying from 5 to 23 in number in each interradius; usually there are 15 to 20. Papillae near the radial shields are the largest, those midway of the arms smallest and finest. Radial shields oval, longer than wide;  $\frac{1}{4}$  the diameter of the disk, separated proximally by a single (sometimes a double) series of long, narrow scales, in contact distally or in some specimens separated even there by a single narrow scale.

First upper plate triangular, broader than long, angle within, distal margin convex. Succeeding plates oval shaped, twice as broad as long, with convex lateral margins, proximal margins convex, distal margins almost straight, wider than proximal margin. On the distal margin is a median notch that varies from a slight indentation to a large notch, which gives the appearance of a concave margin. Side arm plates small, scarcely meeting below. Three arm spines, longer than an arm segment, oval and blunt, flattened at the tips; lower spine rather long; median slightly the longest; upper spine shortest and flattest.

Oral shields triangular, longer than broad. Adoral plates twice as broad as long, widening distally and extending to the genital slits, scarcely meeting within. Three oral papillae on a side, outermost largest, broad and oval; median narrow and rounded; apical heavy and blunt. Teeth prominent, flat and rounded, in some specimens somewhat bilobed.

Interbrachial spaces below covered with fine scales. Genital slits equal to 6 arm segments in length. First under arm plate small, as broad as long, others hexagonal, broader than long, proximal margin straight, proximal lateral, lateral, and distal margins slightly concave. Tentacle scales 2, at right angles to each other; the one on the side arm plate the largest.



*Color*.—Dried specimen, disk dull yellow, with a grayish hue, only the distal ends of the radial shields whitish. Arms and arm spines light brown with irregular darker markings on the dorsal arm plates and spines. Under side grayish brown with some markings of darker brown on the under arm plates. Color in life green and brown, much like *Ophiactis savignyi* (M. & T.) or young *Ophiocoma alexanderi* Lyman and not at all like an *Ophiophragmus*.

*Types*.—Holotype, AHF no. 10; 169 paratypes, 51 in M.C.Z.

*Type locality*.—Station 403-35, shore, Manta, Ecuador, January 20, 1935. An additional 159 paratypes as follows: 50 from Station 474-35, shore, Salinas Bay, Costa Rica, February 10, 1935; 2 from Station 207-34, shore, south of Point St. Elena, Ecuador, February 8, 1934; one from Station 415-35, 45 fms., south of Port Utria, Colombia, January 24, 1935; 5 from Station 229-34, shore, Cabita Bay, Colombia, February 13, 1934; 97, 51 in the Museum of Comparative Zoölogy, from Station 848-38, shore, Cape San Francisco, Ecuador, February 23, 1938, and 4 from Station 400-35, shore, Manta, Ecuador, January 19, 1935.

*Remarks*.—The fine scaling of the disk without primary plates, the slender marginal papillae, the narrow and long radial shields, the relatively short arms with rather slender arm spines, and the triangular oral shields make a combination of characters that readily distinguish this species from other known members of the genus. The coarse disk scaling of *O. marginatus* Lütken and *O. chilensis* Lyman separates those forms at once, while the oral shields, arm plates, arm spines, and the marginal papillae set it apart from *O. paucispinus* Nielsen and *O. tabogensis* Nielsen. This species lives in algae, in sponges or under rocks, in tide pools, more or less gregariously. Adults are likely to be more or less buried in the sand, often several together. Owing to the marked superficial resemblance to *Ophiactis savignyi* (M. & T.) in color, form, and habits, the specific name *ophiactoides* has been chosen.

### **Ophiophragmus papillatus**, new species

Plate 4, Figs. 1-3

*Description*.—Disk diameter, 3.6 mm.; arms, 18 mm. long. Disk thick and rounded, arms short and heavy. Disk covered with circular overlapping scales; those in contact with the radial shields slightly larger. The large, distinct, circular central plate is surrounded by 5 oblong radial plates almost twice as broad as long. Primary plates separated by the

scales, 10 of which bear stout, cylindrical, bluntly rounded papillae twice as long as wide, 2 in each interradius. The marginal fence consists of 8 to 10 broad, flat papillae almost as wide as long, heavy and blunt. Radial shields small, almost twice as long as broad, less than half the disk radius in length. Their pointed ends proximally are separated by 2 or 3 disk scales; distally they are in contact.

Upper arm plates broadly oval with rounded lateral margins, fully in contact with the distal margins overlapping the proximal margins of the succeeding plates. Side arm plates narrow, separated from each other by a naked membrane; arm-spine ridge prominent, bearing 3 short, heavy, flattened, bluntly pointed arm spines, about twice as long as broad, equal to the length of an arm segment.

Oral shields diamond shaped, about as long as wide; distal margins slightly concave. Adoral plates broader than long, margins almost parallel, meeting fully within. Jaw plates long and narrow, meeting proximally to form a V. Three oval papillae on each side, distal 2 broad, block-like, and rounded; distalmost only slightly larger; apical papillae block-like, longer than broad, widely separated. No tooth papillae; teeth wide with rounded cutting edges.

Interbrachial spaces below covered with overlapping scales, more or less uniform in appearance. Two long genital slits in each interradius. First under arm plates rectangular, wider than long, with a notched proximal margin. Second plate squarish with a concave distal margin; succeeding plates about as wide as long, with convex lateral margins; distal margins slightly wider than proximal, fully in contact with each other, the outer one slightly larger.

*Color.*—Dried specimen, disk almost white, a purplish tinge on the primary plates. Upper arm plates irregularly marked, some plates white, others almost black with variations of brown plates with dark markings, white plates with brown and black markings and white plates with parallel lines; there is no definite banding arrangement. Arm spines tinged with purple. Under side entirely white with a few dark bands on the distal under arm plates.

*Type.*—Holotype, AHF no. 11.

*Type locality.*—Station 260-34, shore, Tangola Island, Tangola-Tangola Bay, Mexico, March 1, 1934.

*Remarks.*—This species is easily distinguished from all known members of the genus by the 10 cylindrical papillae on the disk. Because of this characteristic feature the name *papillatus* has been selected.

**Ophiophragmus stellatus**, new species

Plate 6, Figs. 6-9

*Description*.—Disk diameter, 5.5 mm.; arms, about 65 mm. long. Disk flat and pentagonal, covered by numerous overlapping scales in an irregular rosette. Conspicuously placed are the large circular central and radial plates and one or two large oval plates in each interradius. The plates are surrounded by numerous irregular disk scales. About 10 rows of scales in each interradius, median row of scales the largest. Disk margin bears 15 to 18 long, well-spaced, cylindrical papillae, about 4 times their diameter in length. Radial shields large, nearly half the disk radius, longer than broad, acutely pointed within, separated within by 3 or 4 ovate scales.

Upper arm plates oval, twice as wide as long, proximal and distal margins broadly convex, lateral margins acutely convex, in contact with each other. Side arm plates narrow, separated by a naked membrane, not in contact above or below. Spine ridge prominent, bearing 3 heavy, flattened arm spines, about an arm segment in length, uppermost shortest, undermost heaviest and longest.

Oral shields diamond shaped, slightly longer than wide, outer margins concave. Madreporite swollen and considerably larger than other oral shields. Adoral plates triangular, outer margin widest, not meeting within. Jaws small and triangular. Three oral papillae on a side, outermost triangular, broad and flat; median spiniform, more than twice as long as broad, longer than other papillae, resembling the fence papillae more than an oral papilla; inner papillae blocklike, longer than broad, separated from each other. Four broad, blunt teeth, uppermost longest.

Interbrachial spaces below covered with small, uniform, overlapping scales. Genital slits large and wide. Genital ridge covered with a series of large, overlapping scales.

First under arm plate small, proximal margin concave, other margins straight. Second and succeeding under arm plates pentagonal, wider than long, proximal lateral and distal margins concave, lateral margins straight, plates in contact with each other. Two small, oval tentacle scales placed at right angles to each other, inner scales slightly the longer.

*Color*.—Dried from alcohol, upper surface pale gray, disk plates slightly darker. Under surface light cream with some pale gray markings on under arm plates.

*Types*.—Holotype, AHF no. 17; 138 paratypes, 71 in M.C.Z.

*Type locality*.—Station 823-38, 30-40 fms., San Juan Bay, Peru, February 7, 1938. Two paratypes from Station 833-38, 10 fms., Independencia Bay, Peru, February 10, 1938.

*Remarks*.—In the smaller specimens of 2 mm. diameter the rosette was regular and there were 4 rows of scales in each interradius. Only one small scale separated the radial shields proximally. The marginal fence contained only 7 papillae, and the upper arm plates were somewhat triangular. The median oral papillae are spiniform and project above the other papillae as in the type. The madreporite is swollen and considerably larger than the oral shields in all specimens. This species can be distinguished from *Ophiophragmus chilensis* Lyman and other members of the genus by the large radial shields, rosette disk, median oral spiniform papilla, and the unique enlarged and swollen madreporite. The name *stellatus* has reference to the star formed by the large primary plates on the disk.

### Genus AMPHICHONDRIVS Nielsen

#### *Amphichondrius laevis*, new species

Plate 4, Figs. 7-9

*Description*.—Disk diameter, 3.5 mm.; arms, 16 mm. long. Disk pentagonal and swollen, covered with large overlapping disk plates that form a rosette. Surrounding the large central disk plate are 5 small triangular plates, which with equally small distal triangular plates separate the 5 large radial plates from one another and from the central plate. There are a few disk scales surrounding the large plates, while the remainder of the disk is covered with moderate-sized, overlapping disk scales. Five or 6 rows of scales in each interradius. On the disk margin, midway between the arms, is a large, conspicuous, elliptical plate, almost twice as wide as long. The disk granulations of the interbrachial spaces below can be seen distal to the marginal plates. Radial shields small, longer than broad, length less than half the disk radius; separated within by one or two disk scales, outer ends in contact.

Upper arm plates triangular with broadly rounded angles, proximal margin strongly convex. Basally the arm plates are broader than long; distally they become longer than broad. The plates are separated from one another by the side arm plates, which are finely granulated and meet above and below. Spine ridge large and heavy, bearing 3 stout, erect, subequal arm spines less than an arm segment in length, upper spine stoutest and slightly longest.

Oral shields small, diamond shaped, about as long as wide, with an angle within and without. Adoral plates broader than long, meeting within, separated at the outer ends by the first under arm plate. Jaws small, triangular, depressed medianly. Three oral papillae on a side, outermost largest, rectangular, broader than long, slightly elevated above the jaw; median as long as wide, elevated above the jaw; apical slightly longer than wide, separated from each other and set deeper in the mouth than other papillae. Four teeth, uppermost longest, lowest shortest. All plates of the oral frame and mouth more or less swollen and rounded on the angles.

Interbrachial spaces below covered with a dense coat of minute granules; those along the genital slits and disk margin slightly larger. Genital slits long, extending from the oral shields to the disk margin. First under arm plate small, pentagonal, in contact laterally with the adoral plates. Second and succeeding plates pentagonal, slightly wider than long, angle within, proximal lateral margins concave, lateral margins almost straight, distal margin straight, but becoming notched distally, basally all angles rounded. Two rather large tentacle scales, one on the side arm plate, oval, and one on the under arm plate longer than wide; the two are in close contact.

*Color*.—Dried from alcohol, disk light gray with a brownish drab mark centrally on the radial shields and primary plates. Arms light gray, arm spines white. Interbrachial spaces below light tan, mouth parts and under arms dull white.

*Types*.—Holotype, AHF no. 18; 35 paratypes.

*Type locality*.—Station 964-39, 2-8 fms., Tenacatita Bay, Mexico, May 8, 1939. An additional 13 paratypes as follows: one from Station 209-34, 8-10 fms., La Libertad, Ecuador, February 9, 1934; 2 from Station 259-34, 12-20 fms., Tangola-Tangola Bay, Mexico, February 28, 1934; 4 from Station 281-34, 35-40 fms., Santa Maria Bay, Lower California, Mexico, March 7, 1934; one from Station 492-36, 35 fms., San Lorenzo Channel, Espiritu Santo Island, Lower California, Mexico, February 19, 1936; one from Station 541-36, 60 fms., Puerto Refugio, Angel de la Guardia Island, Gulf of California; 3 from Station 767-38, 40-50 fms., off Mexico, Lat.  $15^{\circ} 55' N.$ , Long.  $97^{\circ} 41' W.$ , January 9, 1938; and one from Station 770-38, 7 fms., off San Jose Light, Guatemala, January 11, 1938.

*Remarks*.—This species differs from *Amphichondrius granulatus* Nielsen in having a disk rosette, upper and under arm plates separated by

the side arm plates, radial shields in contact distally, oral shields diamond shaped, granulations on the genital ridge instead of scales with parallel furrows, and triangular-oval upper arm plates little wider than long. The name *laevis* has reference to the very smooth disk.

Genus **AMPHIODIA** Verrill

**Amphiodia sculptilis**, new species

Plate 5, Figs. 1-3

*Description*.—Disk diameter, 5.5 mm.; arms, 26 mm. long. Disk round and thick, covered with numerous plates. A small pentagonal central plate and 5 narrow radiating plates form a star on the disk. Between the narrow plates are 5 larger radial plates about the size of the central disk plate. In each interbrachial area are 7 series of long plates, the middle series broadest and overlapping the other series. Numerous small, overlapping scales radiate out from the center of the disk. Radial shields rounded triangular, longer than broad, outer and distal margins convex. A small triangular scale separates the shields within, and in some cases smaller elongated plates may separate them. The radial shields in all specimens are separated within by at least one triangular scale; without they are in contact. Sides of disk covered with overlapping scales. Lateral to the genital plate and distal to the radial shield is a series of 3 or 4 minute, blunt, cylindrical spines.

Upper arm plates rectangular, almost twice as broad as long, fully in contact with each other, margins straight, distal angles slightly rounded. Side arm plates small, arm spine ridge prominent, bearing 3 short, broad, bluntly rounded arm spines, uppermost slightly largest.

Oral shields very small and diamond shaped, an obtuse angle within and truncated without. Adoral plates triangular, broader than long, widest distally, proximal margins concave, the combination of all the adoral plates and oral shields gives the under side a star-shaped appearance; within each raylike depression the mouth papillae are located. Jaws small and narrow, bearing 3 oral papillae on a side, outermost largest, flat and triangular; median oval, slightly smaller than others; proximal oblong, twice as long as wide, blocklike, and separated from each other. Five broad teeth, uppermost longest.

Interbrachial spaces below covered with uniform overlapping scales that are continuous with the interbrachial scales. Genital slits narrow, bordered by a series of uniform overlapping scales. First under arm plate small, triangular, broader than long. Second and succeeding plates larger,

rectangular, proximal margin convex, distal margin distinctly concave. On the basal under arm plates are 2 longitudinal grooves that divide the plate into a small, oblong center ridge and 2 lateral broader ridges that appear somewhat like supplementary plates, but the plate is not divided. Beyond the disk margin the grooves disappear and the plates are smooth, with parallel lateral margins and convex proximal and concave distal margins. They are fully in contact. One large tentacle scale, longer than wide, widest proximally, almost as long as under arm plate, attached to the lateral margins of the under arm plate.

*Color*.—Dried specimens were pale variegated gray above and dull white below; arms purple gray with irregular white bands.

*Types*.—Holotype, AHF no. 20; 20 paratypes.

*Type locality*.—Station 764-38, 15-20 fms., off White Friar Rocks, Guerrero, Mexico, January 8, 1938. Twenty paratypes as follows: one from Station 121-33, shore, Tenacatita Bay, Mexico, March 16, 1933; 2 from Station 212-34, 45-55 fms., La Plata Island, Ecuador, February 10, 1934; 3 from Station 259-34, 18 fms., Tangola-Tangola Bay, Mexico, February 28, 1934; one from Station 265-34, 5-10 fms., Petatlan Bay, Mexico, March 3, 1934; 2, one in Museum of Comparative Zoölogy, from Station 765-38, 5-10 fms., Chacahua Bay, Mexico, January 9, 1938; 3 from Station 927-39, 4-12 fms., Chacahua Bay, Mexico, March 22, 1939; and 8 from Station 964-39, 2-8 fms., Tenacatita Bay, Mexico, May 8, 1939.

*Remarks*.—This species is closely related to *O. violacea* Lütken, from which it differs by the single tentacle scale, the grooved under arm plates, and the more complex rosette arrangement on the disk. From *O. tabogae* Nielsen, it differs by the shape of the radial shields, semirosette arrangement of the disk scales, and the unique under arm plates. The curious sculpturing of the basal under arm plates and the very small oral shields will distinguish this species from any other known member of the genus. The name *sculptilis* has reference to the characteristic basal under arm plates.

#### Genus OPHIOCNIDA Lyman

#### *Ophiocnida californica*, new species

Plate 5, Figs. 4-6

*Description*.—Disk diameter, 6 mm.; arms, 34 mm. long. Disk pentagonal, thick, covered with irregular scales radiating from a central primary plate. Scales overlapping, those surrounding the radial shields

largest. A number of the plates bear a short, heavy, tapering spinelet. There are from 15 to 20 spinelets irregularly placed on the disk, but they are even more numerous along the sides and margin of the disk. Radial shields long and narrow, about 3 times as long as broad, separated by a series of scales proximally, distal half fully in contact. Surface of radial shields finely granulate. Genital plates in contact with the distal margin of the radial shields and visible from above.

Upper arm plates triangular, twice as broad as long, an obtuse angle proximally, sides slightly convex, distal margin variable according to the number of pieces in the upper plate. Upper plates variable, sometimes in a single piece but often 2 distinct lateral sections and from one to 6 median pieces, usually one small triangular piece distally, 2 small median triangular pieces or often additional pieces proximally. The upper plates are in contact basally, but distally they become separated by the side arm plates. Side arm plates with a prominent spine ridge bearing 3 heavy, tapering, bluntly tipped arm spines. Middle spine longest, about as long as an arm segment. Spines on the first arm plate very short and stubby; they gradually increase in length to the 6th arm segment, from whence they are more or less uniform distally.

Oral shields diamond shaped, slightly wider than long, with an acute proximal angle. Adoral plates twice as broad as long, meeting within, widest distally. Jaws long and narrow. Three oral papillae on a side, outermost rectangular, longer than wide, with a serrate cutting margin; apical blocklike, well separated, longer than broad, cutting edges concave; median heavy, triangular, about as long as wide. Four broad, flat teeth, lowermost shortest, uppermost longest. No tooth papillae.

Interbrachial spaces below covered with thick, overlapping, crowded scales, a few bearing short, heavy, sharp spinelets, irregularly distributed. Genital slits bordered by a series of scales. First under arm plate small, longer than wide, with an acutely convex distal margin. Second and succeeding plates pentagonal, wider than long, with an obtuse proximal angle and straight lateral and distal margins. Plates barely in contact basally, separated distally by the large, coarsely granulated side arm plates. Two long, narrow tentacle scales attached on the distal side of the tentacle pore.

*Color.*—Dried specimens had dark cream-colored disks with darker radial shields. Arms pinkish buff with irregular maroon bands and markings. Interbrachial areas below and mouth parts grayish white, under arms pinkish buff with no banding.



*Types*.—Holotype, AHF no. 13; 15 paratypes.

*Type locality*.—Holotype and 5 paratypes from Station 529-36, 165 fms., off San Francisquito Bay, Lower California, March 1, 1936. Ten paratypes as follows: 2 from Station 526-36, 3-5 fms., off Mangles Anchorage, Lower California, February 28, 1936; 5 from Station 534-36, 125 fms., off San Francisquito Bay, Lower California, March 2, 1936; and 3 from Station 750-37, 60 fms., Outer Gorda Bank, Lower California, April 4, 1937.

*Remarks*.—In the smaller specimens the dorsal arm plates are not divided. *O. californica* can be distinguished from *O. hispida* (Le Conte) by the oral shields, which are about as long as broad; the outermost oral papilla, which is longer than broad; radial shields half in contact; upper arm plates triangular, divided into several pieces in the adults; and the arm length, which is 5 times the disk diameter, while the arm length of *O. hispida* is 10 times the disk diameter. From the other members of the genus, *O. californica* can be readily distinguished by the unique upper arm plates and the oral shields. It has been named *californica*, as the range of this species seems to be confined to the Gulf of California.

### Genus AMPHIOPLUS Verrill

#### *Amphiplus philohelminthius*, new species

Plate 5, Figs. 7-9

*Description*.—Disk diameter, 4 mm.; arms, 51 mm. long. Disk small, pentagonal, with a central and 5 radial primary disk plates; disk covered with small uniform scales, those bordering the radial shields larger. Radial shields large, the length more than half the disk radius, about 3 times as long as broad, slightly separated proximally but in contact distally; somewhat swollen and raised above the remainder of the disk.

First upper arm plate wider than long. Succeeding plates oval, slightly wider than long, becoming more so distally, widest proximally, with a convex margin, distal margin sharply rounded. At the arm extremities the plates become longer than wide and rounded pentagonal or triangular. The plates are separated by the side arm plates throughout the arm length.

Side arm plates 3 times as broad as long, separated from each other by a naked membrane. Spine ridge prominent, bearing 4 flattened, lanceolate, blunt-tipped spines on the 10 basal arm segments, 3 subequal spines on the remainder of the arm, median spines shorter than upper and lowermost.

Oral shields about as long as broad, the inner half much wider than the outer half, proximal margins broadly rounded, lateral margins concave, distal and truncate. Adoral plates triangular, twice as broad as long, widest distally, not quite meeting within. Jaws long and narrow. Four oral papillae on a side, apical largest, rounded and blocklike, longer than wide, tapering slightly proximally to give a triangular appearance to some specimens; other papillae flat and rounded, longer than broad, outermost slightly largest. Four bluntly rounded, broad teeth, lowermost shortest, uppermost longest.

Interbrachial spaces below covered with small overlapping scales distally, but fewer proximally. Genital slits very large, bordered by large and wide genital plates. First under arm plate triangular, longer than wide, lateral margins deeply concave producing lateral lobes, distal margin convex. Succeeding plates rectangular, longer than wide, lateral margins parallel, distal margin concave, proximal margin convex. Distally the proximal margins are produced in a right angle, and near the arm extremities the plates become triangular. Basally the plates are in contact, but distally they become separated by the side arm plates. Tentacle scales, 2 on the basal pores, but the one on the under arm plate is exceedingly small and soon disappears altogether.

*Color.*—In dry specimens the disk and arms are light gray with faint brown markings on the arms. Mouth parts and under arms light yellow.

*Types.*—Holotype, AHF no. 6; 32 paratypes, 16 in M.C.Z.

*Type locality.*—Station 823-38, 30-40 fms., San Juan Bay, Peru, February 7, 1938. An additional paratype in the Museum of Comparative Zoölogy from Station 826-38, 20-30 fms., San Juan Bay, Peru, February 7, 1938, and one from Station 833-38, 8 fms., Independencia Bay, Peru, February 10, 1938.

*Remarks.*—This species lives in great numbers in a soft mud which teems with small, white nematode worms, a most repulsive environment, to which, however, it is well adapted by its small flat disk and long, very slender arms. It is the first *Amphioplus* to be reported from the western coast of South America and differs obviously from the 3 species from the Panamic region described by Lütken and Mortensen in 1899. The oral papillae and disk scaling are quite distinctive. The species has been named *philohelminthius* because of its fondness for living with little worms.

## Ophiochitonidae

Genus **OPHIONEREIS** Lütken

**Ophionereis dictyota**, new species

Plate 6, Figs. 1-5

*Description*.—Disk diameter, 9 mm.; arms broken, longest about 67 mm. long. Disk covered with thick and overlapping scales which become thicker surrounding the radial shields. Extending interradially from the radial shields, at the margin of the disk, is a series of 6 to 8 large, distinct scales, about  $\frac{1}{3}$  as long as the length of the radial shields. Radial shields small and pennantlike, about 3 times as long as broad, proximally finely pointed, distally rounded, surrounded by large disk scales.

First upper arm plate small, oval, proximal margin concave, distal convex. Second plate hexagonal, twice as large as the first; third and succeeding plates larger. The plates are hexagonal, broader than long, fully in contact. Proximal and proximal lateral margins concave, distal lateral margins convex, distal margin nearly straight. Supplementary plates longer than wide, inner margin concave, outer margins convex to form a distinct, rounded, outer distal angle. Side arm plates separated from each other by a soft membrane. Each plate bears 3 rounded, tapering and slightly curved, blunt-tipped arm spines, slightly longer than an arm segment, the median longest. Upper spine flat, blunt and little curved.

Oral shields oval, longer than wide, proximally convex, distal lateral margins concave. Adoral plates lanceolate, wider than long, enlarging distally with a rounded margin, not meeting within. Jaws long and narrow. Four or 5 oral papillae on a side, outermost flat and triangular; others blunt and angular, almost rounded; apical smallest, shorter than others. Four broad and rounded teeth, lowermost shortest and thick, uppermost thin and long.

Interbrachial spaces below densely covered with fine overlapping scales. Genital slit ridge bears numerous fine stumps, longer than broad proximally, becoming shorter and fewer distally. First under arm plate quadrangular, proximal margin narrow and concave, lateral margins almost straight, and distal margin decidedly rounded. Second plate much larger, square, proximal margin little concave, plates only  $\frac{1}{3}$  in contact, distally even less so. One large, oval, flat tentacle scale, almost  $\frac{3}{4}$  the length of under arm plate.

*Color*.—Dried specimens had a cream-colored disk, reticulated with brown markings which continue to the oral shields. Proximally between

the genital slits is a dark brown triangular splotch. Arms light buff with a wide (2 segments), dark brown, almost black band, every 3 to 4 segments. Mouth parts and arm spines cream colored, slight traces of the upper arm bands continue below.

*Types*.—Holotype, AHF no. 7; 5 paratypes.

*Type locality*.—Station 778-38, tide pool, Chatham Bay, Cocos Island, Costa Rica, January 14, 1938. Five paratypes from Station 445-35, shore, Panama City, Panama, February 2, 1935; one from Station 447-35, coral, Secas Islands, Panama, February 4, 1935; one from Station 512-36, shore, Ballena Bay, Espiritu Santo Island, Gulf of California, February 23, 1936; one from Station 515-36, shore, San Francisco Island, Gulf of California, February 24, 1936; and one from Station 522-36, tide pool, Agua Verde Bay, Lower California, Mexico, February 27, 1936.

*Remarks*.—In life the holotype had a bluish gray disk, reticulated with light brown, much as in the West Indian *O. reticulata* (Say). The very long arms, which were much broken in capturing the specimen, were broadly banded with dusky purple. This species differs from other eastern Pacific *Ophionereis* by the irregular coarse disk scaling, a uniform series of 5 or 6 large marginal disk scales extending interradially from the radial shields, large radial shields; and the distinct coloring of the arms and disk. The name *dictyota* has been chosen because of the reticulations on the disk.

### *Ophionereis perplexa*, new species

Plate 7, Figs. 7-9

*Description*.—Disk diameter, 8 mm.; arms, 42 mm. long. Disk more or less depressed and irregular because of shrinkage upon drying. The disk is covered by a membrane, which upon drying shows minute, dense, overlapping, uniform scales, visible only under high magnification. No primary plates are visible, and the scales bordering the radial shields and disk margins are not enlarged or conspicuous. Radial shields small, narrow, more than 4 times as long as broad, acutely pointed within, widely separated, distance apart exceeding the length of radial shields. The minute overlapping scales obscure the outline of the radial shields.

First upper arm plate small, semilunar, wider than long, proximal margin straight, distal margin broadly convex, overlapping next plate. Succeeding plates large, wider than long, basally triangular with rounded corners, proximal margin slightly concave, distal margin convex, less

than half the width of proximal margin; distally the plates become pentagonal or hexagonal with slightly concave proximal and proximal lateral margins and convex distal margins. Supplementary plates triangular, distal margins convex and bearing a series of parallel minute ridges conspicuous under high magnification. Plates  $\frac{1}{3}$  to  $\frac{1}{2}$  the size of upper arm plates. Side arm plates wide, not meeting above or below, spine ridge prominent, bearing 3 large, heavy, broad, bluntly tipped arm spines;  $1\frac{1}{2}$  to 2 arm segments long, middle spine longest, uppermost the shortest.

Oral shields triangular, wider than long, obtuse angle within, lateral angles convex. Adoral plates narrow, not meeting within, broader distally. Jaws small and triangular. Four oral papillae on a side, outermost bluntly pointed, longer than wide; next 2 broad, rounded, and heavy; apical heavy, blunt, and rounded, slightly longer than broad. In the holotype and a few paratypes the 2nd outermost papilla is divided into 2 or 3 fine spiniform papillae with a common base. Four broad and rounded teeth, uppermost longest.

Interbrachial spaces below covered by a thin membrane, which under high magnification shows very minute scales. Genital slits large and wide; a few scales can be seen, but no genital papillae are present. First under arm plate small, slightly longer than wide, distal margin convex, lateral and proximal margins almost straight. Second and succeeding plates large, longer than wide, proximal and distal margins convex, lateral margins almost straight, plates in contact with each other. One large, oval tentacle scale, half the length of under arm plate, attached to the side arm plate.

*Color.*—Dried specimens, disk pale yellow with reticulating purplish lines; above the arm base and between the radial shields is a purple-brown area spotted with cream yellow that blends in with the reticulations of the disk proximally. Upper arms greenish gray with a purple band one segment wide, continuing below and spaced about 3 to 5 arm segments apart. The supplementary plates on each side of the purple band are creamy white. Arm spines are gray with a white base and a transverse purple band above the base and on the tip. Mouth parts and under arm plates are creamy white with the purple arm bands extended from above. Disk below is a brown orange in the naked membrane with the disk colors and reticulations extending onto the interbrachial area.

*Types.*—Holotype, AHF no. 4; 88 paratypes.

*Type locality.*—Holotype and 3 paratypes from Station 333-35, shore, James Island, Galapagos, December 11, 1934. Eighty-five additional paratypes as follows: one from Station 73-33, shore, Cartago Bay,

Albemarle Island, Galapagos, February 13, 1933; 2 from Station 202-34, shore, Osborn Island, Galapagos, January 31, 1934; one from Station 313-35, shore, Black Beach Anchorage, Charles Island, Galapagos, December 6, 1934; 3 from Station 342-35, shore, Bartholomew Island, Galapagos, December 12, 1934; 12 from Station 350-35, shore, South Seymour Island, Galapagos, December 13, 1934; 7 from Station 351-35, shore, Charles Island, Galapagos, December 14, 1934; one from Station 515-36, shore, San Francisco Island, Gulf of California, February 24, 1936; 6 from Station 530-36, 10-20 fms., off San Francisquito Bay, Lower California, Mexico, March 1, 1936; 2 from Station 719-37, 10-25 fms., Consag Rock, Lower California, Mexico, March 24, 1937; 5 from Station 782-38, shore, Darwin Bay, Tower Island, Galapagos, January 16, 1938; 29 from Station 784-38, shore, Tower Island, Galapagos, January 17, 1938; 3 from Station 789-38, shore, South Seymour Island, Galapagos, January 19, 1938; one from Station 795-38, 30-40 fms., Sullivan Bay, James Island, Galapagos, January 21, 1938; 2 from Station 796-38, shore, Sullivan Bay, James Island, Galapagos, January 21, 1938; 4 from Station 800-38, shore, Cartago Bay, Albemarle Island, Galapagos, January 22, 1938; 3 from Station 803-38, shore, Black Beach, Charles Island, Galapagos, January 23, 1938; one from Station 808-38, shore, Academy Bay, Indefatigable Island, Galapagos, January 25, 1938; and 2 from Station 400-35, shore, Manta, Ecuador, January 19, 1935.

*Remarks.*—This species is rather common in the Galapagos Islands and differs from the other members of the genus by its exceedingly fine disk scaling, radial shields which are separated more than their length apart, lack of genital papillae, absence of enlarged scales about the disk margin and radial shields, and coloring. From *O. annulata* (Le Conte) and *O. dictyota* it differs by lacking large disk scales about the radial shields and disk margins. Its 3 arm spines distinguish it from *O. albot-maculata* Smith and *O. eurybrachioplax* H. L. Clark, which basally have 4. From its closest ally, *O. nuda* Lütken and Mortensen, it can be distinguished by its arm length, 4 oral papillae, presence of fine scales, lack of genital papillae, and uniquely separated radial shields. In a series of 64 are a number of variations; in some specimens the disk below is covered by a naked membrane, and in others the upper disk scaling is continuous to the adoral plates. Of the 64 specimens, 45 had 4 oral papillae on each side; 7 had 3 on one or more jaw sides and 4 on the remaining sides; and 4 had 4 oral papillae with either of the 2 middle papillae divided into 2 or 3 spiniform papillae, with a common base. The name *perplexa* has

been selected because of the difficulty of distinguishing this species from other Pacific forms.

### OPHIODESMUS, new genus

Similar to *Ophionereis*, but the disk scaling is coarse and compacted to such a degree that only a small portion of some of the disk scales is visible. The supplementary arm plates are very small, confined mainly to the side of the arm and not conspicuous from above. Upper arm plates oval, slightly wider than long. This genus seems to be a connecting link between *Ophionereis* of the Ophiochitonidae and *Ophiactis* of the Amphiruridae. Since it shows characteristics of both families and the under side is decidedly similar to *Ophionereis*, this genus is placed in the Ophiochitonidae. The name *Ophiodesmus* has reference to its connecting-link position between Amphiruridae and Ophiochitonidae.

*Genotype: Ophiodesmus amphilogus*, new species.

### *Ophiodesmus amphilogus*, new species

Plate 9, Figs. 4-6

*Description.*—Disk diameter, 4.5 mm.; arms, short and slender, gradually tapering, about 11 mm. long. Disk circular and flat, covered by numerous compacted, overlapping, irregular scales. Some of the scales are compacted and overlap to such an extent that only an elliptical portion or narrow margins are exposed. Surrounding the larger scales are several irregularly placed smaller scales. There are 7 to 9 irregular series of scales in each interradius. Primary plates are not conspicuous. Radial shields small, oval shaped, about twice as long as wide, widely separated, about their length apart, by several large and numerous small disk scales. Length of shields about  $\frac{1}{4}$  of the disk radius.

First upper arm plate small, wider than long, distal margin convex. Second plate oval shaped, larger than the first, slightly wider than long, distal margin strongly convex. Third and succeeding plates larger, oval shaped, basally wider than long, distally becoming longer than wide, margins convex. Basally the plates overlap; distally they become separated by the side arm plates. Under high magnification the upper arm plates appear smoother in texture than the side arm plates. Side arm plates wider than long, spine ridge produced and prominent, bearing 3 heavy, flattened, broad, short, subequal arm spines, as long as an arm segment basally, and gradually reducing in length distally to the arm tips where they are

only  $\frac{1}{3}$  the length of the arm segment. Median spine slightly the longest; upper spine heaviest and blunt. Supplementary arm plates small and triangular, about  $\frac{1}{10}$  the size of the upper arm plate; inner margin concave, distal and outer margins convex. The supplementary plate is inserted under the upper and proximal side arm plates and overlaps the distal side arm plate.

Oral shields triangular, about as long as broad, inner margins almost straight. Adoral plates triangular, broader than long, widest distally, meeting within, inner margin slightly concave, other margins straight or slightly concave. Jaws small, triangular. Four oral papillae, about equal in length, on a side. Outermost largest, flat, longer than broad, cutting margin rounded. Inner 3 papillae narrow, flat, longer than broad, bluntly pointed; inner pair heaviest. Distal to the outer papillae is the first tentacle scale, set deep in the mouth, which might easily be taken for an oral papilla. Four broad teeth of equal length, cutting margins convex.

Interbrachial spaces below covered with unequal, overlapping, crowded scales. The largest scales are centrally located; those along the genital slits are smaller and crowded so only a portion of the scales are visible. Genital slits short, equal in length to 2 arm segments. First under arm plate small, longer than broad, distal margin convex. Second and succeeding plates large, octagonal basally, triangular distally, longer than wide; proximal lateral margins straight, lateral margins concave, distal margins broadly convex. Plates in contact basally, separated distally by the side arm plates. One large, oval tentacle scale, longer than wide, not quite half the length of the under arm plate, attached to the side arm plate.

*Color*.—Dried from alcohol, disk white with dark gray circles at the arm base. Arms dark gray with irregularly spaced white and light gray bands. Under side white with irregular gray bands on the arms. Two of the paratypes differ by having the disk uniformly mottled with white, light and dark gray. Arms irregularly banded with white, light and dark gray. Under side white with several gray bands on the arms.

*Types*.—Holotype, AHF no. 22; 3 paratypes.

*Type locality*.—Station 287-34, 10-15 fms., Cerros Island, Lower California, Mexico, March 10, 1934.

*Remarks*.—This species differs from *Ophionereis annulata* (Le Conte) of equal size in its coarser disk scaling, lack of genital papillae, arm length twice the disk diameter, and exceedingly small supplementary plates. From the young of *Ophionereis eurybrachioplax* H. L. Clark, it



differs in having only 3 basal arm spines, shorter and stouter arm spines, arms only twice the disk diameter, as compared to 5 times the disk diameter, small, oval upper arm plates as compared to large, broad, rectangular upper arm plates. The above characteristics distinguish this species from other known related forms. In color it differs from *Ophioreis*, which has regularly dark banded arms. The name *amphilogus* has reference to the doubtful position of this species.

## Ophiolepididae

Genus OPHIOMISIDIUM Koehler

*Ophiomisidium leurum*, new species

Plate 7, Figs. 1-3

*Description*.—Disk diameter, 4 mm.; arms, 4 mm. long. Disk large; arms short, tapering rapidly. Disk covered with 37 large, granulated plates. Central plate pentagonal, surrounded by 5 quadrangular plates, whose acute distal angles separate the proximal portion of the radial shields. Separating the radial shields interradially are 2 plates, a rectangular proximal plate and, distally, a produced, rounded, swollen plate that fills the interbrachial margin and side of the disk. A rounded plate and an oblong plate separate the distal margins of the radial shields. A small plate (distal end of 2nd side arm plate) at the distal margin of each radial shield, bearing 3 large spines, completes the side margins of the disk.

Radial shields oblong, almost twice as long as wide, separated proximally by the primary radial plate, broadly in contact medially but separated distally by 2 plates, one rounded and swollen above the surface of the radial shields, the other much broader, not elevated, lying on the side arm plates at the arm base.

First upper arm plate very small, diamond shaped, succeeding plates becoming still smaller distally until none can be found after the 4th arm segment; plates widely separated by the side arm plates. First side arm plates somewhat swollen, wider than long, meeting within, not visible from above; 2nd plates are visible from above just distal to the radial shields. Succeeding side arm plates narrower, becoming longer distally and fully in contact. There are apparently not more than 10 or 12 arm segments. Arm spines small, only 2 on first arm segment; there are 3 on the next arm segment, well separated, uppermost heaviest, triangular, blunt, longer than wide, median one or 2 shorter, lowermost shortest,

slightly tapering. Three uniform short arm spines on next 2 arm segments, blunt and uniformly tapering. Two very short and peglike arm spines on the remaining arm segments.

Oral shields diamond shaped, longer than broad. Adoral plates diamond shaped, slightly broader than long, meeting fully within. Jaws quadrilateral, longer than broad. Four oral papillae, broad and blocklike, broader than long, their outlines cannot be seen distinctly.

Interbrachial spaces below covered by 2 long, narrow plates, distal of the oral shields, and separated at the disk margin by a triangular plate, the acute angle within and a broadly rounded margin without that extends beyond the disk margin, appearing much like a horizontal keel on the large interbrachial plate. Genital slits not visible. First under arm plate large, shield shaped, succeeding plates similar but becoming smaller distally, disappearing entirely on the 6th arm segment. Under plates widely separated by the side arm plates. Tentacle scales only on the basal 5 arm segments, 2, sometimes 3, small oval tentacle scales on each pore.

*Color.*—All specimens dried from alcohol are bleached nearly white.

*Types.*—Holotype, AHF no. 16; 3 paratypes, one in M.C.Z.

*Type locality.*—Station 810-38, 73 fms., off Barrington Island, Galapagos, January 26, 1938. Paratypes: one from Station 767-38, 45 fms., off Chacahua Bay, Oaxaca, Mexico, January 9, 1938; and 2, one in the Museum of Comparative Zoölogy, from Station 792-38, 75 fms., off Daphne Minor Island, Galapagos, January 20, 1939.

*Remarks.*—This little brittle star differs markedly from other known members of the genus by its smooth, flat disk with 10 marginal knobs (or at least elevations) on the 5 radial and 5 interradial marginal plates. The name *leurum* has been selected with reference to the very flattened form of the entire body.

## Genus AMPHIOPHIURA Matsumoto

### *Amphiophiura irregularis*, new species

Plate 7, Figs. 4-6

*Description.*—Disk diameter, 7 mm.; vertical diameter, 1.3 mm.; arms, 18 mm. long. Disk pentagonal, flat, composed of 24 flat plates, including the radial shields; 8 irregular plates surround the central plate, a large oblong interradial plate separates the radial shields. The number of disk plates ranges from 20 to 26, including radial shields, in the 16

paratypes. A central plate is sometimes found, but a symmetrical rosette has not been seen in the 17 specimens. In several specimens radial shields and interradial plates are in contact with the central plate at one point. Interbrachially is a large, transversely oval plate in contact with the interradial plate and separated from the radial shields by one or 2 smaller plates. Radial shields large, hexagonal, about half the disk radius, slightly longer than wide, broadly in contact.

First upper arm plate small, triangular, with the peak within, bearing 2 to 5 fine spinelets on each lateral margin along the genital slit. Second plate hexagonal, swollen, broader than long, distal and proximal margins straight, lateral margins little concave, bearing 4 to 8 fine spinelets along the genital slit. Third plate hexagonal, about as long as broad, swollen, with straight proximal and distal margins. Succeeding plates pentagonal, then quadrangular, becoming triangular distally, longer than broad, lateral margins straight, distal margins convex. Basal 8 plates in contact, distally they become farther separated by the side arm plates until they are reduced to  $\frac{1}{3}$  the length of an arm segment at the extremities. All plates are finely granulated. First side arm plate greatly reduced, bearing 2 short, broad tentacle scales and 2 long, conical arm spines on the genital slit. Third plate slightly larger, bearing 3 short, broad tentacle scales and 4 long, slender, pointed, well-spaced arm spines along the genital slit. Fourth to 8th plate bearing 2 small, flat, long tentacle scales or modified arm spines, succeeding plates bearing only one. Fourth and succeeding plates bear 5 then 4 long, finely tapering, well-spaced arm spines, about  $\frac{1}{3}$  the length of the arm segment, median spine longest, upper and lowermost shortest.

Oral shields large, occupying the interradius below, oval, longer than wide, with an acute angle within and broad, convex lateral and distal margins. Adoral plates quadrangular, little broader than long, meeting within. Jaws wider than long, scarcely larger than adoral plates. Four or 5 oral papillae on a side, outermost twice as broad as long; next broader than long; next delicate, longer than broad, apical broad, heavy, pointed, longer than broad. Three narrow pointed teeth, undermost shortest.

Interbrachial spaces below covered by the large, oval oral shields and 2 or more small interbrachial plates. Genital slits long, extending from the adoral plates to the radial shields. Genital plates long and narrow, in contact with the distal margin of the radial shields; each plate bears a comb of 18 to 26 fine, long, tapering, pointed spines, well separated at their bases, lowermost becoming shorter and blunt. First under arm plate

largest, longer than wide, proximal margin convex, distal margin deeply concave; lateral margins concave, bearing 3 or 4 reduced tentacle scales, outermost being the largest. Second plate rectangular, broader than long, proximal margin almost straight, distal margin concave, lateral margins bearing 2 short, broad tentacle scales. Third plate rectangular, only slightly broader than long, lateral margins bearing 2 short tentacle scales, outermost largest. Fourth to 8th plates hexagonal, much wider than long; 4th, 5th, and 6th bearing a minute tentacle scale on the distal lateral angle. Succeeding plates pentagonal or oblong, small, becoming triangular and smaller distally, until they occupy only  $\frac{1}{4}$  of the arm segment or less at the extremities. The 6 basal plates are separated by a deep concavity, succeeding plates separated by side arm plates; distally the separation becomes even greater.

*Color*.—Dried from alcohol, disk white with a lavender tinge, arms light cream color. In life, upper surface variegated with light and dark red, or red and yellowish, or red and white; oral surface white. The larger specimens are not deeply colored.

*Types*.—Holotype, AHF no. 12; 60 paratypes, 16 in M.C.Z.

*Type locality*.—Holotype and 33 paratypes, 16 in the Museum of Comparative Zoölogy, from Station 792-38, 70-80 fms., off Daphne Minor Island, Galapagos, January 20, 1938; 2 paratypes from Station 191-34, 70 fms., Lat.  $0^{\circ} 55' S$ ., Long.  $90^{\circ} 39' W$ ., January 26, 1934; and 25 paratypes from Station 190-34, 58-60 fms., Lat.  $0^{\circ} 55' S$ ., Long.  $90^{\circ} 30' W$ ., January 26, 1934.

*Remarks*.—This species is closely related to *A. paucisquama* but differs as follows:

<i>A. irregularis</i>	<i>A. paucisquama</i>
No symmetrical rosette on disk	A symmetrical rosette on the disk composed of a central pentagonal plate and 5 larger, equal radial plates
All plates finely granular	Disk and basal arm plates deeply pitted
Plates flat or slightly swollen	Plates convex, basal upper arm plates almost hemispherical
Radial shields large	Radial shields small
Disk flat, 1.5 mm. thick	Disk elevated, 3.5 mm. thick
Arms about 2.2 times disk diameter, not slender distally	Arms short, 1.8 times disk diameter, becoming very slender distally

The name *irregularis* has been chosen for this species because of the irregular arrangement of the disk scales.

***Amphiophiura paucisquama*, new species**

Plate 8, Figs. 1-3

*Description.*—Disk diameter, 7 mm.; thickness of disk, 3.5 mm.; arms, 13 mm. long. Disk large, arms relatively short, tapering rapidly. Disk covered with 21 very large pitted plates including the radial shields. A large, swollen, pentagonal central plate is surrounded by 5 slightly larger plates that are in contact with the single, large, interradial plate and the radial shields. The interradial plate is pentagonal with the proximal margins concave, forming a peak, lateral and distal margins almost straight. Viewed under an ordinary hand lens all plates are deeply pitted, resembling the mesh on a golf ball. Radial shields much smaller than disk plates, pentagonal, fully in contact, decidedly broader than long, deeply pitted as other disk plates.

First upper arm plate oval, broader than long, fully in contact with the second arm plate and radial shields, lateral margins bear genital slit papillae. Distally the plate bears an elevated transverse ridge which is deeply pitted. Second plate oval, broader than long, with a high convex surface, deeply pitted, in contact with the first upper arm plate. Third plate oval, slightly broader than long and rather high, elevated to resemble a golf ball, deeply reticulated. Succeeding plates diamond shaped, becoming smaller, flatter, and more widely separated by the side arm plates distally. Side arm plates twice as broad as long, swollen, in contact below from the 5th arm segment out and in contact above from the 3rd segment out. Three short, peglike arm spines about  $\frac{1}{3}$  the length of the side arm plates, widely separated, upper longest and heaviest, under shortest. The arm plates are separated from each other or appear that way because of the prominent spine ridge. All plates are deeply pitted by an irregular reticulation similar to that on golf balls.

Oral shields large, triangular, truncated within and broadly convex without, longer than wide, occupying the entire ventral interradius. Adoral plates small, diamond shaped, fully in contact and separated from the oral shield by a furrow. Jaws diamond shaped, twice as long as wide. Four or 5 oral papillae on a side, outermost largest, rectangular, broader than long; 2nd and 3rd outermost rectangular, only slightly broader than long. Inner papillae ovate, pointed, flat, longer than broad. Three bluntly rounded teeth.

Interbrachial spaces below covered by the large oral shield surrounded by a few smaller plates. In the interbrachial area is a large plate in contact with the oral shield and the upper interrachial plate. First under arm plate large, slightly longer than wide, with a convex proximal margin and concave distal margin, widely separated from the 2nd under arm plate by a groove. Second plate rectangular, 3rd and succeeding plates longer than broad, becoming diamond shaped distally, reduced in size and farther separated by the side arm plates, which meet below between the 4th and 5th under arm plates. The first 5 arm plates are separated below by a deep groove. Plates swollen and deeply pitted. Genital slits large, extending from the radial shields to the adoral plates. Thirteen to 18 spines on the genital ridge, those above long, blunt, and well spaced, undermost become shorter, broader, flatter, and compacted. Three broad, flat tentacle scales, outermost largest on 1st under plate. Two broad, flat tentacle scales on the adoral plate. Three flat, broad tentacle scales on the 2nd and 3rd under plates. Three broad flat tentacle scales on the 1st and 2nd side arm plates. Two tentacle scales on the next 3 under arm plates and then only one for 3 plates before disappearing. Two tentacle scales on the 3rd to 5th side arm plate and then only one to the end of the arm.

*Color.*—Dried from alcohol, white with a lavender tinge, stained brownish drab about the base of the arms.

*Types.*—Holotype, AHF no. 8; 13 paratypes, 5 in M.C.Z.

*Type locality.*—Station 818-38, 300 fms., south of Hood Island, Galapagos, January 20, 1938. Thirteen additional paratypes, 5 in the Museum of Comparative Zoölogy, from Station 786-38, 392 fms., N.E. of Indefatigable Island, Galapagos, January 18, 1938.

*Remarks.*—The thick rounded disk, short rapidly tapering arms, symmetrical disk rosette, and unique deep pits on the primary plates, especially the basal upper arm plates, which resemble the mesh on a golf ball, easily distinguish the adults of this species from other known members of the genus. Unfortunately, in small specimens the pitted surface is not noticeable under an ordinary lens but requires a magnification of 40 diameters or more. It approaches *Stegophiura* in the shape of the arms, but the disk scales and arm spines are more like *Amphiophiura*. This species has been named *paucisquama* in reference to the small number of disk plates.

Genus *OPHIOLEPIS* Müller and Troschel*Ophiolepis plateia*, new species

Plate 8, Figs. 4-6

*Description.*—Disk diameter, 13.5 mm.; arms, 38 mm. long. Disk covered with large primary plates, each surrounded by a row of single smaller, regularly arranged scales. Disk very flat and depressed; 2 rounded protruding plates on the interbrachial margin, most conspicuous from the under side. Arms flat, tapering distally; base of arm 4.5 mm. wide, width midway of the arm only 2.5 mm. Radial shields large and distinct, longer than broad, separated from each other and interradially by a primary plate or plates, each surrounded by a single row of small disk scales.

Upper arm plates rectangular, wider than long basally, becoming triangular distally and longer than wide; lateral margins convex basally, concave distally, distal margin concave basally, almost convex distally. Basally 2 triangular supplementary plates are inserted between the upper ends of the side arm plates; distally they are replaced by a single supplementary plate. Side arm plates large, separated above by the supplementary plates. There are 4 short, blunt, conical, well-spaced arm spines basally, but only 3 distally, placed low down on the side arm plates. Arm spines less than half the length of arm segment.

Oral shields narrow, twice as long as wide, proximal angle acute, lateral margins concave, distal margin convex. Adoral plates rectangular, widest without, meeting within, slightly prolonged between the oral shield and the inner side arm plate. Jaws triangular, longer than wide, smaller than the adoral plates. Five oral papillae on a side, the triangular outermost reaching inside the next papilla, which is angular, wider than long; next squarish, followed by an angular papilla, then a pointed papilla; apical papilla flat and oval. Four equally long teeth, the lowermost broad, cutting edge rounded, uppermost narrow, cutting edge straight.

Interbrachial spaces below covered by 2 long genital plates which are separated by irregular scales, outermost largest, and 2 large rounded interbrachial plates. Two small genital slits  $\frac{1}{3}$  the disk radius in length. Under arm plates broader than long basally, becoming longer than broad distally, proximal margins convex, distal and lateral margins concave, plates fully in contact. Two wedge-shaped tentacle scales, closely in contact, abradial scale slightly larger. There may also be a small accessory scale on the basal arm segments.

*Color*.—Dried specimen, disk and arms above dull dark gray and olive buff irregularly mottled. On the disk scales the color is lighter and more distinct. Interbrachial disk plates have a central, light cream color area encircled with a narrow dark brown band. Entire under surface cream color, general appearance light drab gray.

*Types*.—Holotype, AHF no. 14; 222 paratypes, 11 in M.C.Z.

*Type locality*.—Holotype and 191 paratypes, 9 in the Museum of Comparative Zoölogy, from Station 483-35, 6 fms., Tenacatita Bay, Mexico, February 15, 1935. Thirty-one paratypes as follows: 24, 2 in Museum of Comparative Zoölogy, from Station 116-33, 2 fms., Cocos Bay, Puerto Culebra, Costa Rica, March 13, 1933; 6 from Station 965-39, 8-15 fms., Tenacatita Bay, Mexico, May 8, 1939, and one from Station 964-39, 2-8 fms., Tenacatita Bay, Mexico, May 8, 1939.

*Remarks*.—This species is related to *O. variegata* Lütken and *O. crassa* Nielsen, differing from both by its depressed disk, broad, short, and markedly tapering arms, the large, rounded interbrachial plates, larger and broader oral shields, and color pattern. These characters are so conspicuous that *O. plateia* cannot be confused with any known species of the genus. The name selected, *plateia*, refers to the unusually depressed disk.





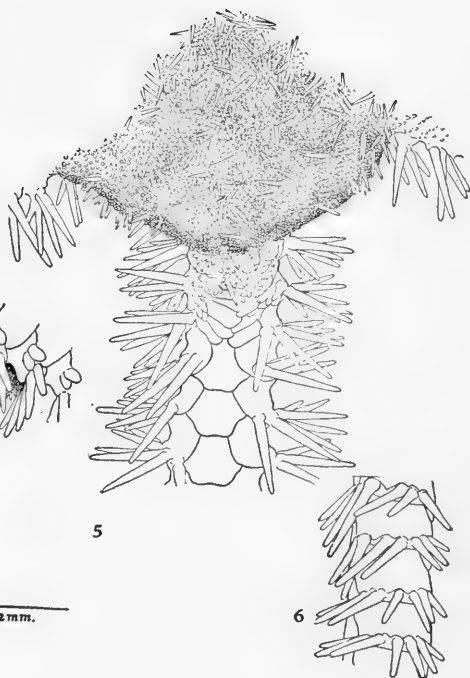
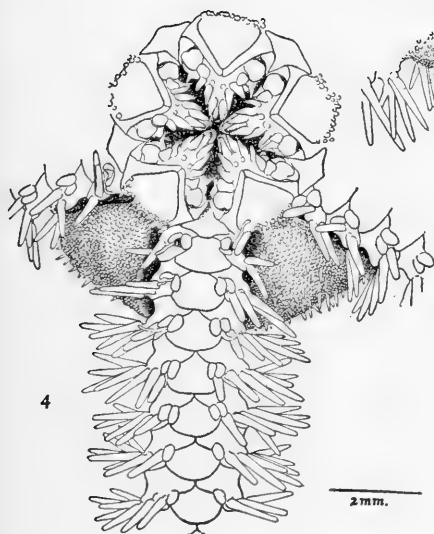
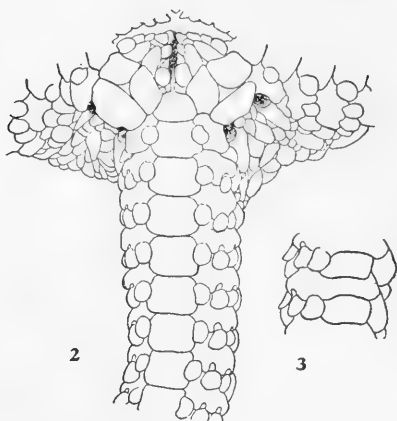
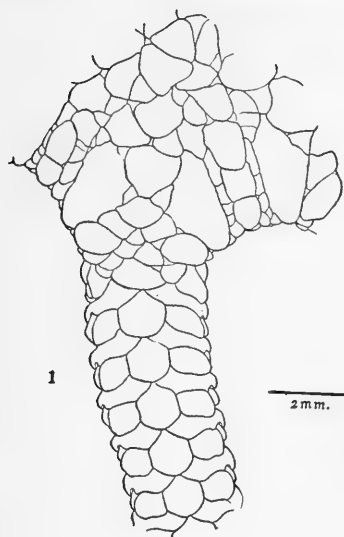
## PLATE 2

*Sigsbeia laevis*, new species

- FIG. 1. Upper view  
FIG. 2. Under view  
FIG. 3. Side arm view

*Ophiacantha phragma*, new species

- FIG. 4. Under view  
FIG. 5. Upper view  
FIG. 6. Side arm view



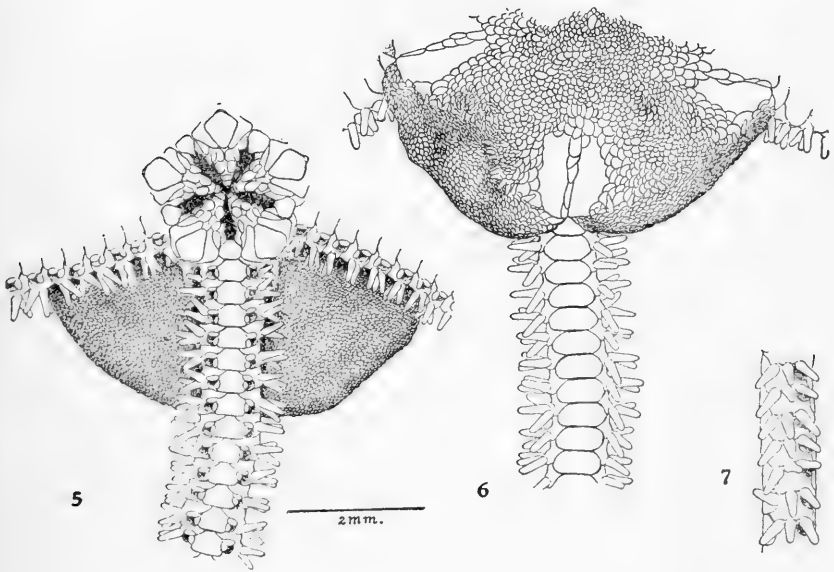
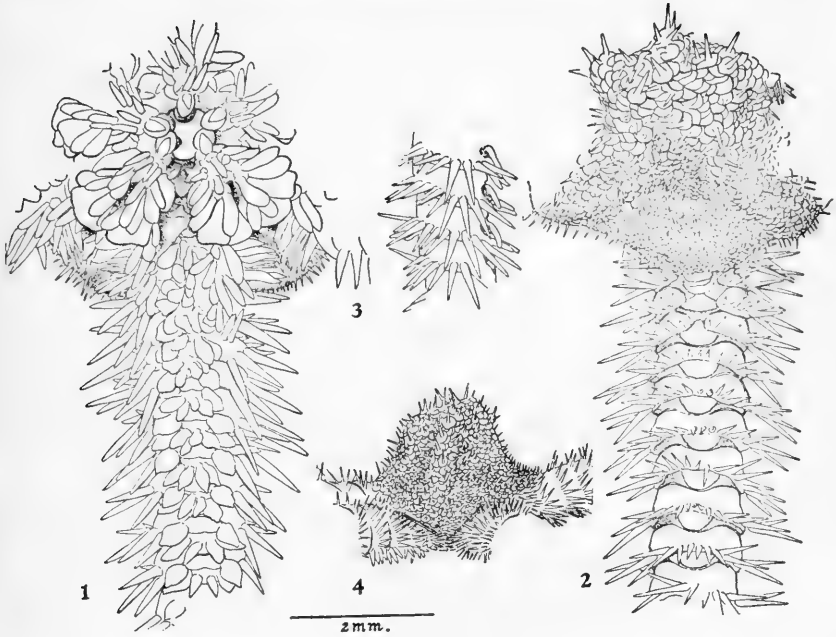
## PLATE 3

*Ophiomyces multispinus*, new species

- FIG. 1. Under view
- FIG. 2. Upper view
- FIG. 3. Side arm view
- FIG. 4. Side view of disk

*Ophiophragmus ophiactoides*, new species

- FIG. 5. Under view
- FIG. 6. Upper view
- FIG. 7. Side arm view



## PLATE 4

*Ophiophragmus papillatus*, new species

FIG. 1. Under view

FIG. 2. Upper view

FIG. 3. Side arm view

*Ophiophragmus lonchophorus*, new species

FIG. 4. Upper view

FIG. 5. Under view

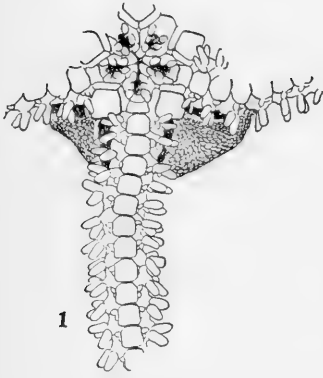
FIG. 6. Side arm view

*Amphichondrius laevis*, new species

FIG. 7. Under view

FIG. 8. Upper view

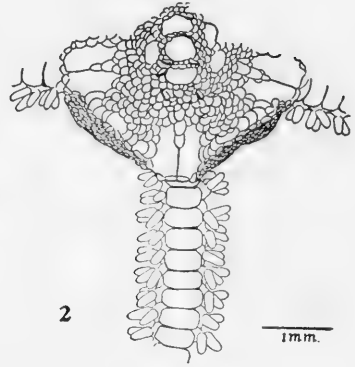
FIG. 9. Side arm view



1

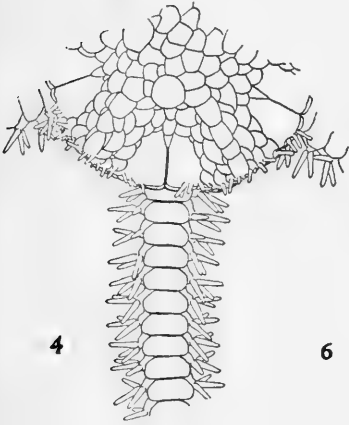


3



2

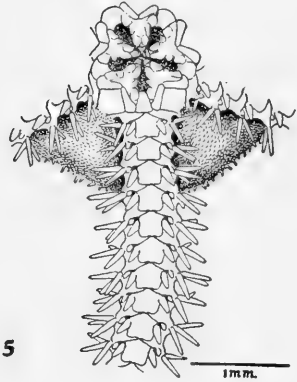
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4

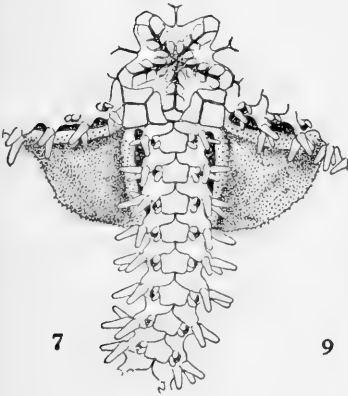


6



5

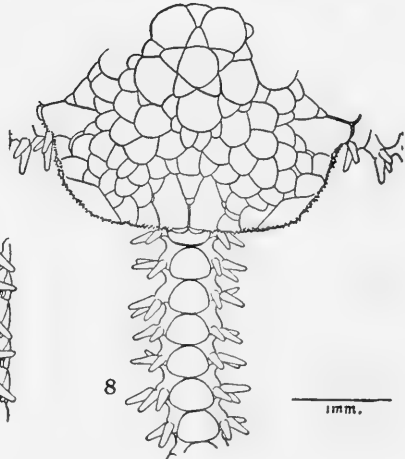
1 mm.



7



9



8

1 mm.

## PLATE 5

*Amphiodia sculptilis*, new species

- FIG. 1. Under view  
FIG. 2. Upper view  
FIG. 3. Side arm view

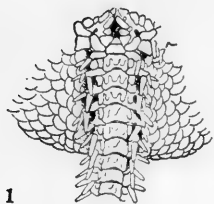
*Ophiocnida californica*, new species

- FIG. 4. Upper view  
FIG. 5. Under view  
FIG. 6. Side arm view

*Amphioplus philohelminthus*, new species

- FIG. 7. Under view  
FIG. 8. Upper view  
FIG. 9. Side arm view

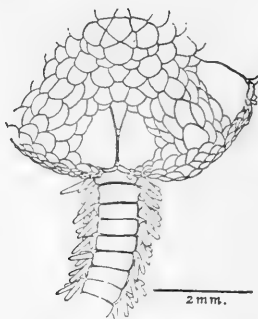




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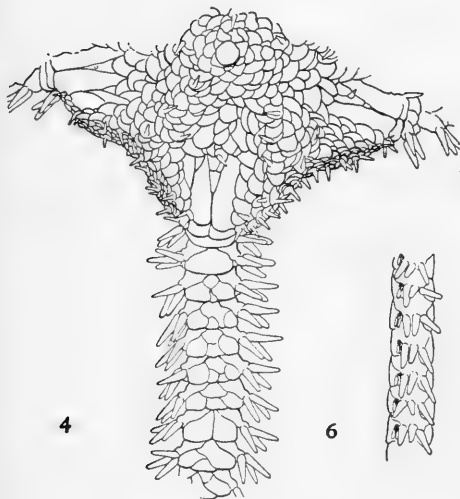


3



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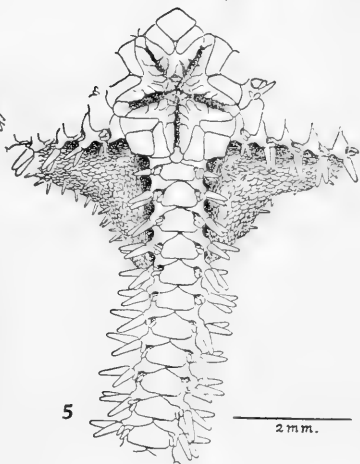
2 mm.



4

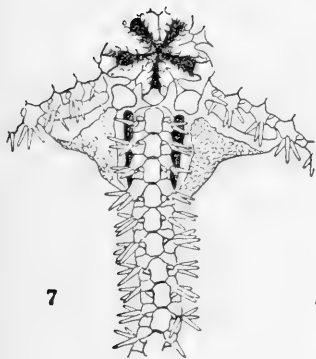


6



5

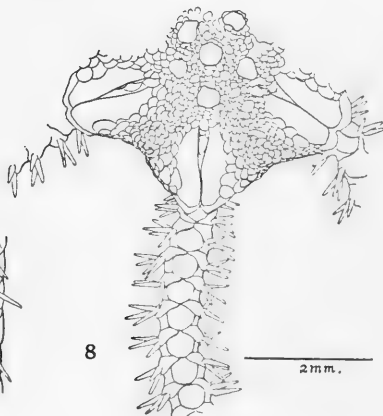
2 mm.



7



9



8

2 mm.

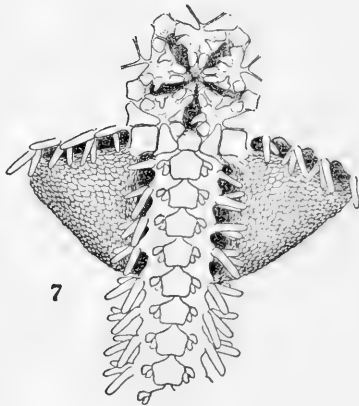
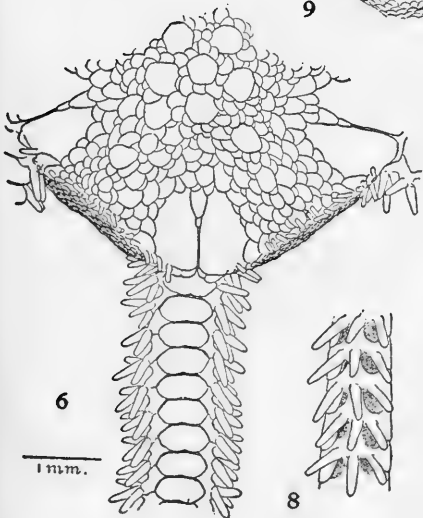
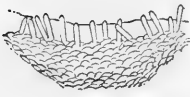
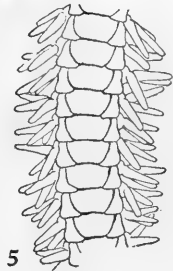
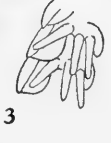
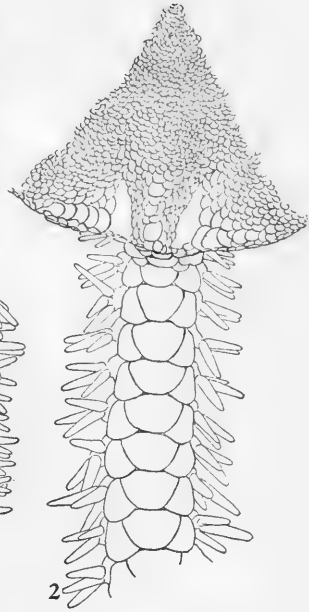
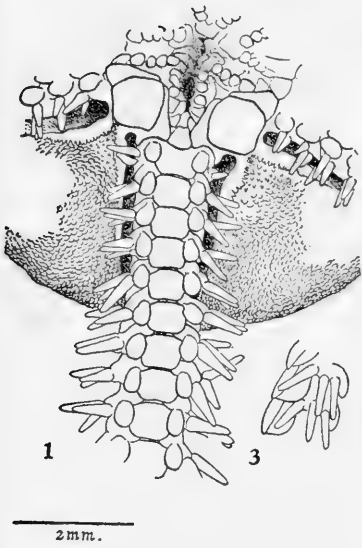
## PLATE 6

*Ophionereis dictyota*, new species

- FIG. 1. Under view
- FIG. 2. Upper view
- FIG. 3. Side arm view
- FIG. 4. Side arm view, mid arm
- FIG. 5. Upper arm view, mid arm

*Ophiophragmus stellatus*, new species

- FIG. 6. Upper view
- FIG. 7. Under view
- FIG. 8. Side arm view
- FIG. 9. Side view of disk showing  
marginal disk papillae



## PLATE 7

*Ophiomysidium leurum*, new species

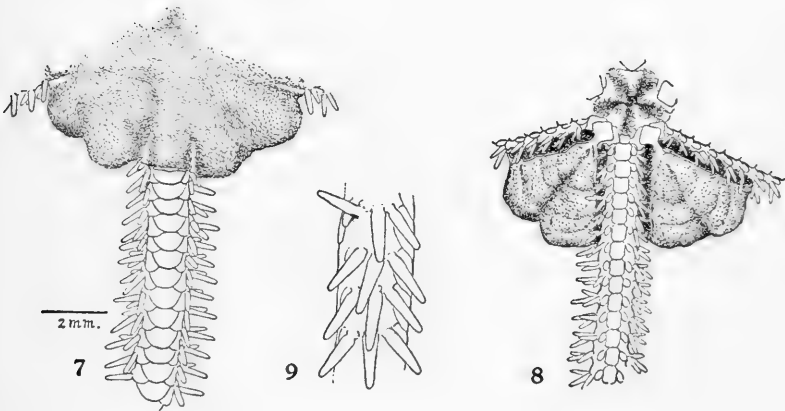
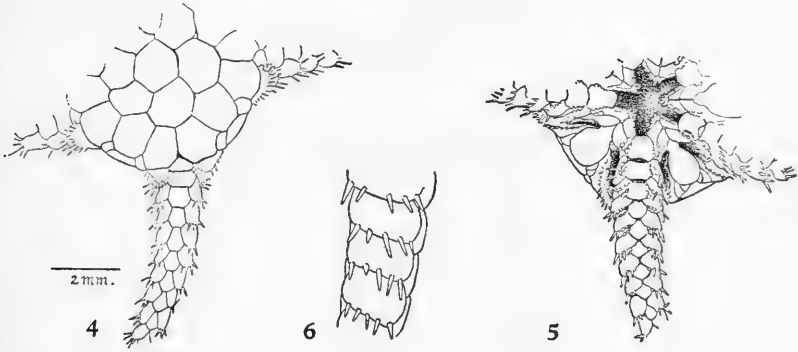
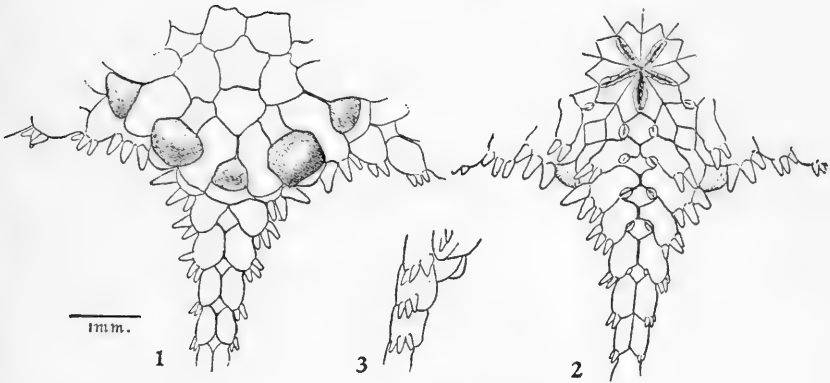
- FIG. 1. Upper view  
FIG. 2. Under view  
FIG. 3. Side arm view

*Amphiophiura irregularis*, new species

- FIG. 4. Upper view  
FIG. 5. Under view  
FIG. 6. Side arm view

*Ophionereis perplexa*, new species

- FIG. 7. Upper view  
FIG. 8. Under view  
FIG. 9. Side arm view



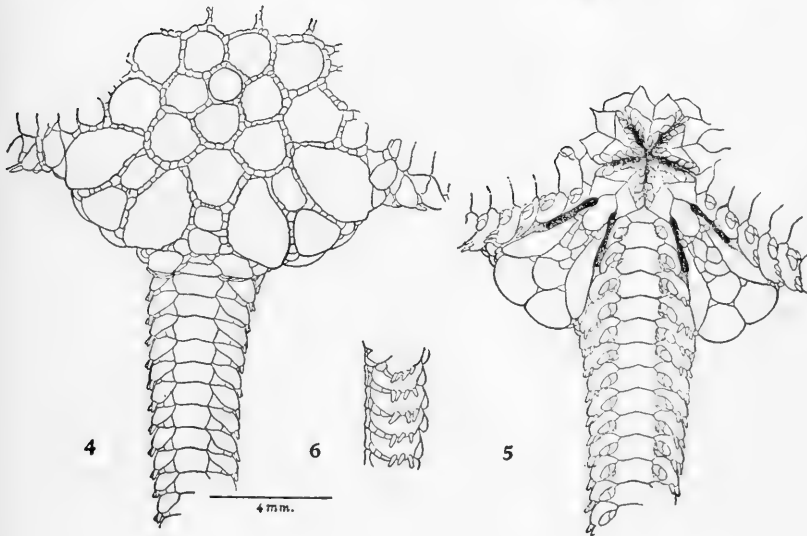
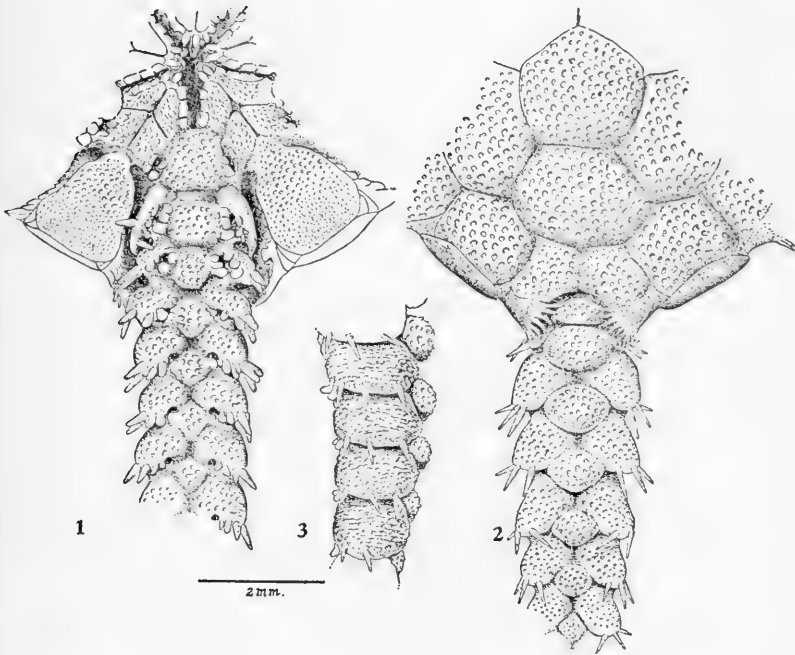
## PLATE 8

*Amphiophiura paucisquama*, new species

- FIG. 1. Under view  
FIG. 2. Upper view  
FIG. 3. Side arm view

*Ophiolepis plateia*, new species

- FIG. 4. Upper view  
FIG. 5. Under view  
FIG. 6. Side arm view



## PLATE 9

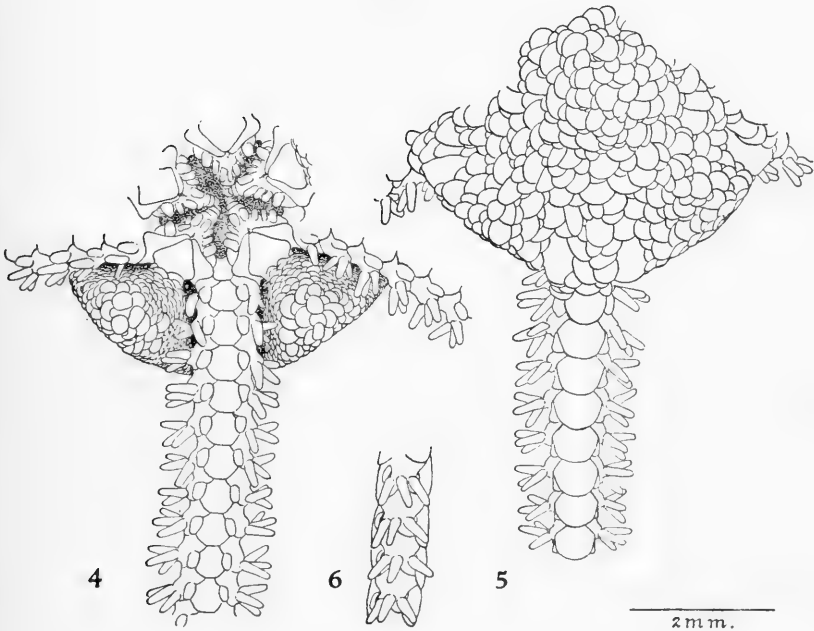
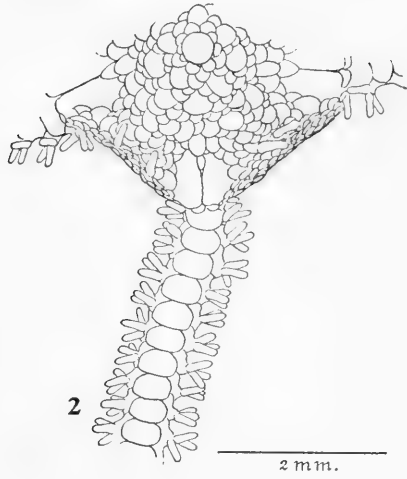
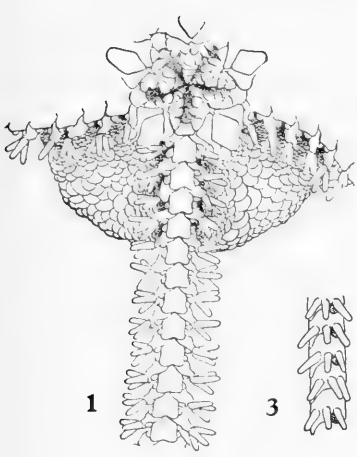
*Ophiophragmus disacanthus*, new species

- FIG. 1. Under view  
FIG. 2. Upper view  
FIG. 3. Side arm view

*Ophiodesmus amphilogus*, new species

- FIG. 4. Under view  
FIG. 5. Upper view  
FIG. 6. Side arm view







REPORTS ON THE COLLECTIONS OBTAINED BY ALLAN HANCOCK PACIFIC EXPEDITIONS OF  
VELERO III OFF THE COAST OF MEXICO, CENTRAL AMERICA, SOUTH AMERICA,  
AND GALAPAGOS ISLANDS IN 1932, IN 1933, IN 1934, IN 1935,  
IN 1936, IN 1937, IN 1938, IN 1939, AND IN 1940.

THE HOLOTHURIOIDEA COLLECTED BY  
THE VELERO III DURING THE  
YEARS 1932 to 1938  
PART I, DENDROCHIROTA  
(PLATES 10-30)

By ELISABETH DEICHMANN



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ALLAN HANCOCK PACIFIC EXPEDITIONS  
VOLUME 8, NUMBER 3  
ISSUED JUNE 20, 1941

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THE HOLOTHURIOIDEA COLLECTED BY THE VELERO  
III DURING THE YEARS 1932 to 1938

PART I, DENDROCHIROTA

(PLATES 10-30)

ELISABETH DEICHMANN

INTRODUCTION

The Panamic region, that is, the stretch of coast which extends from Cerros Island on the western coast of Lower California and southward (including the entire Gulf of California) to Ecuador (with the Galapagos Islands) and Peru, forms zoogeographically a natural unit. As far as holothurians are concerned, it has been almost unknown, undoubtedly because the coast in most localities is so exposed that many species live at a greater depth than in other places, as, for example, in the more sheltered bays and coves of the West Indies.

The study of the fauna has tempted zoologists for many years, and as early as 1866 Verrill began to compile lists of Echinoderms and Coelenterates from east and west of Central America. The purpose was chiefly to accumulate data to show the relation of the two faunas to each other. It was Alexander Agassiz's idea that, since so many forms, especially Echinoderms, in the two areas were closely related, one had here a chance to study the effect of separation, or isolation, on the origin of new species, since it was almost certain that the two faunas had once been identical—before the isthmus had been formed. Verrill's lists included 7 species from the Panamic region; of these, 3 are Dendrochirotes. Since then a few more have been described by various workers. The general impression gained was merely that the holothurian fauna was extremely poor and showed some affinities to that of the West Indian seas. It is only recently that the Allan Hancock Expeditions with the *Velero III* have been able to explode this myth and show that the holothurian fauna actually is as rich as that of the West Indies. During the past six years the *Velero III* has made extensive collections in the Panamic region and particularly dredgings in that zone hitherto so sadly neglected, between 10-100 fathoms. Almost all the species hitherto described from the region during the last hundred years have been secured and in addition a large number of new species. Thanks to the thorough and methodical way in which

the collecting has been undertaken—in most cases under the able leadership of Dr. Waldo L. Schmitt, with the enthusiastic support of several young collectors—the material now assembled appears to be so complete that one dares assert that very few additional species are to be expected. Future investigators must be content to secure more material of the species now known or additional information about the distribution of the individual species.

The collections consist chiefly of material collected in less than 100 fathoms, or what is usually referred to as shallow water, in contrast to the truly deep sea. The species are distributed among the following four orders—Dendrochirota, Aspidochirota, Molpadonia, and Apoda; the fifth order, Elaspoda, made up exclusively of deepwater forms and a few Arctic species from shallow water, was not met with by the *Velero*. The Dendrochirota and Aspidochirota have the greatest numbers of representatives. The material of the former order has proved to be the most interesting, because it includes a large number of new species which are restricted to the Panamic region or have close relatives in the West Indies, while the representatives of the Aspidochirota are mostly widespread species. The Molpadonia and Apoda have so few representatives that it is difficult to make any general statements about their relations to other faunas.

In the following account all the Dendrochirota hitherto known from the Panamic region are monographically treated. Besides the material secured by the *Velero III*, a few undescribed specimens from the M.C.Z. have been included to make the work complete. Much use has also been made of Selenka's old types and other material from the Panamic region which I have had occasion to examine at various times. Special attention has been paid to comparison with the holothurians from adjacent waters, that is, the West Indian, Californian, Chilean, and Hawaiian seas. As far as the Dendrochirotes are concerned, one may say that the affinities are definitely with the West Indian fauna, while a few forms have related representatives in Californian waters. Several species are also known from the Chilean coast, but relationship to the Hawaiian fauna seems to be nil. More extensive explorations may, however, show that a somewhat richer Dendrochirote fauna exists in Hawaii than has hitherto been supposed.

It is a great pleasure to thank the Allan Hancock Foundation for the privilege of studying this valuable collection, thus enabling me to realize my long-felt desire to write a monograph on the holothurians of the

Panamic region. Particularly do I wish to thank Dr. Irene McCulloch for her unflagging interest in this paper and for the amount of her own valuable time which she unstintingly has given whenever I worked in Los Angeles.

#### COMPOSITION OF THE FAUNA

From the Panamic region 15 species of Dendrochirota, valid and dubious, were described up to 1936; during the following years 6 new species were added, thus bringing the total number up to 21.

The present monograph treats 43 species which are valid and 3 which are so poorly described that they must be completely rejected, unless the types should be rediscovered. Three of the 43 valid species are probably extraterritorial—*Pachythyone rubra* (H. L. Clark) and *Thyonepsolus nutriens* H. L. Clark, not known with certainty south of Santa Cruz Island, southern California, and *Psolus patagonicus* Ekman from the Cape Horn region. All the valid species have been examined; of these, 34 are represented in the Allan Hancock Foundation collections, while the remaining 9 have been studied in the M.C.Z. and in the U.S.N.M.; in five cases the types have been available. Of the 34 species in the Hancock collections 16 are new, while the 17th new species came from the collections of the *Stranger*, which are deposited in the M.C.Z.

#### LIST OF DENDROCHIROTA FROM THE PANAMIC REGION, INCLUDING A FEW FROM THE ADJACENT NORTHERN AND SOUTHERN WATERS†

Cucumaria californica Semper p. 79	Leptopentacta nina, new species p. 97
Cucumaria chilensis Ludwig p. 80	Pentacta peruana (Semper) p. 99
Cucumaria dubiosa Semper p. 81	Thyonacta mexicana, new species p. 101
Cucumaria crax, new species p. 83	Thyone neofusus, new species p. 104
Cucumaria godeffroyi Semper (0)* p. 83	Thyone bidentata, new species p. 105
Pentamera zacae Deichmann (0) p. 85	Thyone parafusus, new species p. 106
Pentamera beebei Deichmann (0) p. 86	Thyone strangeri, new species p. 107
Pentamera chierchia (Ludwig) p. 86	Neothyone gibber (Selenka) p. 109
Pentamera chiloensis (Ludwig) p. 88	Neothyone panamensis (Ludwig) p. 112
Pentamera panamensis Verrill (0)* p. 89	Neothyone gibbosa, new species p. 113
Neopentamera anxigua, new genus, new species p. 90	Pachythyone rubra (H. L. Clark) (0) p. 115
Apentamera lepra, new genus, new species p. 92	Pachythyone lugubris (Deichmann) p. 116
Leptopentacta nova, new species p. 95	Pachythyone pseudolugubris, new species p. 116
Leptopentacta panamica, new species p. 96	Athyone glasselli (Deichmann) (0) p. 119
	Anaperus peruviana (Lesson) (0)* p. 120

†Dubious species are marked with an \*; those not secured by the Allan Hancock Expeditions are marked with (0).

Euthyonidium ovulum (Selenka) p. 124	Thyonepsolus hancocki, new species p. 140
Euthyonidium veleronis, new species p. 126	Psolidium dorsipes Ludwig p. 143
Athyonidium chilensis (Semper) p. 127	Psolidium eubullatum, new species p. 144
Pattalus mollis Selenka p. 130	Psolidium ekmani, new species p. 145
Phyllophorus aculeatus Ludwig (0) p. 133	Psolidium planum, new species p. 145
Phyllophorus zacae Deichmann p. 134	Psolus squamatus (Koren), var. segregatus Perrier (0) p. 147
Thyonepsolus nutriens H. L. Clark p. 138	Psolus patagonicus Ekman (0) p. 148
Thyonepsolus beebei Deichmann p. 139	Psolus diomedea Ludwig p. 149
Thyonepsolus veleronis, new species p. 140	

LIST OF STATIONS AT WHICH DENDROCHIROTE HOLOTHURIANS WERE COLLECTED

- 11-32 (?). January 12, 1932. Conway Bay, Indefatigable Island, shore, Galapagos.  
*Thyonepsolus nutriens* H. L. Clark  
(Possibly some error in the station number.)
- 73-33. February 13, 1933. Albemarle Island, Cartago Bay, shore, Galapagos.  
*Pentamera chierchia* (Ludwig)
- 80-33. February 15, 1933. Duncan Island, Smitty's Shore, collecting. In coral.  
*Pentamera chierchia* (Ludwig)
- 132-34. January 4, 1934. Braithwaite Bay, Socorro Island, Mex., 40 fms.  
*Pentamera chierchia* (Ludwig)  
*Neothyone gibber* (Selenka)
- 143-34. January 11, 1934. Wenman Island, Galapagos, 100-150 fms.  
*Psolus diomedea* Ludwig
- 145-34. January 12, 1934. North end of Albemarle Island, Galapagos, 6-7 fms.  
*Pachythyone pseudolugubris*, new species
- 147-34. January 13, 1934. South of Tagus Cove, Albemarle Island, Galapagos, 30 fms.  
*Thyonepsolus veleronis*, new species
- 166-34. January 19, 1934. Charles Island, Galapagos; shore collecting on Black Beach.  
*Neothyone gibbosa*, new species
- 189-34. January 25, 1934. Cartago Bay, Albemarle Island, Galapagos; shore, among *Porites*.  
*Pentamera chierchia* (Ludwig)



190-34. January 26, 1934. Lat.  $0^{\circ}55'S.$ , Long.  $90^{\circ}30'W.$ , 58-60 fms.  
Sand.

*Pentamera chiloensis* (Ludwig)

*Thyone neofusus*, new species

*Phyllophorus zaca* Deichmann

209-34. February 9, 1934. North of Point Sta. Elena, La Libertad,  
Ecuador, 8-10 fms.

*Pentamera chiloensis* (Ludwig)

212-34. February 10, 1934. La Plata Island, Ecuador, dredging,  
45-55 fms. Sand, shale, rock, mud.

*Psolidium eubullatum*, new species

213-34. February 10, 1934. La Plata Island, Ecuador, 7-10 fms.

*Pentamera chiloensis* (Ludwig)

*Thyonepsolus hancocki*, new species

*Psolidium eubullatum*, new species

*Psolidium ekmani*, new species

*Psolus diomedea* Ludwig

244-34. February 21, 1934. Bahia Honda, Panama, dredging between  
Medidor and Pacora islands, 30-35 fms.

*Thyonacta mexicana*, new species

245-34. February 21, 1934. Bahia Honda, Panama, dredging off north-  
west point of Pacora Island, 15-25 fms.

*Thyone bidentata*, new species

249-34. February 22, 1934. Bahia Honda, Panama, dredging in 15-20  
fms. Outside of island, south of bay. Rock.

*Thyone bidentata*, new species

251-34. February 22, 1934. Secas Islands, Panama, dredging south and  
west of group in 15 fms. Rock.

*Thyone bidentata*, new species

259-34. February 28, 1934. Tangola Tangola, Mex., 15-20 fms.

*Leptopentacta panamica*, new species

261-34. March 1, 1934. Tangola Tangola, Mex., 15-20 fms.

In coral.

*Cucumaria californica* Semper

*Euthyonidium ovulum* (Selenka)

*Thyonepsolus beebei* Deichmann

- 264-34. March 2, 1934. South and west of White Friar Island, Petatlan Bay, Mex., 25 fms.  
*Pachythyone pseudolugubris*, new species  
*Pentacta peruana* (Semper)
- 272-34. March 4, 1934. Tenacatita Bay, Mex., dredging in 25 fms., between white rocks and bay. Coarse sand.  
*Thyone parafusus*, new species
- 275-34. March 4, 1934. Off Navidad Head, Tenacatita Bay, Mex., 25-35 fms.  
*Leptopentacta panamica*, new species  
*Thyone bidentata*, new species  
*Thyone parafusus*, new species
- 281-34. March 7, 1934. West coast of L. Calif., Santa Maria Bay, 35-40 fms., 1 mile west of Hughes Point.  
*Leptopentacta nova*, new species
- 283-34. March 9, 1934. Off Thurloe Point, Thurloe Bay, west coast of L. Calif., 8-10 fms.  
*Cucumaria crax*, new species  
*Pachythyone lugubris* (Deichmann)  
*Thyonepsolus beebei* Deichmann
- 286-34. March 9, 1934. Thurloe Point, west coast of L. Calif. Shore collecting.  
*Cucumaria californica* Semper
- 287-34. March 10, 1934. Cerros Island, west coast of L. Calif., 10-15 fms. (close to kelp beds).  
*Pachythyone lugubris* (Deichmann)
- 315-35. December 8, 1934. Indefatigable Island, opposite Gordon Rocks. In corals.  
*Pentamera chierchia* (Ludwig)
- 365-35. January 10, 1935. Off southeast corner of Lorenzo Island, Callao, Peru, 10 fms.  
*Cucumaria dubiosa* Semper
- 366-35. January 10, 1935. Between rocks south of Lorenzo Island, Callao, Peru.  
*Cucumaria dubiosa* Semper
- 375-35. January 13, 1935. Independencia Bay, Peru, shore.  
*Pattalus mollis* Selenka
- 384-35. January 14, 1935. Independencia Bay, Peru, 5 fms.,  $\frac{3}{4}$  mile off shore, east side of bay.  
*Cucumaria dubiosa* Semper

- 391-35. January 17, 1935. Lobos de Afuera, Peru, shore of main island with lighthouse, rocks.  
*Neothyone gibber* (Selenka)  
*Neothyone gibbosa*, new species  
*Pattalus mollis* Selenka
- 401-35. January 19, 1935. Manta, Ecuador, 1 fm., below first rocky point.  
*Pentamera chierchia* (Ludwig)
- 423-35. January 25, 1935. Port Utria, Colombia, 20 fms., close to shore.  
*Leptopentacta panamica*, new species  
*Thyone bidentata*, new species
- 429-35. January 27, 1935. Octavia Bay, Colombia, 30-35 fms., north end of channel. Coarse sand and gravel.  
*Psolus diomedeeae* Ludwig
- 431-35. January 27, 1935. Octavia Bay, Colombia, 45 fms., north of Octavia Strait, south end of channel.  
*Psolus diomedeeae* Ludwig
- 464-35. February 8, 1935. Playa Blanca, Costa Rica, 2 fms., in coral, south shore of bay.  
*Pentamera chierchia* (Ludwig)
- 465-35. February 8, 1935. Playa Blanca, Costa Rica, shale between beach and rocky reef.  
*Euthyonidium veleronis*, new species  
*Neothyone gibbosa*, new species
- 466-35. February 9, 1935. Parker Bay, Costa Rica, shore of small island at north side of bay.  
*Cucumaria californica* Semper  
*Cucumaria dubiosa* Semper  
*Neothyone gibber* Selenka
- 467-35. February 9, 1935. Parker Bay, Costa Rica, 2 fms. Rock and algae.  
*Pentamera chierchia* (Ludwig)
- 473-35. February 9, 1935. Parker Bay, Costa Rica, 2 fms., in coral.  
*Pentamera chierchia* (Ludwig)  
*Neothyone gibber* (Selenka)
- 517-36. February 25, 1936. East side of San Francisco Island, Gulf of Calif., 15 fms.  
*Phyllophorus zaca* Deichmann

- 521-36. February 27, 1936. Agua Verde Bay, Gulf of Calif., 5-10 fms.  
*Thyonepsolus hancocki*, new species
- 527-36. February 28, 1936. South of Mangles Anchorage, Gulf of Calif., shore.  
*Cucumaria californica* Semper
- 529-36. March 1, 1936. Off San Francisquito Bay, Gulf of Calif., 165 fms.  
*Thyonepsolus hancocki*, new species  
*Psolus diomedeeae* Ludwig
- 537-36. March 2, 1936. Spit, north of mill site, Angeles Bay, Gulf of Calif., shore.  
*Cucumaria californica* Semper
- 540-36. March 3, 1936. Puerto Refugio, Angel de la Guardia Island, Gulf of Calif., shore.  
*Neothyone panamensis* (Ludwig)
- 545-36. March 4, 1936. Puerto Refugio, Angel de la Guardia Island, Gulf of Calif., west of rock spit at river wash, shore.  
*Neothyone gibbosa*, new species
- 554-36. March 8, 1936. Parallel to Angel de la Guardia Island, Gulf of Calif., east side, 10 fms.  
*Thyonacta mexicana*, new species
- 557-36. March 8, 1936. Off White Rock, Isla Partida, Gulf of Calif., 45 fms.  
*Apentamera lepra*, new species
- 562-36. March 10, 1936. North of San Esteban Island, Gulf of Calif., 20-70 fms.  
*Thyonacta mexicana*, new species
- 591-36. March 16, 1936. Port Escondido, shore, L. Calif., rock.  
*Neothyone gibbosa*, new species  
*Euthyonidium ovulum* (Selenka)
- 596-36. March 16, 1936. Port Escondido, Gulf of Calif., 20 fms.  
*Pentamera chierchia* (Ludwig)
- 617-37. March 2, 1937. San Juanico Bay, southern end of L. Calif., 24 fms.  
*Cucumaria californica* Semper
- 623-37. March 4, 1937. Cabeza Ballena, east of Cape San Lucas, L. Calif., shore.  
*Cucumaria californica* Semper

633-37. March 6, 1937. San Gabriel Bay, Espiritu Santo Island, Gulf of Calif., 18 fms.

*Thyonacta mexicana*, new species

677-37. March 15, 1937. Ildefonso Island, Gulf of Calif., 50 fms.

*Pentamera chiloensis* (Ludwig)

679-37. March 15, 1937. Outside of Concepcion Bay, Gulf of Calif., 30 fms.

*Thyone bidentata*, new species

683-37. March 15, 1937. Outside of Concepcion Bay, Gulf of Calif., 12 fms.

*Cucumaria californica* Semper

*Pentamera chierchia* (Ludwig)

*Neopentamera anexigua*, new species

*Thyone bidentata*, new species

*Pachythyone pseudolugubris*, new species

686-37. March 16, 1937. Concepcion Bay, L. Calif., 12 fms.

*Thyone bidentata*, new species

699-37. March 19, 1937, Angeles Channel, Gulf of Calif., 30 fms.

*Cucumaria chilensis* Ludwig

719-37. March 24, 1937. Consag Rock, Gulf of Calif., 6-8 fms.

*Thyonacta mexicana*, new species

744-37. April 1, 1937. Near Point Piaxtla, Sinaloa, Gulf of Calif., 6-8 fms.

*Pachythyone pseudolugubris*, new species

*Psolidium dorsipes* Ludwig

780-38. January 14, 1938. Chatham Bay, Cocos Island, Costa Rica, 40-47 fms.

*Psolus diomedea* Ludwig

784-38. January 17, 1938. Darwin Bay, Tower Island, Galapagos, Middle Beach, shore.

*Pentamera chierchia* (Ludwig)

792-38. January 20, 1938. Off Daphne Minor Island, Galapagos, 70-80 fms.

*Psolus diomedea* Ludwig

814-38. January 28, 1938. North of Hood Island, Galapagos, 20-40 fms.

*Thyone neofusus*, new species

- 816-38. January 29, 1938. North of Hood Island, Galapagos, 50-100 fms.  
*Phyllophorus zaca* Deichmann
- 820-38. February 6, 1938. San Nicholas Bay, Peru, 10-25 fms.  
*Pattalus mollis* Selenka
- 824-38. February 7, 1938. San Juan Bay, Peru, 15-20 fms.  
*Cucumaria californica* Semper (poor specimen)
- 828-38. February 8, 1938. San Juan Bay, Peru, shore.  
*Athyonidium chilensis* (Semper)  
*Pattalus mollis* Selenka
- 831-38. February 9, 1938. Independencia Bay, Peru, east side of bay, shore.  
*Athyonidium chilensis* (Semper)
- 833-28. February 10, 1938. Independencia Bay, Peru, off north entrance, 8 fms.  
*Pentamera chiloensis* (Ludwig)
- 837-38. February 11, 1938. North Chincha Island, Peru, shore.  
*Pattalus mollis* Selenka
- 844-38. February 14, 1938. Lobos de Afuera Island, Peru, shore.  
*Neothyone gibber* (Selenka)  
*Neothyone panamensis* (Ludwig)  
*Neothyone gibbosa*, new species  
*Euthyonidium ovulum* (Selenka)  
*Pattalus mollis* Selenka
- 845-38. February 15, 1938. Sechura Bay, Peru, 9.5 fms.  
*Psolidium planum*, new species
- 850-38. February 23, 1938. Cape San Francisco, Ecuador, 15 fms.  
*Leptopentacta nina*, new species
- 854-38. February 24, 1938. Gorgona Island, Colombia, north of island, mud, rocks, 40-60 fms.  
*Thyonepsolus hancocki*, new species  
*Psolidium planum*, new species  
*Psolus diomedea* Ludwig
- 863-38. March 1, 1938. Bahia Honda, Panama, off North Island, 30-50 fms.  
*Apentamera lepra*, new species  
*Psolidium dorsipes* Ludwig  
*Psolidium ekmani*, new species

## Order DENDROCHIROTA

*Diagnosis.*—Plankton feeding holothurians with dendritic tentacles, rarely fingerlike; number varying from 10, the 2 ventral often smaller, in some cases less than 10, or 12-20, up to 30 in a few genera. Feet arranged along the ambulacra or also scattered in the interambulacra; terminal and dorsal ones often modified into papillae.

Internally a calcareous ring, simple, or complex, with shorter or longer posterior prolongations. One or more stone canals, one or more Polian vesicles; usually a well-developed muscle stomach; intestine with the 3 loops attached by mesenteries; that of the third loop may run along the right or the left side of the midventral muscle band. Retractor muscles well developed, distinctly separated from the longitudinal muscles. Respiratory trees mostly well developed, usually attached to the lateral interambulacra. Gonads forming 2 tufts with a shorter or longer genital stolon, and shorter or longer tubes, usually divided near the base.

Spicules tables, cups, buttons, or plates, et cetera, in some cases large scales covering the entire body, or the dorsal side and the ends. Feet with large end plate, or a vestige, or end plate completely reduced. Tentacles with larger or smaller plates or rods, often rosettes, or no spicules at all. In many forms the spicules disappear normally with advancing age, partly or completely.

*Remarks.*—The order seems to be comparatively young. The members occur with few exceptions in shallow water and the distribution of the individual species is rather restricted aside from the deepwater forms and certain Arctic and Antarctic forms.

### KEY TO THE FAMILIES OF DENDROCHIROTA

1. Part of the ventral side developed as a thin-walled creeping sole.  
 . . . . . III. *Psolidae* p. 135
1. No part of the ventral side developed as a thin-walled creeping sole.  
 . . . . . II.
2. Tentacles 10 in number or less. . . . . I. *Cucumariidae* p. 76
2. Tentacles more than 10 in number (12-20, 30).  
 . . . . . II. *Phyllophoridae* p. 122

*Remarks.*—The old division of dekachirote and polychirote forms, designating those with 10 tentacles (or less) and those with more than 10, has been abandoned, as it is completely artificial.

## CHARACTERS USED FOR IDENTIFICATION

*Macroscopical characters*

*Size.*—Where full-grown specimens are available, size constitutes a fairly good character, although some caution must be used, as many species are able to contract their bodies to an unbelievable degree, while others rarely change much. Most Dendrochirotes are small forms, that is, less than 10 cm. long, a number measure between 10-15 cm., and few are large, above 20 cm. The largest forms are known to reach a length of 50 cm. when fully expanded. The chief difficulty about using size for identification is that one so often encounters young individuals. Specimens 1 cm. long are usually difficult to identify; the feet are frequently not distributed in their typical pattern, and the spicules may be very different from what they are in more mature individuals. Where very young specimens are involved, the characters, "feet ambulacral" or "feet interambulacral," cannot be used, as all the forms with interambulacral feet begin with feet in the ambulacra only. In some species the interambulacral feet begin to appear when the animal is less than 1 cm. long, but in others they appear much later, when the animal is 2-3 cm. long.

For that matter, very little is known about the growth rate of the Dendrochirotes or any order of seacucumbers. Mitsukuri found that the Japanese Aspidochirote form *Stichopus japonicus* reaches the unbelievable length of 25 cm. in a little over a year, but such a rapid growth is probably an exception, and under no circumstances can it be assumed to be the normal in the Dendrochirotes without definite proof. Smaller species may probably reach their full length in one or two years; larger forms, as, for example, *Thyone briareus* (Lesueur), require undoubtedly four to five years to reach their full size.

*Tentacles.*—The full number is quickly reached in the "dekachirote" forms. In the "polychirote" forms (those which have tentacles arranged in 2 well-defined circles and definitely of two sizes) seem to develop the full number before they have reached the length of about 1 cm., while in the species which have the 2 circles indistinctly set off and with tentacles of varying size the full number seems to be reached rather late. In many "dekachirote" forms the two ventral tentacles are much smaller than the others, and the difference in size is retained throughout the animal's life. In a few species the number of tentacles falls below ten in various deep sea forms and in that case the tentacles are often unbranched.

*Tube feet.*—The arrangement of the tube feet is of importance in reasonably mature individuals and constant for the different species. The



number of feet increases with advancing age. Many descriptions, "feet in 3-4 rows," "single row, etc.," are of little value except when the animal is well expanded and its size also is given. In some species the feet are heavily armed with spicules and unable to retract; in others equally well armed they may be withdrawn. Where the feet contain few spicules, the feet are often completely retractile. In younger individuals the arrangement of the feet is often untypical, as mentioned above.

*Inner organs.*—Much space has usually been devoted to the inner anatomy of the Dendrochirotes, but with the exception of the calcareous ring, the stone canal, Polian vesicle, and gonads, all other organs may usually be ignored. A few species are said to lack a muscle stomach, but I am not sure that the observation is correct. The course of the intestine and the attachments of the mesenteries to the body wall are fairly stable characters, although some variation has been noted, but the contracted, contorted condition wherein the material often is preserved, or the complete loss of inner organs, makes it impossible to use these structures consistently. The *Cucumariidae* seem typically to have the third mesentery attached on the right side of the midventral muscle band, the *Phyllophoridae* seem to have it attached to the left, and the *Psolidae* have it either way. The thickness or thinness of the longitudinal muscles, the place of attachment for the retractors, the shape of the branches of the respiratory trees, et cetera, are all characters of rather dubious value and the use of them has often caused misidentification.

*Calcareous ring.*—The calcareous ring presents a character of utmost importance, as certain types invariably seem to be combined with a certain arrangement of the tube feet and certain types of spicules.

The calcareous ring is designated as simple when the radials and interradials have fairly low, broad basal portions with shorter or longer anteriorly projecting teeth, while the posterior margin may be almost straight or undulated, sometimes with faint protuberances on the radials. In the complex ring the radials have distinct posterior prolongations, the so-called "tails"; and the body of the radials may be deeply cleft, sometimes almost to the base of the anterior tooth. In some species the tails may be secondarily more or less resorbed or hidden in the tissue and hence less noticeable. The interradials either are fairly broad, overlapping the radials as heart-shaped or diamond-shaped pieces, or are narrow, often quite tall, rectangular, and firmly united with the radials; rarely are they vestigial; the anterior tooth may be short or long. The complex calcareous ring may furthermore be composed of several smaller pieces as a

mosaic, but this "polyplacous" condition is perhaps not always an entirely reliable character, as in certain species some specimens have polyplacous rings, while in others the condition is little or not at all pronounced—observed in *Pentamera calcigera* (Stimpson).

*Stone canal and Polian vesicle.*—In most *Dendrochirota* there is a single dorsal stone canal with round or oblong head, attached to the dorsal mesentery, or free, and one or two ventral Polian vesicles. In a few species, particularly among the "polychirote" forms, there are several free stone canals and often a large number of Polian vesicles also. In some species the Polian vesicles have been found to be branching, but in most cases they are simple.

*Gonads.*—Only few and scattered observations have been made on the gonads in the holothurians and here also too much emphasis has been laid on the size of these organs in different animals. In *Stichopus japonicus* Mitsukuri observed that the sexually mature individuals, about 3 years old, in short time developed few long tubes of eggs and sperms, which were shed, and the tubes shriveled up and new ones developed in the following year. This condition is probably the typical one in the aspidochirote forms. In the larger *Dendrochirota* it seems as if the gonad tubes increase in size over a period of years. It is possible that some eggs or sperms are developed before the full size of the tubes is reached. In *Thyone briareus* (Lesueur) it has been observed (Kille, 1939) that the number of tubes increases slightly with advancing age. The increase takes place in the anterior part of the gonads, while a few shriveled-up tubes are found posteriorly. A similar observation has been made on *Athyonidium chilensis* (Semper). Very likely smaller, immature tubes will be found to be present in most *Dendrochirotes*, which continue their growth for several years. It is also possible that some of the so-called "hermaphroditic gonads" merely represent the mature and immature portions of a unisexual gonad. In the larger species the number of tubes is large, more than 100 in each tuft; in the smaller and supposedly more short-lived forms the number of tubes in each tuft is low, varying between 5-20 or thereabout, and no immature portion seems to be present. More observations are, however, needed before any definite statements can be made.

#### *Microscopical characters*

The spicules in the integument, feet, introvert, and tentacles form valuable characters for identification of *Dendrochirota* as well as most other holothurians. Certain types of spicules or derivatives of these occur, usually together, and accompany certain anatomical features. The spicules

change considerably during the animal's life, either becoming more complex or degenerating; in some cases they disintegrate almost completely, with the exception of the end plate which normally seems to persist in the species where it is well developed from the beginning; when it is rudimentary in the young individual, it quickly becomes resorbed.

In the integument two layers of spicules are typically present, an external, the function of which is presumably to give roughness to the skin, and an inner layer, which gives stiffness. The spicules in the outer layer seem definitely fixed in their position, usually with the external side rough with spines, often perforating the skin, while the spicules in the inner layer are able to slide over each other when the animal contracts—as the cards in a deck—and these spicules are therefore more smooth and flat. Either layer or both may be reduced or lacking; the inner layer is never present in very young individuals, while the outer layer frequently is lost or reduced with age. Usually the spicules in the 2 layers are extremely different, in other cases they are less sharply differentiated. Common types in the external layer are: the table, a basal plate with a number of pillars (1-6) ending in a varying number of teeth, or the basket (or cup)—a hollow body usually with a number of spines developed on the edge. Other types are oval buttons and plates, often with spines or a rough reticulated mass on the external side. The inner layer consists of regular or irregular buttons or plates, smooth or knobbed. Sometimes also large and more complex bodies may be found.

A few forms have the body covered partly or completely by scales. In that case the external layer of spicules is usually quite insignificant, although it may contain rather interesting types of deposits.

In the tube feet a large end plate is almost invariably present in the species which have well-developed tails on the calcareous ring. Likewise, a well-developed end plate is usually accompanied by supporting tables with a curved disk and a spire of varying development—sometimes the spire is totally absent except in very young individuals, but it is usually possible to ascertain whether a supporting rod is derived from the table type or not. In more papilliform appendages the end plate is usually small or lacking.

No end plate, or a vestigial end plate is usually combined with a simple calcareous ring, and the supporting rods are either simple or provided with a third arm, more or less platelike, often irregularly star shaped.

The introvert (the thin-walled skin between the base of the tentacles and the anteriormost tube feet) often contains characteristic spicules. In the species where the spicules are reduced gradually they are frequently retained here. They usually resemble those found in the external layer of the skin but are often more delicate and more complex. The tentacles may be filled with large perforated plates or rods, or contain minute rods or delicate plates, rarely a mixture of both. Rosettes seem typical of certain species; they are apparently restricted to tropical and subtropical forms and occur often in both the introvert and the tentacles. In many cases the spicules in the tentacles become completely reduced with advancing age.

### Family I. Cucumariidae

#### KEY TO THE GENERA OF CUCUMARIIDAE KNOWN FROM THE PANAMIC REGION

1. Body more or less globose, covered by large, reticulated scales. Deepwater forms. . . . . *Sphaerothuria* Ludwig
1. Body not globose, not covered by large, reticulated scales. . . . . 2
2. Spicules spinous crosses. Deepwater forms. . . . .  
. . . . . *Staurocucumaria* Ekman
2. Spicules not spinous crosses. . . . . 3
3. Feet restricted to ambulacra. . . . . 4
3. Feet also found in the interambulacra. . . . . 7
4. Feet retractile, soft, with end plate reduced or lacking. Spicules plates or buttons, often reduced. . . . .  
. . . . . 1. *Cucumaria* Blainville (*partim*) p. 77
4. Feet not retractile. . . . . 5
5. Skin covered by huge reticulated plates and smaller spicules. Calcareous ring at most with short posterior prolongations. . . . .  
. . . . . 5. *Leptopentacta* H. L. Clark p. 92
5. Skin not covered by huge reticulated bodies. Calcareous ring with long posterior prolongations. . . . . 6
6. Spicules 2-pillared tables, spire sometimes reduced. Feet with large end plate. Spicules rarely reduced. 2. *Pentamera* Ayres p. 84
6. Spicules knobbed buttons, or irregular. Feet with large end plate. . . . . 3. *Neopentamera*, new genus p. 90
7. Feet occur in interambulacra but chiefly in the dorsal ones. 8

- 7. Feet occur in interambulacra but chiefly in the ventral ones. (Thyone s. l.) . . . . . 9
- 8. Dorsal feet normally developed, soft, retractile. Spicules plates or buttons, often reduced. 1. *Cucumaria* Blainville (*partim*) p. 77
- 8. Dorsal feet mostly papilliform. Spicules few or numerous. . 10
- 9. Dorsal interradiial feet few, small, easily overlooked; radial feet numerous. Resembles *Pentamera*.  
. . . . . 4. *Apentamera*, new genus p. 91
- 9. Dorsal feet partly large, wartlike or papilliform. Spicules crowded. . . . . 6. *Pentacta* Goldfuss p. 96
- 10. Spicules numerous, forming a crowded layer. . . . . 11
- 10. Spicules more or less reduced, scattered, or lacking. . . . . 14
- 11. Spicules as 2- or 4-pillared tables. Calcareous ring with long posterior prolongations. . . . . 8. *Thyone* Oken p. 102
- 11. Spicules as knobbed buttons. . . . . 12
- 12. Feet at first comparatively few, in distinct rows along the ambulacra, later crowded in the interambulacra, mostly papilliform. . . . . 7. *Thyonacta*, new genus p. 101
- 12. Feet numerous, but in almost indistinct rows along the ambulacra . . . . . 13
- 13. No external plates covered by reticulum. Either baskets or buttons with spinous handle. . . 9. *Neothyone*, new genus p. 108
- 13. External plates covered by a reticulum. . . . .  
. . . . . 10. *Pachythyone*, new genus p. 114
- 14. Spicules swollen buttons, often obviously derived from tables. Calcareous ring with long, well-developed posterior prolongations. . . . . 11. *Athyone*, new genus p. 118
- 14. Spicules apparently lacking except the end plate in the feet. Calcareous ring with short posterior prolongations sometimes reduced. . . . . 12. *Anaperus* Troschel p. 120

Genus 1. **CUCUMARIA** Blainville

*Diagnosis.*—Dendrochirotes with 10 tentacles, of equal size or the ventral ones smaller. Feet large, soft, in 5 bands, in some forms also scattered in the interradii, particularly dorsally. Calcareous ring low, simple.

Spicules plates or buttons, knobbed or smooth, often reduced. Feet with a vestige of an end plate or none at all; walls supported by rods, often 3 armed, or plates. Introvert and tentacles with perforated plates and rods. The spicules show tendency to become reduced in many forms.

*Type species.*—*Cucumaria frondosa* (Gunnerus).

*Remarks.*—The diagnosis embraces only the members of the genus *Cucumaria* sensu strictiore. The well-known type species is the only representative of the genus in the northern Atlantic, while the northern Pacific, including Bering Sea, harbors 3 large species: *C. japonica* Semper, *C. fallax* Ludwig, and *C. miniata* Brandt. From the west coast of North America a number of smaller forms have been described: *C. vegae* Théel, *C. lubrica* H. L. Clark, *C. curata* Cowles, *C. pseudocurata* Deichmann. From the Panamic and Peruvian-Chilean region 4 species are reported with certainty, while a fifth species, from Chile, imperfectly described, is briefly discussed below.

#### KEY TO THE SPECIES OF *Cucumaria* s. str. KNOWN FROM THE PANAMIC REGION

- |   |  |   |
|---|--|---|
| 1. Spicules small, crackerlike buttons or plates with marginal holes or incisions. . . . .  | 4. <i>Cucumaria crax</i> , new species |   |
| 1. Spicules larger plates and buttons, knobbed to smooth, often reduced in older individuals . . . . .  |  | 2 |
| 2. Feet not restricted to the ambulacra, fairly numerous in the dorsal interambulacra. . . . .  | 3. <i>Cucumaria dubiosa</i> Semper     |   |
| 2. Feet restricted to the ambulacra. . . . .  |  | 3 |
| 3. Tentacles soft, bushy, of equal size. Spicules usually almost lacking in larger individuals (6-10 cm. long), in young individuals as knobbed oblong plates, often with a dentate handle; supporting rods in feet predominantly 3-armed rods. . . . . | 1. <i>Cucumaria californica</i> Semper |   |
| 3. Tentacles rigid with spicules, not bushy, ventral ones small. Spicules strongly knobbed circular plates or smooth ones, usually without a spinous handle. Feet with narrow, bandlike supporting rods. . . . .  | 2. <i>Cucumaria chilensis</i> Ludwig   |   |

*Remarks.*—Not included in the key is *Cucumaria godeffroyi* Semper, which possibly is a strictly southern form. See p. 83.

1. *Cucumaria californica* Semper

Plate 10, Figs. 6-8

*Cucumaria californica* Semper, 1868, p. 235, pl. 39, fig. 16; pl. 40, fig.

10.—Lampert, 1885, p. 147.—Théel, 1886, p. 109; 1886a, p. 8.

Nec *Cucumaria californica* Edwards, 1910, p. 601 (i.e., *C. fallax* Ludwig—an Arctic species, known from Bering Sea).

*Diagnosis*.—Medium-sized form (10 cm.), with soft, bushy tentacles of equal size. Skin soft, slippery; feet large, soft, completely retractile, restricted to the ambulacra. Calcareous ring simple, other anatomical features very nearly as in the type species. Spicules oblong knobbed plates, often with a spinous handle, and 4-holed buttons, frequently reduced or lacking. Feet with a vestige of an end plate and numerous 3-armed perforated supporting rods. Introvert and tentacles with perforated plates or rods, often completely reduced. Color varying from dark slate gray or black to almost white; tentacles seem always to be darkly pigmented.

*Holotype*.—Possibly in Germany.*Type locality*.—Mazatlan, Mexico.*Distribution*.—West coast of Mexico and Central America, possibly to Peru.*Depth*.—From shore to about 100 fms.*Specimens examined*.—Numerous in the U.S.N.M., and the following from the Allan Hancock Expeditions:

- 261-34. Tangola Tangola, Mex., 15-20 fms., March 1, 1934, 4 specimens.
- 286-34. Thurloe Bay, Thurloe Point, L. Calif., Mex., shore, March 9, 1934, 8 specimens.
- 466-35. Parker Bay, Costa Rica, shore, February 9, 1935, 3 specimens.
- 527-36. South of Mangles Anchorage, L. Calif., Mex., shore, February 28, 1936, 1 specimen.
- 537-36. Spit, north of mill site, Angeles Bay, L. Calif., Mex., shore, March 2, 1936, 10 specimens.
- 617-37. San Juanico Bay, L. Calif., Mex., 24 fms., March 2, 1937, 2 specimens.
- 623-37. Cabeza Ballena, east of Cape San Lucas, shore, March 4, 1937, 2 specimens.
- 683-37. Concepcion Bay, L. Calif., Mex., 12 fms., March 15, 1937, 1 specimen.
- 824-38. San Juan Bay, Peru, 15-20 fms., February 7, 1938, 1 specimen.

*Remarks.*—The species seems to be common in the Gulf of California and along the west coast of Mexico and Central America. A single record exists from Peru, possibly an error in labeling. Its soft skin, bushy tentacles, and usually dark coloration make it easy to recognize. In life it is often bright red; in alcohol it fades to white with dark tentacles.

The name *californica* has unfortunately been applied to the common *frondosa*-like form from Bering Sea, *C. fallax* Ludwig. During the *Albatross* expeditions a single specimen of this Arctic form evidently got mixed up with some material from the Galapagos Islands; Edwards, who worked over the material, gave the name *californica* to this specimen with the dubious locality, as well as to the larger individuals of *C. fallax* from Bering Sea (while the smaller individuals were identified as *C. fallax*). The supposedly Galapagos specimen, which shows strong signs of having been dried up, is a typical huge, brownish, *frondosa*-like form and cannot be separated from the individuals of *C. fallax* of the same size collected in the Bering Sea.<sup>1</sup> *Cucumaria californica*, on the other hand, is much smaller and either completely slate gray or black, or the tentacles and part of the anterior end are dark colored. Its spicules are entirely different from those found in *C. fallax*.

## 2. *Cucumaria chilensis* Ludwig

Plate 11, Figs. 3-5

*Cucumaria chilensis* Ludwig, 1875, pl. 6, fig. 11 (used only in the plate explanation).

*Cucumaria exigua* (*partim*) Ludwig, 1874, p. 84.—Lampert, 1885, p. 145.—Théel, 1886, p. 108.

*Diagnosis.*—Medium-sized form. Feet restricted to ambulacra, retractile. Tentacles not bushy, filled with spicules, the 2 ventral ones small. Calcareous ring simple; other anatomical features apparently typical of the genus.

Spicules 4-holed buttons and smooth to knobbed plates. Feet with rudimentary end plate and numerous slender supporting rods, slightly shorter in the dorsal appendages. Introvert and tentacles with large perforated plates and rods. Color yellow, with or without irregular spots, or mottled gray and brown.

*Holotype.*—Hamburg Museum.

*Type locality.*—Chile.

*Distribution.*—Various localities in Chile.

<sup>1</sup> Material in U.S.N.M.



*Depth.*—Not recorded for the type and paratypes.

*Specimens examined.*—A single specimen from *Velero III* Station 699-37, Angeles Channel, Gulf of California, 30 fms., March 18, 1937.

*Remarks.*—The name *chilensis* has been re-established, since it is almost unbelievable that the species from China is identical with the Chilean form. Ludwig evidently considered the 2 species as different and then decided to unite them in spite of the differences which they exhibited. It is not clear from his description whether he found any cross-shaped bodies in the Chilean specimens (present in *G. exigua* from China). The combination of characters, viz., simple ring and small ventral tentacles and the unusually narrow supporting rods in the feet, is such that it seems almost certain that the present species is identical with the one described by Ludwig. Most of the plates found in the *Velero* specimen are considerably more complex than indicated by Ludwig, but simple 4-holed buttons are also present, and it is well known that the spicules are often more or less reduced in this group. (The earlier authors, often on general principle, avoided figuring the more complex spicules, as study of certain holotypes has revealed, and figured only those which could be easily reproduced.)

The *Velero III* specimen measures 3 cm. in length, but is so strongly retracted that it probably measured 10 cm. or more when expanded. Ludwig's types measured about the same, but it is not known whether they were very strongly contracted or not.

### 3. *Cucumaria dubiosa* Semper

Plate 11, Figs. 1-2

*Cucumaria dubiosa* Semper, 1868, p. 238, pl. 39, fig. 19.—Lampert, 1885, p. 151.—Théel, 1886, p. 111.

*Cucumaria leonina* Ludwig, 1898, p. 36.—Ekman 1925, p. 52, text figure 10.

Nec *Cucumaria leonina* Semper, 1868, p. 53, pl. 15, fig. 9.

*Diagnosis.*—Medium-sized form, length up to 10 cm. Feet in 5 bands and numerous in the dorsal interambulacra. Tentacles bushy, of unequal size. Color uniformly parchmentlike (in alcohol). Calcareous ring simple, other features as in the typical forms. Spicules numerous, oblong, knobbed plates, often with spinous handle<sup>2</sup> and 4-holed buttons.

<sup>2</sup> In very young specimens (1 cm. long) a number of almost circular plates with a long narrow handle are found (see Ekman's text figure). Such plates with handles have not been discovered in *Cucumaria lubrica* from the western coast of North America.

Feet with rudimentary end plate, or none at all, and numerous supporting rods, mostly 3 armed. Introvert and tentacles with perforated plates and rods.

*Type*.—Possibly in Germany.

*Type locality*.—Coast of Peru.

*Distribution*.—From Peru to the south end of South America, including Falkland Islands, also Costa Rica. See Ekman, 1925.

*Depth*.—Not recorded for the type.

*Specimens examined*.—Numerous from the following stations of *Velero III*:

- 365-35. Callao, Peru, off southeast corner of Lorenzo Island, 10 fms., January 10, 1935, 21 specimens.
- 366-35. Callao, Peru, between rocks, south of Lorenzo Island, 8 fms., January 10, 1935, 1 young specimen.
- 384-35. Independencia Bay, Peru,  $\frac{3}{4}$  mile off shore, east side of bay, 5 fms., January 14, 1935, 1 young specimen.
- 466-35. Parker Bay, Costa Rica, small island at north side of bay, shore, February 9, 1935, 1 specimen. This record so far north is unusual.

*Remarks*.—The examined specimens range in size from 1.5 cm. to 6 cm. Even the smallest individual has a number of tube feet scattered in the dorsal interambulacra and therefore cannot be mistaken for *C. californica* of the same size; the latter species has, moreover, darkly pigmented tentacles.

The spicules resemble those found in *Cucumaria lubrica* H. L. Clark (including *C. fisheri* Wells) from the west coast of North America, and it is rather difficult to express the differences in such variable forms. The northern form seems always to have numerous 4-holed buttons which apparently sometimes are lacking in the southern form.

The name *dubiosa* has been preferred to *leonina* against such authorities as Ludwig (1887 and 1898) and Ekman (1925). Semper's *leonina* is supposed to have come from Singapore, and it is only a surmise that it is identical with *C. dubiosa*. Since it is very unlikely that the same species occurs in both Singapore and Chile and since the Chilean (and Peruvian) locality is above reproach, it has been concluded that the locality Singapore was wrong. But it is quite possible that *C. leonina* came from Singapore; species with similar spicules are known from other places, for example, *C. köllikeri* from the Mediterranean Sea and *C. salmini* from Celebes. The latter was listed by Lampert, 1885, as occur-

ring in the Strait of Magellan, and since then it was concluded that the locality Celebes was wrong. Very likely *salmini* from Celebes is a synonym of *leonina* from Singapore but different from the species from Peru and Chile.

#### 4. *Cucumaria crax*, new species

Plate 10, Figs. 1-5

*Diagnosis*.—Small form (?). Skin soft, smooth; feet large, soft, completely retractile, arranged in 5 bands, apparently not present in the interambulacra. Tentacles soft, bushy, of equal size. Calcareous ring low, simple, strongly undulated posteriorly; radials deeply incised; a single stone canal attached in the dorsal mesentery, 2 ventral Polian vesicles. Retractors short, fleshy, gonads attached near the middle of the body. Spicules, a scattered layer of small biscuit-shaped bodies, usually with 4-8 marginal holes, frequently incompletely closed, and knobbed margin. Feet with rudimentary end plate and short 3-armed supporting rods. Introvert and tentacles, respectively, with buttons and numerous narrow rods with perforated ends, large in the stem, small and almost hair fine in the ends of the tentacles. Color mottled brown with paler ambulacra; tentacles black.

*Type*.—Holotype, AHF no. 23, 6 paratypes.

*Type locality*.—Station 283-34, Thurloe Point, Thurloe Bay, west coast of L. Calif., 8-10 fms., March 9, 1934.

*Distribution*.—Known from the type locality.

*Depth*.—From 8-10 fms.

*Specimens examined*.—The type and 6 paratypes.

*Remarks*.—The type measures 1.5 cm. in length and is strongly contracted. The gonads are well developed, but this fact in itself constitutes no clue to the size which the species may attain when full grown.

Superficially it resembles a small specimen of *C. californica* Semper, but the spicules are entirely different. If the spicules disappear completely as the animals grow larger, it may become impossible to distinguish between the two forms.

#### 5. *Cucumaria godeffroyi* Semper

*Cucumaria godeffroyi* Semper, 1868, p. 53, pl. 15, figs. 12, 14.—Lam-pert, 1885, p. 144.—Théel, 1886, p. 99.—Clark, 1910, p. 352.

Nec *Holothuria crocea* Lesson, 1830, p. 153, pl. 52. Suggested by Semper but not accepted by later writers.

*Description*.—Imperfectly known. Presumably the feet are restricted to the ambulacra and the tentacles probably of equal size. The calcareous ring is simple. The Polian vesicle is single; the stone canal attached in the dorsal mesentery. Spicules perforated plates with lacinated edge and one end narrower with long marginal spines, this end projecting through the skin.

*Type*.—Hamburg.

*Type locality*.—Iquique, Chile.

*Distribution*.—Coast of Chile.

*Depth*.—Not noted.

*Specimens examined*.—None.

*Remarks*.—No specimen seems to have been secured since the type was described. The type measured 3.5 cm. in length, possibly strongly contracted. The interambulacral feet may have been overlooked. The spicule figured could be interpreted as a degenerate plate from an aged *C. dubiosa*.

## Genus 2. PENTAMERA Ayres, 1852

*Pentamera* Ayres, 1852, p. 207.—Deichmann, 1938, p. 373; 1938a, p. 105.

*Diagnosis*.—Small to medium-sized forms; ventral tentacles small; feet long, nonretractile, arranged in 5 bands but never scattered in the interambulacra. Calcareous ring with long posterior prolongations on the radials. Spicules 2-pillared tables or derivatives from these with the spire reduced or developed as acornlike bodies. Feet with large end plate and supporting tables, usually with well-developed spire; in some forms the spire is more or less completely reduced. Tentacles with rods or plates, in some forms devoid of spicules, at least in the older individuals. Spicules in most forms numerous throughout the animal's life, in some species the spicules are few and degenerate.

*Type species*.—*Pentamera pulcherrima* Ayres.

*Remarks*.—The diagnosis has been modified to include also *Pentamera chierchia* Ludwig and *P. zaca* Deichmann, the former with few and mostly reduced spicules, the latter with peculiar acorn-shaped bodies—as it seems unwise for the present moment to segregate these two forms which otherwise conform so well with the typical members of the genus.

The type species seems to be the only representative known from West Indian waters, while *P. calcigera* (Stimpson) is widespread in the northern Atlantic and Pacific oceans, and 7 related species have developed along the western coast of North America (see Deichmann, 1938).

From the Panamic region (and Chile) 4 species are known. One of these is closely related to the type species.

KEY TO THE SPECIES OF *Pentamera* KNOWN FROM THE PANAMIC REGION

- 1. Spicules in skin acorn-shaped bodies, possibly derived from tables. Feet with end plate and curved supporting tables with well-developed spire. Color white. . . . . 1. *Pentamera zaca*e Deichmann
- 1. Spicules in skin 2-pillared tables or derivatives of these (with spire reduced to knobs or spines). . . . . 2
- 2. Spicules scattered, tables reduced to disks with spinous edge and mostly with 2 knobs or spines indicating the spire. Feet with large end plate and a few spectacle-shaped rods, rarely any trace of a spire. Color dark brown to black. . . . . 3. *Pentamera chierchia* (Ludwig)
- 2. Spicules crowded tables with well-developed spire, disk with smooth edge. Feet with end plate and supporting tables with well-developed to excessively developed spire. . . . . 3
- 3. Supporting tables in feet partly with excessively tall spire. Tables small. . . . . 2. *Pentamera beebei* Deichmann
- 3. Supporting tables in feet with moderately tall spire. Tables not small. . . . . 4. *Pentamera chiloensis* (Ludwig)

1. *Pentamera zaca*e Deichmann

Plate 12, Figs. 10-17

*Pentamera zaca*e Deichmann, 1938, p. 375, text fig. 9.

*Diagnosis.*—Small form (few cm. long) body strongly curved, tapering toward both ends. Feet cylindrical, nonretractile, in 5 bands, most numerous on the ventrum, more scattered on the dorsum and toward the oral and anal ends. Spicules a crowded layer of peculiar small bodies resembling acorns, with a tapering spire, mostly composed of 2 rods and a basal cup-shaped part. Feet with large end plate and numerous support-

ing tables with curved disk with 4 central holes and a small hole in each end, spire with 2 pillars and ending in a few lobes or blunt teeth which lie in one plane. Color white.

*Type*.—M.C.Z.

*Type locality*.—Zaca Sta. 196 D-17.

*Distribution*.—Tangola Tangola Bay, Mex.

*Depth*.—From 23 fms.

*Specimens examined*.—The type.

*Remarks*.—The type measures about 3 cm. in length. The skin is rigid with spicules. The oral end with the tentacles and calcareous ring is lost as well as most of the inner organs. It is therefore only tentatively that the species is referred to *Pentamera*.

## 2. *Pentamera beebei* Deichmann

Plate 12, Figs. 1-9

*Pentamera beebei* Deichmann, 1938, p. 374, text fig. 7.

*Diagnosis*.—Typical small pentamerid with minute tables (diameter 0.03 mm.) with mostly 4 larger holes and 4 smaller ones; spire 2 pillared, ending in a tuft of spines. Feet with large end plate and curved supporting tables with from 2-7 crossbeams in the spire and a terminal tuft of flat lobes. Color white.

*Type*.—M.C.Z.

*Type locality*.—Zaca Sta. 213 D-15.

*Distribution*.—Known from Ballena Bay, Gulf of Costa Rica.

*Depth*.—From 40 fms.

*Specimens examined*.—The type.

*Remarks*.—The type measures few cm. in length. Its striking spicules set it apart from all other species known from the Panamic waters.

## 3. *Pentamera chierchia* (Ludwig)

Plate 13, Figs. 19-21

*Cucumaria chierchia* Ludwig, 1887, p. 13, pl. 1, fig. 5.

*Pentamera chierchia* Deichmann, 1938, p. 374, text fig. 8.

*Diagnosis*.—Small form (about 3-4 cm. long) with numerous feet in 5 narrow bands. Calcareous ring with long posterior prolongations. Spicules in varying numbers, in some individuals almost completely lacking. Skin with 4-holed tables with dentate margin and 2-pillared spire with few irregular teeth; often the spire is reduced to knobs or com-

pletely lacking. Feet with large end plate and a varying number of mostly spectacle-shaped rods, often with 4 central holes incomplete or complete, and a number of smaller holes in the ends. Introvert with a few tables. Tentacles with curved perforated plates and rods. Color black, rarely brown with pale underside.

*Type*.—Possibly in Germany.

*Type locality*.—Coast of one of the islands in the Gulf of Panama. A single specimen secured.

*Distribution*.—From Ecuador and Galapagos to L. Calif.

*Depth*.—Shore to 40 fms.

*Specimens examined*.—The following from the Allan Hancock Expeditions:

- 73-33. North Beach, Cartago Bay, Albemarle Island, Galapagos, shore, February 13, 1933, 22 specimens.
- 80-33. Smitty's Shore, Duncan Island, Galapagos, shore, February 15, 1933, 15 specimens.
- 132-34. Braithwaite Bay, Socorro Island, Mex., 40 fms., January 4, 1934, 13 young specimens.
- 189-34. Cartago Bay, Albemarle Island, Galapagos, shore, January 25, 1934, 5 specimens.
- 315-35. Indefatigable Island, opposite Gordon Rocks, coral, 1-2 fms., December 8, 1934, 3 specimens.
- 401-35. Manta, Ecuador, below first rocky point, 1 fm., January 19, 1935, 5 specimens.
- 464-35. Playa Blanca, Costa Rica, 2 clumps of coral, south shore of bay, shore, February 8, 1935, 2 specimens.
- 467-35. Parker Bay, Costa Rica, rock and algae, 2 fms., February 9, 1935, 2 specimens.
- 473-35. Parker Bay, Costa Rica, coral, 2 fms., February 9, 1935, 39 specimens.
- 596-36. Port Escondido, L. Calif., 20 fms., March 16, 1936, 1 specimen.
- 683-37. Outside of Concepcion Bay, L. Calif., Mex., 12 fms., March 15, 1937, 17 specimens.
- 784-38. Darwin Bay, Tower Island, Galapagos, Middle Beach, shore, January 17, 1938, 7 specimens.

Also several from the *Zaca* expedition, 1938.

*Remarks*.—Apparently one of the most common forms in the Pan-amic region.

4. *Pentamera chiloensis* (Ludwig)

Plate 13, Figs. 15-18; text figure 1

*Cucumaria chiloensis* Ludwig, 1887, p. 12, pl. 1, fig. 4.—Deichmann, 1938, p. 373, *passim*.

*Cucumaria tabulifera* R. Perrier, 1904, p. 14; 1905, p. 17, pl. 1, figs. 4-5; pl. 3, figs. 1-5.

*Diagnosis*.—Typical pentamerid, resembles the type species. Spicules tables with oval to squarish disk (diameter 0.06 mm.) with 4 or 8 holes; spires 2 pillared with one or two crossbeams and a few short teeth at the top. Feet with large end plate and numerous curved supporting tables with low spire with 2 pillars and a few flat teeth on the top. Introvert with rosettes; tentacles with delicate rods. Color white.

*Type*.—Possibly in Germany.

*Type locality*.—Chiloe Island, Chile.

*Distribution*.—Cape Horn and vicinity to L. Calif.

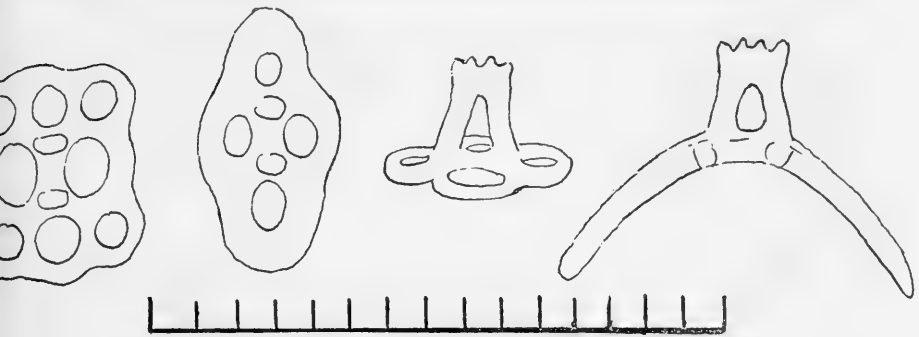
*Depth*.—The type came from 40 m. depth; the *Velero* specimens were taken at from 8-60 fms. depth.

*Specimens examined*.—The following material from the Hancock Expeditions:

- 190-34. Lat. 0° 55' S., 90° 30' W., Galapagos, 58-60 fms., January 26, 1934, 1 specimen.  
209-34. La Libertad, Ecuador, north of Point Sta. Elena, 8-10 fms., February 9, 1934, 1 specimen.  
213-34. La Plata Island, Ecuador, north of anchorage, 7-10 fms., February 10, 1934, 1 specimen.  
677-37. Ildefonso Island, L. Calif., Mex., 50 fms., March 15, 1937, 3 specimens.  
833-38. Independencia Bay, Peru, off north entrance, sand and shell, 8 fms., February 10, 1938, 1 specimen.

*Remarks*.—The species resembles the type species from the West Indies. Ludwig's specimen measured only 9 mm., while Perrier had two specimens, 20 and 23 mm. long. The *Velero* material falls about within these limits. The species may be expected to reach a length of about 5 cm.; the tables in younger individuals may possibly have larger disks with 2 circles of holes; some tables have a dentate edge as if one row of holes had been resorbed. It differs from *C. pulcherrima* in the lack of perforated plates in the tentacles and the presence of rosettes in the introvert, and the smaller size—characters which may prove to be abso-





Text fig. 1. *Pentamera chiloensis* (Ludwig)?  
Spicules from juvenile individual.  
Scale divisions indicate  $\frac{1}{100}$  mm.

lutely worthless. A small specimen from Sta. 190-34, 1.5 cm. long, had the genital tubes packed with ripe eggs.

The very young individual from Station 209-34 had much smaller spicules than the other individuals, but it can hardly be doubted that it represents *P. chiloensis*.

Doubtful form:

***Pentamera panamensis* (Verrill)**

*Ocnus panamensis* Verrill, 1867, p. 321.—Lampert, 1885, p. 132.—  
Théel, 1886, p. 116.

From Verrill's incomplete description it can only be learned that the type measured about 4 cm. in length; the feet were restricted to the ambulacra, in double rows on the ventrum, in single rows toward the ends and on the dorsum; the tentacles were 10 in number and the 2 ventral smaller. The skin was thin, coriaceous, filled with numerous minute calcareous grains or plates. The color was grayish brown, the tentacles yellowish brown.

*Type*.—Apparently lost.

*Type locality*.—Gulf of Panama.

*Distribution*.—Known only from the type locality.

*Depth*.—Presumably shallow water.

*Specimens examined*.—None.

*Remarks*.—This may be any of the species belonging to *Pentamera*, *Apentamera*, or *Neopentamera*, except *P. chierchia* and *A. lepra*. The

few feet on the dorsal side suggest *P. beebei*, while the description of the spicules suggests *P. zacaе*. As it is completely impossible to place the species, the name must once and for all be rejected.

### Genus 3. NEOPENTAMERA, new genus

*Diagnosis*.—Externally resembling *Pentamera* Ayres, with tube feet restricted to the 5 ambulacra (?). Calcareous ring with well-developed posterior prolongations. Spicules irregular, 4-holed, knobbed buttons; feet with end plate and narrow ribbonlike rods, possibly derived from tables.

*Type species*.—*Neopentamera anexigua*, new species.

*Remarks*.—The genus and species are based upon a number of small specimens, apparently adult, secured by the Hancock Expeditions. As the specimens are so small, there is of course the possibility that tube feet may appear later in the interradials, which will necessitate a modification of the diagnosis. The spicules bear some resemblance to those of *Eupentacta pseudoquinquesemita* Deichmann from the coast of Alaska but are so much smaller that I have felt justified in establishing a new genus for this species. It cannot be confused with any other dendrochirote form hitherto recorded from the Panamic region.

### *Neopentamera anexigua*, new species

Plate 13, Figs. 11-14

*Diagnosis*.—Small form (few cm. long), externally as internally a typical pentamerid. Spicules numerous, irregularly knobbed buttons or plates. Feet with large end plate and ribbonlike supporting rods with no indications of a spire. Introvert with plates and rosettes. Tentacles with rosettes and delicate rods derived from rosettes. Tentacles dark brown. Color white.

*Type*.—Holotype, AHF no. 24, one paratype.

*Type locality*.—*Velero III* Station 683-37, outside of Concepcion Bay, L. Calif., Mex., 12 fms., March 15, 1937.

*Distribution*.—Known only from the type locality.

*Depth*.—Taken at 12 fms. depth.

*Specimens examined*.—The type and a paratype.

*Remarks*.—The types are poorly preserved and measure only 2 cm.

in length. In the type the gonads are large; many tubes measure almost 2 cm.; presumably it is a male, as no traces of eggs were seen.

It is possible that an external layer of more delicate spicules normally is present but has been destroyed. The spicules are slightly reminiscent of those characteristic of *Eupentacta pseudoquinquesemita* Deichmann, from the Alaskan waters, but they are smaller, and the tails on the calcareous ring are distinctly longer in the present species.

The name *anexigua* is given because it was at first glance assumed that the present species was identical with Ludwig's *Cucumaria exigua* from China and, supposedly, also Chile (see p. 81). The species from Chile is now called *C. chilensis*, as indicated in Ludwig's figures; it was actually rediscovered by the Allan Hancock Expedition (see p. 80). Dissection revealed, however, that the calcareous ring was entirely different—with long tails—and the species must therefore be regarded as new.

#### Genus 4. APENTAMERA, new genus

*Diagnosis.*—Small forms (few cm. long) with tube feet in 5 bands, papilliform toward the ends where 5 valves are formed; a few smaller papilliform tube feet are scattered in the dorsal interambulacra, may be lacking in small individuals. Tentacles 10, the 2 ventral smaller. Skin rigid, packed with spicules. Calcareous ring with long posterior prolongations; other internal features almost as in *Pentamera*.

Spicules an external layer of flattened baskets almost rosettelike, easily overlooked and may possibly be lost in older individuals, and an inner layer of regular 4-holed knobbed buttons. Feet with end plate smaller in the terminal appendages; walls packed with curved supporting tables with 2 pillars and a few blunt teeth. Introvert with oblong tables or plates with slightly knobbed edge. Tentacles packed with plates and rods which gradually decrease in size in the branches; apparently no rosettes.

*Type species.*—*Apentamera lepra*, new species.

*Remarks.*—The material of the type species was originally referred to 2 genera related respectively to *Pentamera* and *Pentacta*, possibly with affinities to some of the *Thyone*-like forms. After all other species had been classified, it became evident that these two "genera" represented only one, which in spite of its affinities to the *Thyone*-like forms could not be placed among these.

**Apentamera lepra**, new species

Plate 13, Figs. 1-10

*Diagnosis.*—As for the genus. Color white, mottled with reddish brown.

*Type.*—Holotype, AHF no. 25.

*Type locality.*—Station 557-36, off White Rock, Isla Partida, Gulf of Calif., in 45 fms., March 8, 1936.

*Distribution.*—Gulf of Calif. to Panama.

*Depth.*—From 30-50 fms.

*Specimens examined.*—The following material from the Hancock Expeditions:

557-36. Isla Partida, Gulf of California, 45 fms., type and 2 paratypes.

863-38. Bahia Honda, Panama, off North Island, 30-50 fms., March 1, 1938, 3 specimens (M.C.Z.).

*Remarks.*—The type specimens measure 3.5, 3.4, and 2.0 cm. in length; the gonads are well developed in the 3 individuals, so presumably the animals are full grown. The material has been carefully compared with the other forms with 4-holed knobbed buttons, but it seems impossible that it represents the juvenile stages of any of these. The only form which possibly could be considered is *Neothyone gibbosa* (see p. 113), but the latter has numerous interambulacral feet when it is as large as *A. lepra*, and its spicules are definitely larger; the buttons are more oblong and it has numerous rosettes in the tentacles.

**Genus 5. LEPTOPENTACTA** H. L. Clark, 1938

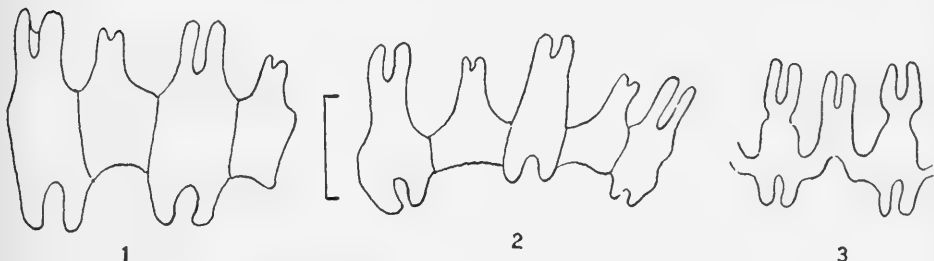
*Synonym.*—*Ocnus* Auctores. Nec *Ocnus* Forbes, 1841. See H. L. Clark, 1938, p. 453.

*Diagnosis.*—Body slender, skin rigid. Tentacles 10 (or 8), the ventral ones small (or lacking). Feet restricted to the ambulacra, rigid, filled with spicules, arranged either in single rows with feet well spaced or in more crowded or zigzaggy rows. Toward the oral and anal ends the feet are scattered and papilliform, often forming 5 valves as in *Pentacta*. Calcareous ring simple, or with short posterior prolongations. Retractors short, longitudinal musculature feebly developed. Gonads with few tubes in each tuft, attached near the middle of the animal.

Spicules reticulated bodies or baskets, larger or smaller, reticulated scales or grains and 4-holed buttons, swollen or knobbed. Feet with or without end plate, with or without supporting rods. Tentacles with large perforated rods or plates; sometimes also rosettes and smaller rods.

*Type species.*—*L. grisea* H. L. Clark, 1938.

*Remarks.*—The genus may possibly be further divided into two, viz., *Leptopentacta*, which includes the type species, *L. panamica* spec. nov., possibly also Sluiter's "*Ocnus*" *javanicus*, and a species listed here as *L. nina*, based on a juvenile individual from the Hancock Expeditions,—and another, for which the name *Parocnus* is proposed,—to accommodate "*Ocnus*" *imbricatus* Semper and "*Ocnus*" *typicus* Théel, which possibly are identical, and *L. nova*, spec. nov.



Text fig. 2. 1. Calcareous ring from *Leptopentacta grisea* H. L. Clark.  
 2. *Leptopentacta panamica*, new species.  
 3. *Leptopentacta javanica* (Sluiter).  
 Scale, 1 mm.; Sluiter's figure has no indication of what magnification is used; probably it is about as large as the other two.

"*Ocnus*" *molpadioides* Semper definitely does not belong in this genus, while "*Ocnus*" *pygmaeus* Semper, based upon a specimen 1 cm. long, has long and rather flexible feet and probably represents a juvenile specimen of some species of *Cucumaria* or *Thyone* (in the broad sense). It is not possible to ascertain whether the calcareous ring is simple or has posterior prolongations. Semper figures a simple ring but mentions that the ring has long posterior prolongations. His figures of the ring of *imbricata* show no posterior prolongations, and in his description he emphasizes the way in which the ring is cut off posteriorly. (See footnote, p. 94.)

KEY TO THE KNOWN SPECIES OF *Leptopentacta*

- 1. External layer of spicules consisting of small biscuit-shaped plates or rosettes. Feet with no supporting rods, and apparently without end plate. Calcareous ring simple (not known in *L. typica*) . . . . . 2

1. External layer of spicules consisting of baskets, reticulated bodies, or hollow plates. Feet with supporting rods or plates, in some species also with end plate. Calcareous ring with short tails. . . . . 4
2. External spicules consisting of small biscuit-shaped bodies with 4-5 holes, often one side prolonged into a sharp tooth. Feet few, scattered, 5-6 in the dorsal ambulacra, 8-10 in the ventral ones. . . . . 1. *Leptopentacta nova*, new species
2. External spicules consisting of rosettes. Feet fairly numerous, although arranged in single rows. . . . . 3
3. Feet 24-26 in the ambulacra (in individuals 35-40 mm. long). . . . . *Leptopentacta imbricata* (Semper)
3. Feet 15-20 in the ambulacra (in individuals 40 mm. long). . . . . *Leptopentacta typica* (Théel)
4. External spicules consisting of simple, 4-spoked, deep baskets with knobbed to dentate rim. Feet with numerous supporting rods or plates. . . . . 5
4. External spicules consisting of complicated reticulated bodies or concave plates. . . . . 6
5. Buttons swollen or irregularly knobbed. Baskets comparatively large and delicate, with 4 marginal holes. . . . . *Leptopentacta grisea* H. L. Clark
5. Buttons predominantly strongly knobbed and regular. Baskets small, not delicate, and apparently never with marginal holes. . . . . 2. *Leptopentacta panamica*, new species
6. External spicules reticulated bodies<sup>3</sup>; feet 20-23 in ventral rows (in individual, 40-45 mm. long). . . . . *Leptopentacta javanica* (Sluiter)
6. External spicules large concave plates with a varying amount of reticulated bars. Inner layer knobbed buttons slightly irregular and large reticulated plate. Feet with oblong supporting plates smooth or knobbed, with a varying number of holes. . . . . 3. *Leptopentacta nina*, new species

<sup>3</sup> Sluiter's figure (1880, pl. 4, fig. 10) looks suspiciously as if it belonged to a *Paracaudina*. His description is not very clear, and in 1901, p. 79, he writes "*javanica* with *typica* and *imbricata*," following Ludwig, 1837, p. 1221 (reprint p. 5). If one can trust Semper's figure (plate 14, fig. 12), *imbricata* must be different from *javanica*, as it has a simple calcareous ring. Although Ludwig's "*imbricata*" has distinct tails on the ring, it is not proved that it is identical with Semper's species or with Théel's.

1. *Leptopentacta nova*, new species

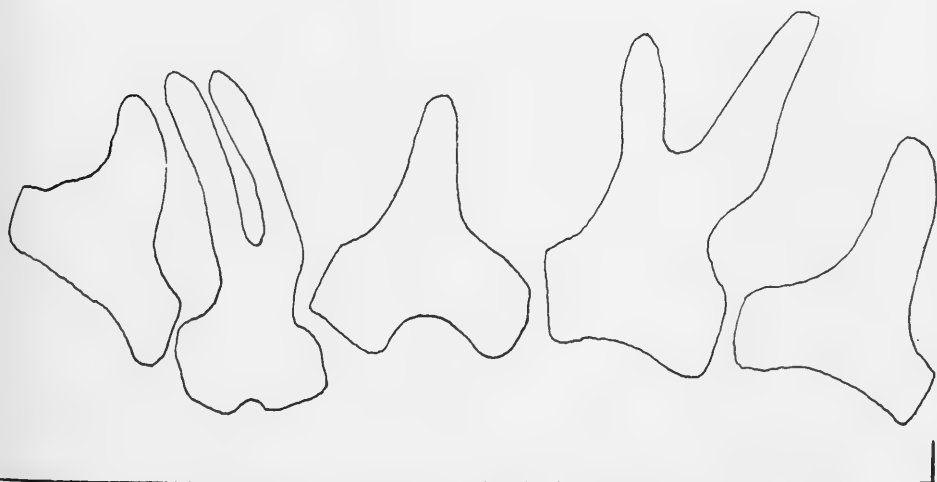
Plate 14, Figs. 13-22; text figure 3

*Diagnosis.*—Body slender, slightly curved with rigid body wall. Feet few, contracted into conical protuberances, well spaced. The ventral ambulacra possess from 8-10 feet, while the dorsal ones each have 4 feet anteriorly and one or two posteriorly. Skin with large cobblestone-like scales, and the space between them filled with masses of smaller spicules. Tentacles fingerlike (in the type which measures 2 cm. in length) and apparently only 8 are present, but the 2 small ones may have been overlooked. Calcareous ring low, with no indication of posterior prolongations. Inner anatomy not remarkable in any respect.

Spicules large scales or grains with reticulated structure, 4-holed buttons, irregular, swollen or with irregular knobs, and minute perforated biscuit-shaped plates with 4-5 holes and frequently a long spine developed on one side. Feet with no supporting plates and apparently no end plate. Introvert with reticulated plates which intergrade into rosettes; tentacles with curved perforated or branching rods which decrease in size toward the ends.

*Type.*—Holotype, AHF no. 26, 1 paratype.

*Type locality.*—Station 281-34, Santa Maria Bay, west of Hughes Point, L. Calif., 35-40 fms.



Text fig. 3. *Leptopentacta nova*, new species.  
Scale, 1 mm.

*Distribution.*—Known from the type locality.

*Depth.*—Dredged at 35-40 fms.

*Specimens examined.*—The type.

*Remarks.*—The type and other specimen measure 2 cm. in length and 3 mm. in width. The surface of the skin appears mottled, because of the large scales' being glassy and contrasting with the solid white of the smaller spicules which are massed between them. The tentacles which are completely retracted are small and finger shaped; only 8 could be counted, but 2 small ones may possibly have been overlooked. The calcareous ring is low with no indication of posterior prolongations; the stone canal is small and attached as usual in the dorsal mesentery, and the Polian vesicle is single and ventrally placed. Other anatomical features are not remarkable. The gonads form few tubes of varying length, and are attached near the middle of the dorsal midline.

This species seems most closely related to *L. imbricata* (Semper) and *L. typica* (Théel). It differs in having small biscuit-shaped plates instead of rosettes in the external layer of the skin, fewer feet, and, presumably, in having simple tentacles. However, *L. nova*, *L. imbricata* (and *L. typica*) may well be placed in a separate genus for which the name *Parocnus* is proposed, with *imbricata* as type.

## 2. *Leptopentacta panamica*, new species

Plate 14, Figs. 6-12; text figure 2

*Diagnosis.*—Slender form with curved body, ambulacra forming 5 indistinct ridges. Feet in scattered double rows in the middle portion of the ambulacra, toward the ends in single rows, around the base of the introvert forming 5 large valves as in *Pentacta*. Tentacles 10, bushy, the 2 ventral smaller. Surface of skin rough on account of the numerous spinelike projections on the spicules which pierce the skin. Calcareous ring with short posterior prolongations. Other features also typical of the genus.

Spicules consisting of an external layer of strongly knobbed 4-holed buttons with minute holes and smaller buttons, less strongly knobbed and with larger holes and numerous 4-spoked baskets, and an inner layer of large, reticulated ovoid or spherical scales or grains. Feet possibly with an end plate (not discovered in type)<sup>4</sup> and numerous perforated supporting

<sup>4</sup> The type species has a large and well-developed end plate in the feet (overlooked by H. L. Clark), and one would expect that an end plate would also be present in the present species. Two tube feet have been examined, but the feet are strongly contracted and no trace has been found of end plates. Still it is possible that they may be present.



plates, and the same type of spicules as in the integument. Particularly numerous in the appendages, although also scattered in the skin are some peculiar oblong heavy plates with small holes and one end drawn out into a shorter or longer spine which pierces the skin (visible with low magnification). Introvert with rosettes, tentacles with large curved perforated plates and rods, also rosettes, and in the finer branches, delicate rods with perforated ends.

*Type*.—Holotype, AHF no. 27.

*Type locality*.—Port Utria, Colombia, close to shore, north of point and west of islands, 20 fms., January 25, 1935.

*Distribution*.—From Port Utria, Colombia, to Tenacatita Bay, Mex.

*Depth*.—From 20-35 fms.

*Specimens examined*.—The type and 3 other specimens from the following *Velero* stations:

259-34. Tangola Tangola, Mex., 15-20 fms., February 28, 1934, 1 paratype.

275-34. Tenacatita Bay, Mex., off Navidad Head, 25-35 fms., 2 specimens.

423-35. Port Utria, Colombia, close to shore, 20 fms., 1 specimen, type.

*Remarks*.—The type measures about 4 cm. in length; the other individuals are smaller. The color in alcohol is dirty yellow with large irregular brown patches. The gonads are ripe and filled with eggs. (Specimens collected in January.)

The species seems fairly closely related to the type species, *L. grisea* H. L. Clark, from Broome, West Australia (plate 14, figures 1-5). It differs chiefly in the presence of the peculiar, spine-bearing plates, the strongly knobbed buttons, and the much smaller and more simple baskets.

### 3. *Leptopentacta nina*, new species

Plate 15, Figs. 1-12

*Diagnosis*.—Small form (?), type measures 1.2 cm. with the tentacles contracted. Body curved, slender; skin rigid; feet cylindrical, retractile, restricted to the ambulacra (the type has about 25 tube feet in the ventral rows and considerably fewer in the dorsal). Calcareous ring with distinct posterior tails on the radials and long teeth, deeply grooved on radials and interradials (resembles that of Sluiter's species, see text figure 2).

Spicules an external layer of concave plates, often with a delicate reticulum across the hollow surface; an inner layer of knobbed, irregular buttons, and larger plates with knobbed surface, sometimes transformed into large convex bodies. Feet apparently devoid of end plate; walls with short, broad, perforated supporting rods. Introvert and tentacles not examined. Color of the preserved specimens white.

*Type*.—Holotype, AHF no. 28.

*Type locality*.—Station 850-38, Cape San Francisco, Ecuador, 15 fms., February 23, 1938.

*Distribution*.—Known only from the type locality.

*Depth*.—From 15 fms.

*Specimens*.—The type.

*Remarks*.—The type represents undoubtedly an immature individual. On account of its small size and its rigid skin it was almost impossible to dissect, and no attempt was made to study the tentacles and introvert. The inner organs were poorly preserved, and nothing can be said about the stone canal and Polian vesicle. The musculature is feebly developed, and the intestine and respiratory trees form a structureless mass; a well-developed muscle stomach could, however, be seen. The calcareous ring is highly reminiscent of the one figured by Sluiter for *javanica* (see text figure 2), and it is of course remotely possible that the present species has previously been described from the East Indies. As the various earlier descriptions are rather unsatisfactory, as also the figures hitherto published, it has been deemed wiser to designate the unique individual to a new species.

*L. nina* differs distinctly from both *L. nova* and *L. panamensis* in its calcareous ring as well as in its spicules. It cannot be confused with any other species at present described from the Panamic region.

## Genus 6. PENTACTA Goldfuss, 1820

*Pentacta* Goldfuss, 1820, p. 177.—H. L. Clark, 1923, p. 416.

*Colochirus* Troschel, 1846, p. 64. (Type species.—*C. quadrangularis* Troschel.)

*Cercodemas* Selenka, 1867, p. 343. (Type species.—*C. anceps* Selenka.)

*Diagnosis*.—Body with more or less flattened ventral side with the tube feet arranged in 3 bands; dorsal side vaulted with feet of different size, often as large papillae, frequently scattered in the interambulacra. Around the base of the introvert and the anus the ambulacra form thick

valves. Tentacles 10, the 2 ventral smaller. Skin rigid, filled with spicules. Calcareous ring simple, posteriorly often strongly undulated but never with posterior prolongations.

Spicules consisting of an external layer of either baskets or delicate reticulated bodies, and inner layer of knobbed buttons, heavy plates, or reticulated bodies. Feet apparently with no end plate; walls supported by perforated rods or plates; dorsal papillae with mostly curved supporting plates. Tropical shallow water forms.

*Type species.*—*Pentacta doliolum* (Pallas).

*Remarks.*—The name has been used by various authors for members of the genus *Cucumaria* s.l., and Ludwig (1899, p. 344) claims that it ought to be used instead of Blainville's name, from 1835. H. L. Clark (1923, p. 416) has, however, called attention to the fact that Troschel's name *Colochirus* is a complete synonym of *Pentacta*, for Goldfuss designated Pallas' *doliolum* from Cape of Good Hope as the type species and the latter is generally accepted as the typical "*Colochirus*."

The genus *Pentacta* is most abundantly represented in shallow water in the East Indies. The type species represents the only form known from the South African waters, and only one form is known from Brazil and the West Indies. From the western coast of South America Semper described a new species which was never found again and hence was regarded as rather dubious. There is no doubt that it is the one which the Allan Hancock Expeditions now have brought back, thereby proving that Semper's specimens were correctly labeled.

The genus may possibly in the future be divided into 2, viz., one for those with more complicated spicules, and one for those with regular, knobbed buttons and simple baskets.

The 2 species known from the American waters both belong to the latter group.

### ***Pentacta peruana* (Semper)**

Plate 16, Figs. 1-8

*Colochirus peruanus* Semper, 1868, p. 239, pl. 39, fig. 20.—Lampert, 1885, p. 126.—Théel, 1886, p. 123.—H. L. Clark, 1910, p. 353.

*Diagnosis.*—Small form, few cm. long, with cylindrical feet in 3 crowded bands on the greater part of the ventral side, transformed into papillae toward the ends, dorsally 2 bands of papillae and a number scattered in the interambulacra. Oral and anal ends closed by 5 distinct valves. Inner anatomy typical of the genus.



Spicules an external layer of regular baskets, the hollow part formed by broad bars, the narrow rim with few teeth. An inner layer of regular 4-holed knobbed buttons and larger knobbed plates and huge reticulated grains. Ventral feet mostly with a minute end plate and the walls packed with supporting rods mostly 3-armed, smooth to knobbed. Dorsal appendages apparently lacking end plate but with heavier 3-armed rods. Introvert with a few oblong buttons smooth or knobbed. Tentacles with stems packed with narrow plates or rods, smaller, curved and often 3-armed rods in the finer branches.

*Type*.—Possibly in Germany.

*Type locality*.—Peru, probably at comparatively low depth.

*Distribution*.—From Peru to Mexico.

*Depth*.—The Hancock material came from 25 fms.

*Specimens examined*.—The following specimens from the Allan Hancock Expeditions:

264-34. Petatlan Bay, Mexico, 25 fms., south and west of White Friars Island, rock with gorgonids, 4 specimens.

*Remarks*.—The 4 specimens measure between 3-4 cm. in length and are thus somewhat larger than the types which measured only 15-18 mm. Semper's description is not very detailed,<sup>5</sup> and his figure of a basket shows a more irregular type than the one which commonly occurs. He mentions hollow knobbed bodies and large smooth plates, the latter referring possibly to the smooth supporting plates. He gives, however, no reference to the regular 4-holed knobbed buttons, possibly because he considers them growth stages of the larger knobbed bodies; also they may possibly be more scarce in younger individuals. It must further be mentioned that the ventral tentacles in the present material are very slightly smaller in size than the other.

<sup>5</sup> Semper's original description: "Zehn Tentaklen, die zwei ventralen kleine. Habitus Ascidien-artig. Auf den Rücken stehen die Ambulacral-papillen regellos zerstreut, am Bauche in drei deutlichen Reihen, deren jede zwei Füßchen in der Breite zeigt. Es bleibt sich eine Art Bauchscheibe dadurch das die Füßchen hinten in Ambulacral-papillen übergehen. Farbe gelblich (im Spiritus). Drei Exemplare, 15-18 mm. lang, 6-7 mm. breit.

Am Gefässring eine einzige Polische Blase, eine kleine dorsaler Steinkanal. Lungen fast so lang wie der Körper, mit wenig, aber sehr langen einfachen Nebenasten. Geschlechtsteile zwei Büschel sehr kleiner unverästelter Schlauche, ihre Basis am Mesenterium sehr weit nach vorne, vor dem Wassergefässring. Kalkring aus 10 einfachen Gliedern bestehend; die Radialen etwas breiter als die Interradialen, nicht nach hinten verlängert. Keine Kaumagen. Die Retraktoren inserieren sich in der Mitte des Körpers.

Grosse glatte Kalkplatten in der ganz starre Haut, darüber ein Schicht durchbrochenene, etwas knotiger Halbkugeln."

One specimen, which was opened, had few but well-developed genital tubes. The color of the 4 individuals is light brown with darker freckles; the general impression of the preserved material is a nondescript grayish-brown color.

### Genus 7. **THYONACTA**, new genus

*Diagnosis*.—Medium-sized to large form, 10-15 cm. long in contracted condition. Skin thick, filled with spicules. Tube feet in 5 bands and in varying number in the interambulacra, depending on the animal's age; toward the oral and anal ends thickened valves are developed. Many tube feet are conical, papilliform. Tentacles 10, the 2 ventral smaller. Calcareous ring low but with short posterior projections; stone canal small, attached to the dorsal mesentery; Polian vesicle single, ventral in position; retractors exceptionally short, attached closely behind the calcareous ring (when the crown of tentacles is withdrawn). Gonads placed unusually far back, in the posterior third of the body.

Spicules consist of an external layer of simple baskets, and an inner layer of 4-holed buttons of different size, also a few larger plates; mostly regularly knobbed. Feet apparently without any end plate (at least in larger individuals); walls with numerous supporting rods and plates besides buttons and baskets. Introvert with rosettes; tentacles with large, mostly narrow perforated plates and rods which decrease in size toward the tips of the branches.

*Type species*.—*Thyonacta sabanillensis* (Deichmann).

*Remarks*.—At present 2 species have been referred to this genus, both restricted to the American waters. Very likely some of the members of the old genus *Thyone* from the western Pacific and Indian oceans ought to be transferred to this genus. The type species came from the West Indian seas, while the other species, described below, has been secured from various localities in the Panamic region.

### **Thyonacta mexicana**, new species

Plate 17, Figs. 1-13

*Diagnosis*.—As for the genus. Spicules rather stout and deep baskets and buttons of 2 types, a large and strongly knobbed one and a smaller, less regularly knobbed and often with accessory holes. Color varying shades of brown.

*Type*.—Holotype, AHF no. 29, 5 paratypes.

*Type locality*.—Station 633-37, San Gabriel Bay, Espiritu Santo Island, L. Calif., 18 fms., March 6, 1937.

*Distribution*.—Widespread in the Gulf of California and as far as Panama.

*Depth*.—From 10-35 fms.

*Specimens examined*.—The type and 5 specimens from the following *Velero* stations:

- 244-34. Bahia Honda, Panama, 30-35 fms., February 21, 1934, 1 specimen.  
554-36. Parallel to Angel de la Guardia Island, east side, 10 fms., March 8, 1936, 2 specimens.  
562-36. North of San Esteban Island, L. Calif., 20-70 fms., March 10, 1936, 1 specimen.  
633-37. San Gabriel Bay, Espiritu Santo Island, L. Calif., 18 fms., March 6, 1937, 1 specimen.  
719-37. Consag Rock, L. Calif., 10-25 fms., March 24, 1937, 1 specimen.

*Remarks*.—The material shows to perfection how impossible it is to give an exact description of the general appearance of most holothurians. Two individuals are well expanded with tapering bodies, one is contracted to a short *Pentacta*-like form, and two resemble slightly deformed oranges. The spicules, however, are completely identical, and a closer study of the anatomical features, calcareous ring, etc., showed that the specimens also in these respects are alike.

*T. mexicana* is closely related to the type species but differs distinctly in the shape of the spicules. The extremely deep baskets and the large strongly knobbed buttons alone are sufficient to distinguish the present species from all other related forms known from the Panamic region.

## Genus 8. **THYONE** Oken, 1815

*Thyone* Oken, 1815, p. 351.

*Anaperus* Troschel, 1846, p. 60 (*partim*).

*Diagnosis*.—Small to medium-sized forms (rarely more than 10 cm. long, many species smaller). Body thin skinned with numerous nonretractile fairly delicate feet, most numerous ventrally. Tentacles 10, the 2 ventral smaller. Calcareous ring with long posterior prolongations on the radials.

Spicules small 2-pillared tables or derivatives of these. Feet with large end plate and numerous curved supporting tables usually with a well-developed spire, which in some forms, however, is completely reduced. Tentacles with delicate rods and often rosettes. Spicules gradually reduced with age in certain species.

*Type species.*—*Thyone fusus* (O. F. Müller).

*Remarks.*—The genus is well defined and corresponds to *Pentamera* in *Cucumaria* sensu latiore. It is sometimes almost impossible to identify very young specimens of *Pentamera* and *Thyone*, as the latter passes through a *Pentamera*-stage. Fortunately that stage seems to be so short that one usually is able to find a few feet in the interambulacra. When dealing with specimens less than 1 cm. long, it is, however, wise to consider all the species of *Pentamera* and *Thyone* which are known in the region under consideration. Often the spicules in the introvert and tentacles differ in species which have spicules in the body wall which are alike, but this character cannot always be relied upon.

The type species is common in the eastern and northeastern part of the Atlantic Ocean, while a closely related species is known from the West Indies, but not reaching the coasts of New England (*T. fusus* ? Deichmann, 1930, p. 167). Another species with more robust tables, often with a handle on the inner side of the buttons, is likewise known from the West Indies (*T. pseudofusus* Deichmann, 1930, p. 168).

From the Panamic region the Hancock Expeditions have secured 3 new species, while a fourth was in the M.C.Z., collected by the *Stranger*. Of these 4 species, 2 are closely related to the West Indian species mentioned above.

KEY TO THE SPECIES OF *Thyone* s. str. KNOWN FROM THE PANAMIC REGION

1. Tables delicate with 4 to 8 holes; disk oval or squarish; spire of medium height usually with 6 diverging teeth. Supporting tables with spire completely reduced; disk curved, with 4 central holes and ends expanded with a varying number of minute holes. . . . . 1. *Thyone neofusus*, new species
1. Tables more or less stout; supporting tables in tube feet with well-developed spire. . . . . 2
2. Disk of table medium-sized to large, round, squarish, or oblong, with numerous holes and often with a few knobs or the entire

- margin distinctly thickened; spire in most cases low, in process of becoming vestigial; supporting tables with an enormous conical spire. . . . . 4. *Thyone strangeri*, new species
2. Disk of tables small, oval or squarish in outline, with 4-8 holes, in some cases the disk is lozenge shaped with a few small holes in the ends; no knobs. . . . . 3
3. Disk oval or lozenge shaped; spire moderately well developed, mostly with few, indistinct teeth. Supporting tables with 2 pillars which unite into a tapering cone ending in 2 small diverging teeth (often broken off). . . . .  
. . . . . 2. *Thyone bidentata*, new species
3. Disk oval with 4 central holes and a "handle" on the inner side; spire tapering with 3-4 small teeth at the top; supporting tables with 2-3 pillars in the spire which ends in 2-3 teeth.  
. . . . . 3. *Thyone parafusus*, new species

1. **Thyone neofusus**, new species

Plate 18, Figs. 1-6

*Diagnosis*.—Small form (few cm. long?); feet delicate in 5 indistinct bands and scattered in the interambulacra. Calcareous ring typical; single small stone canal and single ventral Polian vesicle.

Spicules delicate tables with 4-8 holes and 2-pillared spire. Feet with large end plate and numerous curved supporting plates or rods with 4 central holes and a varying number in the expanded ends and no trace of a spire. Introvert with rosettes; tentacles with delicate rods and rosettes. Color of the preserved specimens white.

*Type*.—Holotype, AHF no. 30, 2 paratypes.

*Type locality*.—Station 190-34, Lat. 0° 55' S.; Long. 90° 30' W.; 58-60 fms.

*Distribution*.—Off the Galapagos and vicinity.

*Depth*.—From 20-60 fms.

*Specimens examined*.—The type and the following specimen from the *Velero* Expeditions:

190-34. Lat. 0° 55' S.; Long. 90° 30' W.; 58-60 fms., January 26, 1934, 1 specimen, type.

814-38. North of Hood Island, Galapagos, 20-40 fms., January 28, 1938, 2 specimens.

*Remarks*.—The type measures about 2 cm. with the tentacles withdrawn. The gonads form 2 well-developed tufts; so the animal may pos-



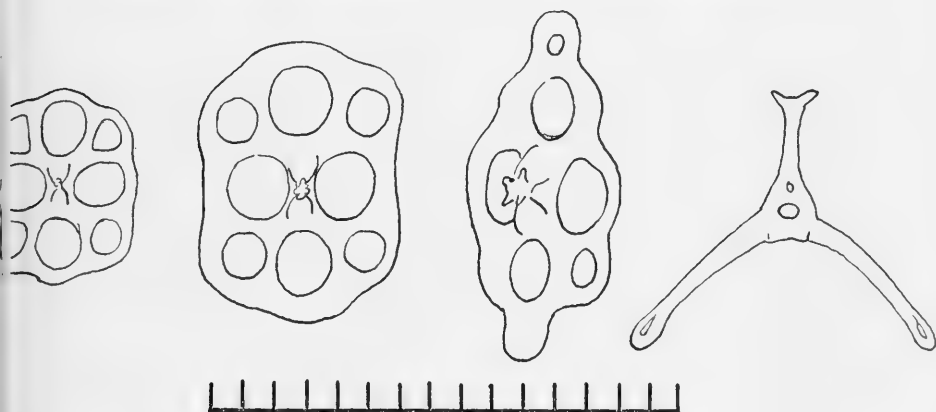
sibly have reached its full size. Other members of the genus, as for example *Thyone fusus*, reach a considerably greater length.

*Thyone neofusus* resembles *Thyone fusus*? from the West Indies (Deichmann, 1930, p. 167) but differs in the complete lack of a spire on the supporting plates; this may of course be a variable character. For the present it seems natural to segregate the various forms of *fuscus* until different material has been gathered to permit a critical survey. So far no closely related species have been reported from the Californian and Chilean waters or from Hawaii.

## 2. *Thyone bidentata*, new species

Plate 18, Figs. 13-16; text figure 4

*Diagnosis.*—Small form (few cm. long) with delicate to fairly stout feet, often in distinct bands and also scattered in the interambulacra. Inner anatomy typical of the genus. Spicules tables with oval to lozenge-



Text fig. 4. *Thyone bidentata*, new species, juv.  
1-3. Tables from integument.  
4. Supporting table from tube foot.  
Scale,  $\frac{1}{100}$  mm.

shaped disk with 4 central holes (and a few holes in the ends when the disk is lengthened); spire tapering to a cone with few teeth. Supporting tables with spire composed of 2 rods united into a slender spine, ending in 2 diverging teeth. Introvert with tables with numerous holes and low spire with diverging teeth; tentacles with a few rosettes. Color of preserved specimens pale brown.

*Type*.—Holotype, AHF no. 31.

*Type locality*.—Station 275-34, Tenacatita Bay, Mex., dredging in 25-35 fms., March 4, 1934.

*Distribution*.—From Gulf of Calif. to Colombia.

*Depth*.—From 12-30 fms.

*Specimens examined*.—The type and the following specimens from the *Velero* expeditions:

- 245-34. Bahia Honda, Panama, dredging 15-25 fms., February 21, 1934, 1 specimen.
- 249-34. Bahia Honda, Panama, 15-20 fms., February 22, 1934, 1 specimen.
- 251-34. Secas Islands, Panama, dredging in 15 fms., February 22, 1934, 1 specimen.
- 275-34. Tenacatita Bay, Mex., off Navidad, 25-35 fms., March 4, 1934, 3 specimens, type and paratypes.
- 423-35. Port Utria, Colombia, close to shore, 20 fms., January 25, 1935, 1 specimen.
- 679-37. Outside of Concepcion Bay, Gulf of Calif., 30 fms., March 15, 1937, 1 specimen.
- 683-37. Outside of Concepcion Bay, Gulf of Calif., 12 fms., March 15, 1937, 1 specimen.
- 686-37. Concepcion Bay, Gulf of Calif., 12 fms., March 16, 1937, 1 specimen.

*Remarks*.—The smallest paratype measures 0.5 cm. in length; the type and other larger specimens measure about 2 cm. In the smallest specimens the spicules are considerably smaller than in the larger as is so often the case, and many of the tables have a squarish disk with 4 accessory holes. In some of the larger individuals many tables are lozenge shaped with small accessory holes in the ends, while other individuals of the same size have almost exclusively oval disks with 4 holes.

The exterior of the animals shows considerable variation in regard to the size of the tube feet, which vary from delicate to fairly stout.

### 3. *Thyone parafusus*, new species

Plate 18, Figs. 7-12

*Diagnosis*.—Small form (few cm. long) with fairly stout feet, more or less distinctly arranged in bands and scattered in the interambulacra. Inner anatomy typical of the genus. Spicules form a crowded layer of

tables with oval disk with 4 holes and a well-developed handle on the inner side; spire tapering, ending in a few teeth. Feet with well-developed end plate and numerous supporting tables normally with 3 rods in the spire, which rapidly tapers into a short spine with a few teeth on the tip. Introvert with oblong tables with a varying number of holes. Tentacles packed with perforated plates of different sizes, with numerous holes; rosettes and delicate rods are present in the terminal branches.

*Type*.—Holotype, AHF no. 32, 1 paratype.

*Type locality*.—Station 272-34, Tenacatita Bay, Mex., 25 fms., March 4, 1934.

*Distribution*.—Tenacatita Bay, Mex.

*Depth*.—From 25 to 35 fms.

*Specimens examined*.—The type and one paratype from the *Velero* Expeditions:

272-34. Tenacatita Bay, Mex., 25 fms., dredging off Navidad Head, March 4, 1934, 1 specimen.

275-34. Tenacatita Bay, Mex., 25-35 fms., March 4, 1934, 1 specimen, type.

*Remarks*.—The type measures about 2 cm. with the oral end expanded. Several tentacles are torn off, and most of the inner organs are ejected.

The spicules resemble closely those found in *T. pseudofusus* Deichmann (1930, p. 168) from Yucatan, 25 fms. depth. The spicules differ in various respects; the West Indian form has tables with a short robust spire with numerous teeth and lacks apparently the numerous perforated plates in the tentacles.

#### 4. *Thyone strangeri*, new species

Plate 19, Figs. 1-11

*Diagnosis*.—Medium-sized form; numerous delicate feet scattered all over the body wall, often with conical or wartlike base. Calcareous ring with long posterior prolongations; interradials broad, more or less heart shaped, united by sutures with the radials. Stone canal small with a small head with thickened edges coiled up like a ball; Polian vesicle single.

Spicules a crowded layer of oblong tables, often with thickened edge and a varying number of knobs; number of holes in disk variable; spire small, on the verge of being reduced; teeth almost completely lacking on

the tip. Feet with large end plate and numerous supporting tables with a conical spire. Introvert with oblong tables, disk with knobbed edge and low spire. Tentacles with rosettes and delicate rods. Color brown, tentacles dark, blackish.

*Type*.—M.C.Z.

*Type locality*.—Isle Grande, west coast of Mexico (Lat.  $170^{\circ} 46'$  N.; Long.  $101^{\circ} 42'$  W.).

*Distribution*.—Known from the type locality.

*Depth*.—From 7 fms.

*Specimens examined*.—The type.

*Remarks*.—The type measures about 4 cm. with the tentacles withdrawn. The anterior portion is well preserved, but most of the intestine and respiratory trees are eviscerated. The gonads form well-developed tufts near the middle of the dorsal midline.

The spicules are extremely characteristic and different from those found in all other species known from the Panamic region as well as the adjacent waters. Superficially they may be mistaken for those of *Phyllophorus aculeatus* Ludwig, but comparison of the figures (plate 25) shows that they are entirely different.

### Genus 9. NEOTHYONE, new genus

*Stolus* Selenka (*partim*), 1867, p. 356.

*Diagnosis*.—Medium-sized forms with numerous feet; skin thick, packed with spicules. Tentacles 10, the 2 ventral smaller. Calcareous ring with posterior prolongations on the radials, in some species fairly short and soft, often inward curled, so that they easily escape notice. Single stone canal, one or more Polian vesicles, ventrally placed.

Spicules an external layer of specially modified buttons, with spines either on the outer handle or transformed into reticulated baskets, in some cases lost with advancing age. An inner layer consisting of numerous knobbed buttons, mostly with 4 holes; knobs distinct or almost obliterated. Feet with large end plate and numerous supporting tables with or without a spire. Introvert with a varying amount of tables or reduced buttons; tentacles with a varying number of heavy plates or rods, sometimes reduced with age. Rosettes seem to be present in certain species, at least in the younger individuals; possibly they represent a variable character.

*Type species*.—*Neothyone gibber* (Selenka).

*Remarks.*—The genus has been established to accommodate some of the species which have numerous buttons and distinct posterior prolongations on the radials. For the present 2 species from the West Indian waters and 3 from the Panamic region are placed in the genus. Of these latter, one may possibly deserve a genus of its own. No attempt has been made to discuss the various East Indian species with similar spicules that possibly belong in the genus.

KEY TO THE SPECIES OF *Neothyone* KNOWN FROM THE PANAMIC WATERS

- 1. Spicules large buttons, faintly knobbed; external layer of buttons with strongly spinous handle. Feet with stout supporting tables with well-developed spire. . . . . 1. *Neothyone gibber* (Selenka)
- 1. Spicules smaller or larger buttons strongly knobbed; external layer of buttons with few spines on the handle (often lost in older individuals) or transformed into baskets (the button itself is almost smooth with long delicate projections on the external side uniting into a delicate reticulum). . . . . 2
- 2. Feet with large smooth supporting rods with no trace of spire (except in some of the dorsal appendages). External layer of smooth buttons modified into baskets with the external side covered by a delicate reticulum; these deposits are apparently retained throughout the animal's life. . . . . 2. *Neothyone panamensis* (Ludwig)
- 2. Feet with curved, stout supporting tables with a varying amount of spire; spire often large and deformed in dorsal appendages; older individuals may lack spire completely, but often one side is expanded and lobate. External layer of buttons often with a few spines on the handle but this type is often rare or lacking in older individuals; often a few concave buttons with marginal spines form a simple type of baskets. . . . . 3. *Neothyone gibbosa*, new species

1. *Neothyone gibber* (Selenka)

Plate 20, Figs. 1-9; text figure 5

*Stolus gibber* Selenka, 1867, p. 356.

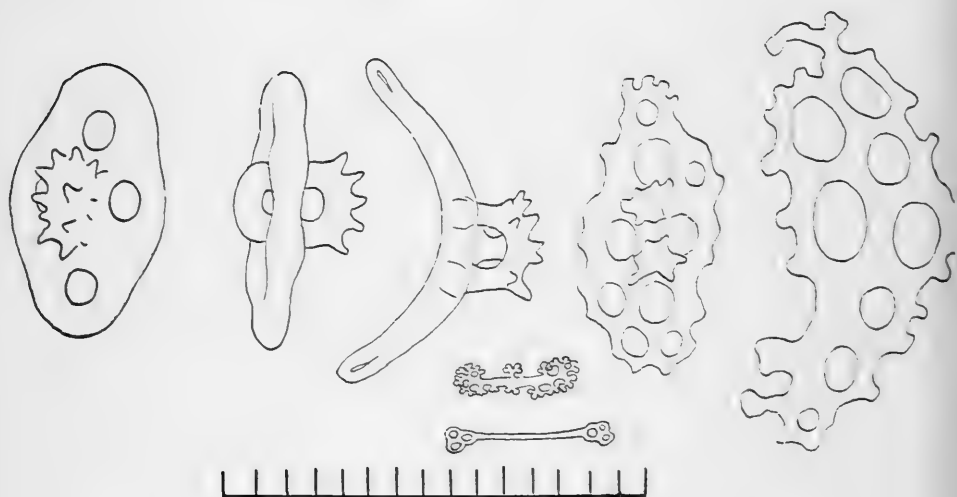
*Thyone gibber* Semper, 1868, p. 66.—Théel, 1886, p. 139.—Deichmann, 1936, p. 64 (*passim*).

Nec *Thyone gibber* Deichmann, 1938, p. 376, text figure 11 (*Neothyone gibbosa*, spec. nov., see below).

*Thyone similis* Ludwig, 1887, p. 23, pl. 2, fig. 7.

*Diagnosis*.—Medium-sized form, often with body strongly contracted and the blunt oral and anal ends upward curved. Calcareous ring fairly delicate with well-developed posterior prolongations on the radials; interradians narrow. Single dorsal stone canal, usually several Polian vesicles.

Spicules large 4-holed buttons varying from regularly knobbed to swollen; the latter are especially characteristic of the older individuals. The 2 knobs in the center of the button are often united to a handle on both sides of the button. The external layer of buttons has normally distinct teeth developed on the handle of the external side; sometimes accessory rods from the margin of the button connect with the spines. Feet with large end plate and numerous stout supporting tables with several rods in the spire and a varying number of teeth on the top. Introvert with



Text fig. 5. *Neothyone gibber* (Selenka), juv., still in the "Pentamera" stage.

- 1-2. Buttons.
  3. Supporting table.
  4. Table from introvert.
  5. Plate from tentacle.
  - 6-7. Rosette and rod from tentacle.
- Scale,  $\frac{1}{100}$  mm.

delicate tables with low spire and lacelike disk approaching rosettes in complexity. Tentacles with perforated plates which often disappear in the older individuals; besides more delicate rods and plates in the branches, also rosettes. Color dirty white to almost black; oral end or at least the tentacles and the introvert are always dark purplish to black in color.

*Type*.—M.C.Z.; paratypes in Göttingen.

*Type locality*.—Panama, depth not reported.

*Distribution*.—Known from Acapulco, Mex., to Lobos de Afuera Island, Peru, often in the same locations as *N. panamensis* (Ludwig).

*Depth*.—Tidemark to few fms., clinging to rocks.

*Specimens examined*.—The type and several specimens in various collections (from Acapulco, Panama, etc.).

From the *Velero* Expeditions the following specimens have been examined:

- 132-34. Braithwaite Bay, Socorro Island, Mex., 40 fms., January 4, 1934, 5 small specimens.
- 391-35. Lobos de Afuera Island, Peru, shore of main island with light-house, rocks, January 17, 1935, 34 specimens.
- 466-35. Parker Bay, Costa Rica, shore, February 9, 1935, 14 specimens.
- 473-35. Parker Bay, Costa Rica, rocks and algae, 2 fms., February 9, 1935, 2 specimens.
- 844-38. Lobos de Afuera Island, Peru, shore, February 14, 1938, 14 specimens.

*Remarks*.—Selenka's description is exceedingly brief and not accompanied by any figures. A good description and excellent figures are given by Ludwig, who described the species as *Thyone similis*, also from Panama.

*Neothyone gibber* differs from the other species with knobbed buttons from the Panamic region in its larger buttons, with strong tendency to obliteration of the knobs and the presence of numerous spines on the external handle. Deichmann referred erroneously a specimen of *Neothyone gibbosa* to this species (see p. 113), but the latter has very distinct knobs on the buttons, and these are also much smaller as shown by the figures here given.

The smallest individuals, from Station 132-34, measure less than 0.5 cm., and the feet are restricted to the ambulacra. The spicules are considerably smaller than in the larger individuals.

2. *Neothyone panamensis* (Ludwig)

Plate 21, Figs. 1-6

*Thyone panamensis* Ludwig, 1887, p. 22.—Deichmann, 1936, p. 64 (*passim*); 1938, p. 378 (*passim*).

*Diagnosis*.—Medium-sized form with numerous cylindrical tube feet on the ventrum, fewer and most papilliform on the dorsum. Calcareous ring with relatively broad radials with short posterior prolongations, often inward curved, so that they are easily overlooked. Other anatomical features as in the other species.

Spicules an external layer of baskets derived from oval smooth buttons, which on their external side develop a number of delicate projections that unite into a fragile meshwork. Spicules in the inner layer small regular 4-holed buttons, strongly knobbed. Ventral feet with large end plate and numerous large, almost flat, smooth supporting plates or rods, obviously derived from supporting tables but with no trace of spire. In the dorsal appendages the end plate is smaller, and the supporting tables often show traces of a spire and are more curved. Introvert with delicate buttons with various projections on the external side; tentacles normally with heavy rods or plates with numerous small holes and in the finer branches smaller, more delicate rods and plates. Apparently no rosettes. Color of dorsum and tentacles black; ventral side mostly white except near the oral and anal ends.

*Type*.—Possibly in Italy.

*Type locality*.—Coast of one of the islands in the Gulf of Panama.

*Distribution*.—Ranging from Panama to Peru, often taken in numbers with *Neothyone gibber*.

*Depth*.—From tidemark to few fms. depth.

*Specimens examined*.—The following individuals secured by the *Velero* Expeditions:

- 391-35. Lobos de Afuera Island, Peru, shore of main island with light-house, rocks, January 17, 1935, 2 specimens.
- 540-36. Puerto Refugio, Angel de la Guardia, Gulf of Calif., shore, March 3, 1936, 1 specimen.
- 844-38. Lobos de Afuera Island, Peru, shore, February 14, 1938, 13 specimens.

*Remarks*.—The type measured only 23 mm., while the present material (which is well expanded) measures up to 6 cm. in length. It is with some doubt that the material is referred to Ludwig's species, as he main-



tains that the calcareous ring lacks posterior prolongations, and he does not mention the difference in the form of the dorsal and ventral appendages and the striking black and white coloration. The calcareous ring does, however, superficially look as if it lacks posterior prolongations, and the differences between the dorsal and ventral appendages and the coloring may quite well be less pronounced in younger individuals. On the other hand, the description of the spicules shows no discrepancies, and the present species is the only "*Thyone*"-like form with such spicules as those described by Ludwig. Also it speaks in favor of the identification that it is usually found in the same localities as *Neothyone gibber*.

*Neothyone panamensis* is easily recognized on account of its color and the arrangements of its feet. Also the spicules are very striking. The baskets seem to be retained throughout the animal's life and are numerous in all preparations, while the large, smooth supporting plates from the ventral feet form another character which is not easily overlooked.

The *Velero* specimens have large tufts of gonads and appear to be adult individuals.

### 3. *Neothyone gibbosa*, new species

Plate 21, Figs. 7-11; Plate 22, Figs. 1-8

*Thyone gibber* Deichmann, 1938, p. 376, text figure 11. Nec *Thyone* (*Stolus gibber* Selenka, 1867, p. 356, now *Neothyone gibber*, see above).

*Diagnosis*.—Medium-sized form superficially resembling *Thyone gibber* in its external and internal anatomy.

Spicules an insignificant layer of shallow knobbed baskets derived from buttons, easily overlooked, and an inner layer of regular 4-holed buttons strongly knobbed mostly with handle and some with a few spines of varying size on the handle. Feet with large end plate, walls with numerous heavy supporting tables, mostly with low spire composed of several rods, occasionally more well-developed spire may be found; especially in the dorsal feet in older individuals a number are developed as smooth plates often with one side expanded, with scalloped edge. Introvert with a varying number of mostly larger tables with numerous holes in the oblong disk and a low spinous spire. Tentacles with heavy perforated plates and rods decreasing in size in the branches; in many cases also rosettes. Color in alcohol dirty gray or reddish, often darker mottled in the interambulacra; tentacles rather darkly colored.

*Type*.—Holotype, AHF no. 33.

*Type locality*.—Station 545-36, Puerto Refugio, Angel de la Guardia Island, Gulf of Calif.

*Distribution*.—From the upper end of the Gulf of Calif. to Mazatlan, Mex.

*Specimens examined*.—The type and the following individuals from the *Velero* Expeditions:

- 465-35. Playa Blanca, Costa Rica, shore, February 8, 1935, 1 specimen.  
545-36. In Puerto Refugio, Angel de la Guardia Island, west of rock spit at river wash, shore, March 4, 1936, type and 4 paratypes.  
591-36. Port Escondido, L. Calif., Mex., shore, March 16, 1936, 2 specimens.  
844-38. Lobos de Afuera Island, Peru, shore, February 14, 1938, 1 specimen.

Also a number of specimens in the M.C.Z. collection from Mazatlan, Mex., shore, Situantanejo Bay, Mex., and Costa Rica, shore.

*Remarks*.—It is with some doubt that the present material has been referred to a new species, for the spicules are—aside from the absence of heavy plates covered by a stout reticulum—highly reminiscent of those found in *Pachythyone pseudolugubris*, which is described below, and the latter does actually occur in the same localities as *Neothyone gibbosa*. The buttons have, however, more frequently 3 knobs on the external handle and show little tendency to become elongate as in *pseudolugubris* where the 2 central knobs frequently remain separate.

#### Genus 10. PACHYTHYONE, new genus

*Diagnosis*.—Small forms (few cm. long) with stout feet in 5 bands and numerous in the interambulacra; dorsally and toward the ends more papilliform. Ventral tentacles smaller. Calcareous ring with short posterior prolongations. Single stone canal, single Polian vesicle. Gonads forming 2 tufts of few tubes.

Spicules an external layer of oval buttons or plates with the external side covered by a dense reticulum; an inner layer of oblong 4-holed buttons regularly knobbed. Feet with end plate, reduced in the papilliform feet; walls supported by supporting tables with numerous rods in the reticulated spire; a few developed as plates. Introvert with oblong tables; tentacles with heavy perforated plates which gradually become smaller and more delicate in the branches.

*Type species*.—*Pachythyone rubra* (H. L. Clark).

*Remarks.*—Only 3 species have been referred to the genus; all are known from the western coast of North and Central America and two are viviparous.

KEY TO THE SPECIES OF *Pachythyone*

- 1. Color white ventrum and red dorsal side and ends. Spicules slightly larger and robust; plates in tentacles mostly knobbed.  
 . . . . . 1. *Pachythyone rubra* (H. L. Clark)
- 1. Color mottled brown. Spicules more delicate; plates in tentacles mostly smooth . . . . . 2
- 2. Supporting tables with strongly branching spire, even in the ventral feet. . . . . 2. *Pachythyone lugubris* (Deichmann)
- 2. Supporting tables with low spire, at least in the ventral feet.  
 . . . . . 3. *Pachythyone pseudolugubris*, new species

1. ***Pachythyone rubra*** (H. L. Clark)

Plate 23, Figs. 10-12

*Thyone rubra* (H. L. Clark), 1901, p. 166; text figures 1-5; 1901a, p. 494.—Deichmann, 1939, p. 5 (*passim*); text figure 3.

*Diagnosis.*—Small, robust form, few cm. long, with stout cylindrical feet in 5 longitudinal bands and scattered in the interambulacra; dorsally the feet show some tendency to become papilliform. External and internal anatomy typical of the genus. Spicules an outer layer of oval plates covered on the external side by a large reticulum; an inner layer of mostly regular 4-holed buttons with 10 marginal knobs and usually 2 central knobs; often the button is lozenge shaped with an accessory hole in each end. Feet with large end plate, reduced in some of the dorsal feet, and numerous large supporting tables with a huge reticulated spire; in some of the dorsal feet it covers almost the entire disk of the supporting table. Introvert with oblong tables with more or less completely reduced 2-pillared spire, sometimes with a few teeth. Tentacles with knobbed plates or rods. Apparently rosettes are not present. Color bright orange-red dorsum and ends, ventrum pure white. (Color retained in alcohol.) Viviparous; the body cavity of the female contains often about half a dozen embryos of different developmental stages.

*Type.*—M.C.Z.

*Type locality.*—Monterey Bay.

*Distribution*.—From Monterey Bay to Santa Cruz Islands, off Santa Barbara County, southern California.

*Specimens examined*.—The type and numerous individuals, preserved as well as living, from Monterey to Santa Cruz Islands.

*Remarks*.—Differs from the other 2 species in the color and the much heavier spicules.

## 2. *Pachythyone lugubris* (Deichmann)

Plate 23, Figs. 7-9; text figure 6

*Thyone lugubris* Deichmann, 1939, p. 1, text figures 1-2.

*Diagnosis*.—As for the genus. Color mottled brown. Spicules slightly smaller and more delicate than in *P. rubra*; tentacles without knobbed plates. Rosettes absent or rare. Viviparous.

*Holotype*.—U.S.N.M.

*Type locality*.—Magdalena Bay, west coast of L. Calif., 10-15 fms.

*Distribution*.—Between Magdalena Bay and Cerros Island, west coast of L. Calif.

*Depth*.—10-40 fms.

*Specimens examined*.—The types and the following specimens from the *Velero* Expeditions:

283-34. Thurloe Bay, L. Calif., 8-10 fms., off Thurloe Point, March 9, 1934, 5 specimens.

287-34. South Bay, Cerros Island, Mex., 10-15 fms., March 10, 1934, 12 specimens.

*Remarks*.—The type, a female, contained 13 embryos (collected in June). In the Hancock material collected earlier in the year no embryos were discovered.

While the type material appeared to be devoid of rosettes in the tentacles, a few were found in the Hancock material which came from a much more northern locality.

## 3. *Pachythyone pseudolugubris*, new species

Plate 22, Figs. 9-10; Plate 23, Figs. 1-6; text figure 6

*Diagnosis*.—Medium-sized form (up to 5 cm. long). Resembles *lugubris* in the external and inner anatomical features. Spicules an external layer of reticulated plates, an inner layer of regularly knobbed 4-holed buttons rarely elongate and with accessory holes in the ends. Feet with well-developed end plate; walls supported by numerous curved supporting tables with a low spire or none in the ventral feet; in the dorsal a number

have a well-developed complex spire, although rarely as large as in *lugubris*. Introvert with large tables with numerous holes and reduced spire. Tentacles exclusively with delicate rods or plates perforated by a large number of holes. Color mostly mottled brown, sometimes almost black; occasionally a pale faded specimen may be encountered in the preserved material.

*Type*.—Holotype, AHF no. 34.

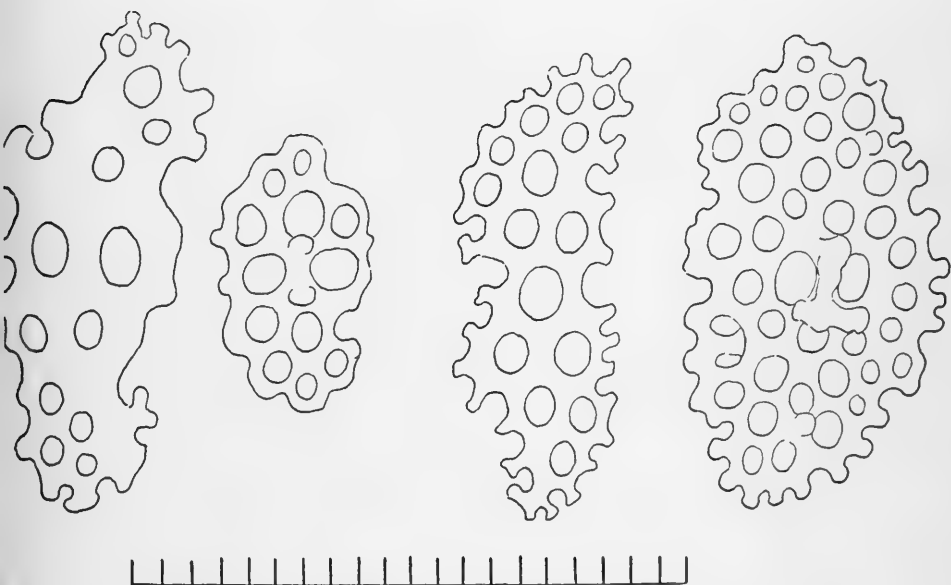
*Type locality*.—Station 744-37, near Point Piaxtla, Sinaloa, Mex., Gulf of Calif., April 1, 1937, 6-8 fms.

*Distribution*.—From the upper end of the Gulf of Calif. to the Galapagos.

*Depth*.—From 6-25 fms.

*Specimens examined*.—The type and paratypes and a number of individuals secured at the following *Velero* stations:

145-34. North end of Albemarle Island, 6-7 fms., January 12, 1934, 1 specimen.



Text fig. 6. *Pachythyone lugubris* (Deichmann).  
 1-2. Plate from tentacle and table from introvert.  
*Pachythyone pseudolugubris*, new species.  
 3-4. Plate from tentacle and table from introvert.  
 Scale,  $\frac{1}{100}$  mm.

- 264-34. Petatlan Bay, Mex., 25 fms., March 2, 1934, 1 specimen.  
683-37. Outside of Concepcion Bay, Mex., March 15, 1937, 30 specimens.  
744-37. Near Point Piaxtla, Sinaloa, Mex., Gulf of Calif., April 1, 1937, 7 specimens.

*Remarks.*—The species resembles *lugubris* to an extraordinary degree, and future workers may decide that it merely represents a variety of that form. It is easily distinguished by the more simple supporting tables in the ventral feet, the shorter buttons which seem to lack all tendency to become lozenge shaped with accessory holes in the ends, and in the larger tables in the introvert and the absence of heavier rods and plates in the stem of the tentacles. The larger size and the darker color are, of course, quite useless characters, as *lugubris* possibly may be discovered to reach the same size and, although a dark color is common, paler individuals have been found. In no case have embryos been discovered, so presumably this species is not viviparous as are *lugubris* and *rubra*.

The species has in some localities been found with the larger and paler *Neothyone gibbosa*, and the possibility has been considered that the latter represents senescent specimens of *pseudolugubris*, in which the external layer of reticulated plates has been lost. The spicules seem, however, to be definitely different. *Pachythyone pseudolugubris* shows little tendency to form handles, and the buttons have rarely more than 2 central knobs (except in the lozenge-shaped buttons), while *Neothyone gibbosa* normally forms handles, and as often as not the external handle has 3 knobs. Also the latter species shows definitely a tendency to develop large, smooth supporting plates in the ventral feet, while such plates are almost unknown in *Pachythyone pseudolugubris*, where the few supporting plates which lack a spire are narrow, thick, and in most cases knobbed.

#### Genus 11. *ATHYONE*, new genus

*Diagnosis.*—Medium-sized to large forms. Feet numerous, fairly stout. Tentacles large, bushy, the 2 ventral smaller. Skin soft, with few spicules. Calcareous ring stout with broad radials with distinct posterior prolongations and tall interradials with short anterior tooth.

Spicules scattered swollen 4-holed buttons, often incomplete. Feet with loose-meshed end plate and numerous supporting rods, undoubtedly derived from tables. Introvert and tentacles with rosettes.

*Type species.*—*Athyone glasselli* (Deichmann).

*Remarks.*—The diagnosis is based on the type of *glasselli*, a single adult individual. More material is needed, especially of younger individuals, to complete the diagnosis. The genus is not related to any other form known from the Panamic region. From the west coast of North America a form with somewhat similar spicules is known, *Thyone benti* Deichmann, including a variety, var. *zacaе*, from off Cerros Island, Lower California, but that species has a taller, more delicate calcareous ring, exceedingly small tentacles, and larger spicules.

### *Athyone glasselli* (Deichmann)

*Thyone glasselli* Deichmann, 1936, p. 63, text figure 1; 1937, p. 170, text figure 2. (Comparison with *T. benti*.)

*Diagnosis.*—As for the genus. Color brownish. Resembles superficially *Thyone briareus* (Lesueur) from the coast of North America. Shallow-water form.

*Type.*—M.C.Z., cat. no. 736.

*Type locality.*—Punta Penasco, Sonora, Mexico.

*Distribution.*—Known only from the type locality.

*Depth.*—Shore, buried in sand.

*Specimens examined.*—The type.

*Remarks.*—The strongly contorted type specimen must have measured more than 10 cm. in expanded, normal condition. More material is necessary to explain from what type of spicules the buttons and rods are derived. Very likely younger individuals may have distinct spire on the buttons and the supporting rods and thus be derived from tables.

The species is not closely related to any other species known from the Panamic region. *Thyone benti*, from Puget Sound, and var. *zacaе* from Cerros Island have similar spicules but much larger and definitely derived from tables; the calcareous ring is much more tubular and more delicate and the tentacles are unusually small. From the southern part of South America *Thyone lechleri* Lampert is known to have similar swollen buttons, but the calcareous ring is entirely different with no posterior prolongations at all.

The only other soft-skinned *Thyone* with few spicules described from the Panamic region is the dubious *Anaperus peruana* Troschel, possibly identical with Lesson's species (see discussion, p. 120).

Regarding *Thyone ovulum* Selenka, which Deichmann (1936, p. 65) mentioned as possibly the juvenile stage of *A. peruana*, the type has been re-examined and found to be a phylloporid (see p. 125).

## Genus 12. ANAPERUS Troschel

*Anaperus* Troschel (*partim*), 1846, p. 60.

*Diagnosis*.—Large form with soft skin and numerous feet distributed without order. Tentacles 10, the 2 ventral smaller. Anus with calcareous teeth. Calcareous ring with posterior prolongations (apparently short); retractor muscles fleshy. Spicules not numerous except in the stem of the tentacles.

*Type species*.—*Anaperus peruviana* (Lesson).

*Remarks*.—As type species for this dubious genus Lesson's large dendrochirote species from Payta, Peru, has been chosen since it is a question whether *Thyone briareus* (Lesueur) from the western Atlantic belongs in the genus; *Thyone fusus* (O. F. Müller)—the type species for *Thyone* s. str.—does definitely not belong here, and the fourth species, listed by Troschel as *Thyone cigaro* Troschel, from Labrador, cannot be identified.

It is furthermore doubtful whether Lesson's and Troschel's species are identical. Very likely Lesson's species is a phylloporid (*Pattalus mollis* (Selenka)), while Troschel's species is a soft-skinned *Thyone* which resembles *T. briareus*; (Selenka actually united the 2 species after having examined Troschel's material in Berlin).

The only other soft-skinned large *Thyone* known from the upper end of the Gulf of California is *Athyone glasselli* (Deichmann), which possibly may occur as far south as Peru. If we discount Troschel's statements about the color and size of his *A. peruana*—as they seem to be borrowed from Lesson's description—the assumption is not unreasonable. If re-examination of Troschel's material in Berlin should prove that that is the case, the name *Athyone* becomes a synonym of *Anaperus*; in that case *Thyone briareus* is excluded from the genus, and Troschel's species must be named *Anaperus glasselli* (Deichmann), syn. *A. peruana* Troschel, nec *Holothuria peruviana* Lesson.

Another possibility is that Troschel's species is simply material of *Thyone briareus* which has been wrongly labeled. Such errors were by no means unusual in older times.

**Anaperus peruviana** (Lesson)

*Holothuria peruviana* Lesson, 1830, p. 124, pl. 46, fig. 1.

*Trepang peruana* Jaeger, 1833, p. 25.—Brandt, 1835, p. 57.

*Anaperus peruanus* Troschel, 1846, p. 61.—J. Müller, 1854, pl. 9, fig. 9.



*Thyone peruana* Selenka, 1867, p. 354.—Lampert, 1885, p. 160.—Semper, 1868, p. 242.—Théel, 1886, p. 140.—Deichmann, 1936, p. 65 (*passim*).

Nec *Anaperus carolinus* Troschel, 1846, p. 62, nec *Thyone tenella* Selenka, 1867, p. 354, pl. 20, figs. 113-114. Referred to *Thyone peruana* by Selenka, 1868, p. 118 (both are synonyms of *Thyone briareus* and both came from the Atlantic coasts of North America).

*Diagnosis*.—No diagnosis can be given, as Lesson and Troschel possibly had two different species before them.

*Type*.—Probably lost, or in Paris.

*Type locality*.—Payta, Peru.

*Remarks*.—Lesson's description and figure refer to an exceptionally large form, 6 inches long, with 8 bushy tentacles, numerous feet, and soft skin. The color of the animal was deep purplish.

Troschel's numerous specimens in Berlin, likewise from Peru, refer apparently to a typical *Thyone*. They seem to resemble the West Indian *Thyone briareus* Lesueur and have similar short posterior prolongations on the radials and distinct anal teeth; the 2 ventral tentacles are smaller (according to Troschel they were probably overlooked by Lesson, since he figured only 8). The calcareous spicules were not studied; Troschel mentions merely that they were numerous in the stem of the tentacles. The size and color given by Troschel may very likely be quoted directly from Lesson.

Selenka re-examined Troschel's material and decided that *Anaperus carolinus* Troschel and his own *Thyone tenella* from, respectively, Carolina and Texas were synonyms of the Peruvian form (both names are synonyms of *Thyone briareus* Lesueur, the common large *Thyone* from the eastern coasts of the United States).

Lampert may possibly have examined some specimens of *T. briareus* and based his few remarks concerning *Thyone peruana* on a study of this material but not on the true Peruvian form; J. Müller discusses (1854, p. 85) the stone canal and figures (p. 9), one from *A. peruana*, possibly from Troschel's material, but nothing of importance can be gleaned from his drawing.

Whether Selenka for once was hasty in his identification or whether Troschel's material was mislabeled and actually represented material of *Thyone briareus* is impossible to decide. If the latter is true, it is obvious that the statements regarding the size and color came from Lesson's de-

scription. So far, no species which resembles *Thyone briareus* is known from the Pacific coasts of America except *A. glasselli*.

To solve the question it is necessary to re-examine Troschel's material in Berlin and possibly Lesson's type, if still extant. Very likely Lesson described *Pattalus mollis*, the only large purplish form, and overlooked some of the tentacles, while Troschel had either mislabeled material of *Thyone briareus* before him, an undescribed *Thyone*, or *Athyone glasselli*.

## Family II. Phylloporidae

*Diagnosis.*—Dendrochirota with more than 10 tentacles, the number ranging from 15 to 30. The tentacles either definitely of two sizes, large in the external circle, small in the inner, and appearing almost simultaneously, or the sizes intergrade, the 2 circles being indistinctly set off from each other, and the full number is reached comparatively late in life. Feet restricted to the ambulacra, or scattered also in the interambulacra. Calcareous ring simple, or with distinct posterior prolongations; stone canal and Polian vesicle often in large numbers.

Spicules of various kinds, mostly as tables, often reduced with age. Feet with end plate; walls with or without supporting tables or rods. Introvert with tables or plates, tentacles with or without spicules. The majority are shallow-water forms.

*Remarks.*—A preliminary revision has been undertaken (Deichmann, 1938) which includes all the genera known from the American waters. To this list is now added *Athyonidium*, established for the species formerly known as *Thyone chilensis* Semper. The latter is synonymous with *Eucyclus duplicatus*, new genus, new species, established by Lampert, 1885, pp. 290-292. Lampert was fully aware of the close similarity to Semper's species *Thyone chilensis* from Chile. Théel discussed the question; he believed the two species were identical but concluded that the number of tentacles possibly was more variable in the polychirote forms than generally known. Ludwig concurred in Théel's opinion and assumed that the tentacles were merely overlooked by Semper. He rejected, however, the genus *Eucyclus* as superfluous and united it with *Thyonidium* under *Phylloporus*. The *Velero III* has procured ample material of a form which unquestionably refers to the species which Semper examined. As in the case of *Thyone ovulum* Selenka—now *Euthyonidium*—in which Selenka overlooked the inner circle of smaller tentacles, so here the inner

circle of smaller tentacles was completely missed by Semper and the species therefore likewise referred to *Thyone*.<sup>6</sup> The genus resembles the northern genus *Thyonidium* but is distinguished by the almost completely resorbed interradials. As *Eucyclus* is preoccupied, a new genus had to be established.

KEY TO THE GENERA OF PHYLLOPHORIDAE KNOWN FROM THE  
PANAMIC REGION AND CHILEAN WATERS

All the genera known from this region have at utmost 20 tentacles, and the feet are numerous in the interambulacra as in the genus *Thyone*.

1. Tentacles distinctly of 2 sizes, i.e., 10 large ones in the external circle and either 5 small ones, more or less deeply divided, or 5 small pairs of equal size in the inner circle. . . . . 2
1. Tentacles of varying number and size, sometimes of almost the same size; the 2 circles are more or less confluent. . . . . 3
2. Calcareous ring low, simple (or with insignificant posterior projections); interradials well developed, often pentagonal or heart-shaped—in many cases overlapping the radials. Spicules derived from 2- to 4-pillared tables, often reduced to plates with 2-4 knobs or spines indicating the pillars. Feet with end plate but no supporting tables, sometimes a few rods. Tentacles with rosettes and delicate rods. 1. *Euthyonidium* Deichmann p. 124
2. Calcareous ring low, simple; radials with long anterior tooth, interradials completely vestigial, easily overlooked. Spicules apparently lacking except for the end plate and a few branching rods. . . . . 2. *Athyonidium*, new genus p. 127
3. Calcareous ring simple; radials tall, posteriorly slightly incised; interradials well developed. Spicules almost totally lacking, except for end plate and a few perforated plates. Tentacles 20, large, of almost equal size. Large reddish species. . . . .  
. . . . . 3. *Pattalus* Selenka p. 129
3. Calcareous ring with long posterior prolongations. Tentacles of different size, fairly delicate. Spicules 2- to 4-pillared tables sometimes scarce in older individuals. Small- to medium-sized forms. . . . . 4. *Phyllophorus* Grube p. 132

<sup>6</sup> In other specimens Semper noticed the inner circle of smaller tentacles and these he referred to *Pattalus* with a comment on the variability of the tentacles in this genus.

Genus 1. **EUTHYONIDIUM** Deichmann

*Euthyonidium* Deichmann, 1938, p. 380.

*Diagnosis.*—Medium-sized form (length 10 cm. or less). Tentacles definitely arranged as 10 large ones in 5 external pairs and 5 inner pairs (or 5 single ones?)<sup>7</sup> which are smaller. Apparently all the tentacles appear at an early stage. Calcareous ring simple with tall rectangular radials, posteriorly with short protuberances which may be interpreted as rudimentary prolongations. Interradials well developed.

Spicules small tables with oval to squarish disk, often with dentate or branching margin; spire low, 2-4 pillared often reduced to knobs or spines or totally resorbed. Feet with large end plate and often a few small supporting rods, rarely with trace of being derived from tables. Introvert with tables with numerous holes in the disk and spire often reduced. Tentacles with rosettes and delicate rods. Spicules often reduced with advancing age. Shallow-water forms, restricted to the tropical waters.

*Type species.*—*E. seguroensis* (Deichmann).

*Remarks.*—From the West Indies 2 species are known, viz., the type species and *E. occidentalis* (Ludwig). From the Panamic region 2 species are now known; one represents the species which formerly was known as *Thyone ovulum* Selenka, and the other, which is new, is closely related to *E. occidentalis* from the West Indies.

KEY TO THE SPECIES OF *Euthyonidium* KNOWN FROM THE  
PANAMIC REGION

1. Spicules oblong tables with dentate edge; spire 2 pillared, low, often reduced to knobs or spines, or lacking. Color grayish. . . . . 2. *Euthyonidium veleronis*, new species
1. Spicules large tables with cross-shaped disk, often irregularly lacinated; spire mostly reduced to a few knobs or spines. Color reddish brown. . . . . 1. *Euthyonidium ovulum* (Selenka)

1. ***Euthyonidium ovulum*** (Selenka)

Plate 24, Figs. 1-7

*Stolus ovulum* Selenka, 1867, p. 356, pl. 20, fig. 117.—Semper, 1868, p. 66.—Lampert, 1885, p. 162.—Théel, 1886, p. 138.

<sup>7</sup> The inner smaller pairs may possibly in some forms be found to be 5 single tentacles which are deeply divided as Heding (1936, p. 23) has found it to be the case in the type species of the closely related genus *Thyoniidium* from the northern seas.

*Thyone ovulum* Deichmann, 1936, p. 64 (*passim*).

*Euthyonidium ovulum* Deichmann, 1938, p. 380, text figure 12.

*Diagnosis*.—Medium-sized form (probably about 10 cm. long) with soft, thick skin with numerous soft feet. Tentacles 10 large external ones and 10 inner ones which are much smaller and may be completely retracted into small pockets. Calcareous ring with radials posteriorly broad and deeply incised and tapering toward the anterior end; interradials unusually broad and heart shaped with a slight posterior incision, anteriorly tapering to a point. Stone canals numerous and free, also several Polian vesicles. Inner anatomy otherwise normal.

Spicules a scattered layer of tables with irregular disk varying from cross-shaped to a more or less branching or lacinated plate. Spire almost always reduced to a few spines. Feet with large end plate; supporting rods are apparently totally lacking. Introvert seems to lack spicules; tentacles with few rosettes and delicate rods. Spicules more or less completely reduced with advancing age and, except for the end plate, likely to be completely overlooked.

*Type*.—M.C.Z.

*Type locality*.—Acapulco, Mexico.

*Distribution*.—From Lower California to Peru.

*Specimens examined*.—Selenka's type specimens (3) and several specimens from the Allan Hancock Expeditions:

261-34. Tangola Tangola, Mex., 1 fm., March 1, 1934, 1 specimen.

591-36. Port Escondido, L. Calif., Mex., shore, March 16, 1936, 40 specimens.

844-38. Lobos de Afuera Island, Peru, shore, February 14, 1938, 1 specimen.

*Remarks*.—Re-examination of Selenka's type material of *Stolus ovulum* showed that Selenka had overlooked the inner circle of tentacles which were completely withdrawn into little pockets and that it was identical with various individuals collected by the Hancock Expeditions, and also by the *Zaca*.

*Euthyonidium ovulum* has the same reddish-brown color which is extracted in alcohol as the much larger species *Pattalus mollis* Selenka from Peru and Chile. It would therefore be correct to consider whether the two forms are merely growth stages of the form which possibly ought to be called *Pattalus peruana* (Lesson)—see discussion under *Pattalus* and *Anaperus*. Deichmann (1936) considered *ovulum* as possibly being identical with Lesson's species (which was figured as having 8 tentacles)

but was at that time unaware that *ovulum* was not a true *Thyone*. It would, however, be a hitherto unknown phenomenon that the smaller tentacles in the inner circle of a phylloporid should be able to catch up in size with the large ones, and for that reason alone it would seem unlikely that *ovulum* could grow into *Pattalus mollis* usually with about 20 tentacles of almost identical size. Furthermore, the latter shows great variation in the number of tentacles, while *ovulum* invariably seems to acquire the full number at an early age.

## 2. *Euthyonidium veleronis*, new species

Plate 24, Figs. 8-11

*Diagnosis*.—Medium-sized form, up to 10 cm. long; body tapering toward both ends with numerous soft feet scattered over the interambulacra; toward the oral and anal ends arranged in a more orderly manner along the ambulacra. Tentacles 5 large external pairs, and 5 inner smaller pairs closely appressed.<sup>8</sup> Calcareous ring with 5, almost rectangular radials; posteriorly with short projections; interradials more or less heart shaped, with the point forward directed, and overlapping the radials. Stone canal single, attached in the dorsal mesentery; Polian vesicles usually 3 in number, muscle stomach delicate; intestine with normal course; retractors attached near the middle of the body where the 2 tufts of gonads are also attached.

Spicules a scattered layer of small tables with oval to squarish disk with about 8 holes and dentate edge; spire low, mostly with 2 pillars, often reduced to knobs. Feet with large end plate and occasionally a few supporting rods. Introvert with tables; tentacles with rosettes and small curved rods, mostly with perforated ends. Color mottled grayish.

*Type*.—Holotype, AHF no. 35.

*Type locality*.—Station 465-35, Playa Blanca, Costa Rica, shale beach between sand beach and rock reef, shore, February 8, 1935, 1 specimen.

*Distribution*.—The type locality.

*Depth*.—Shore.

*Specimens examined*.—The type.

*Remarks*.—The species is closely related to *E. occidentalis* (Ludwig) known from the West Indies.

<sup>8</sup> As only the type was available, the tentacles in the inner circle were not dissected out, but very likely this species has only 5 tentacles, deeply cleft, in the inner circle.

Genus 2. **ATHYONIDIUM**, new genus

*Eucyclus* Lampert, 1885, p. 290.—Théel, 1886, p. 268.—Ludwig, 1887, p. 1239 (reprint p. 23). Name preoccupied.

*Diagnosis*.—Large forms (25 cm. or more) with thick, soft skin and numerous stout feet. Tentacles 5 large external pairs and 5 small inner pairs. Calcareous ring with 5 stout, almost rectangular radials and 5 insignificant interradians, often completely concealed in the tissue. One large dorsal stone canal, often branched and one or two tufts of smaller stone canals with minute heads. Numerous tufts of branched Polian vesicles. Inner anatomy seems otherwise quite typical of the family.

Spicules large well-developed end plates, a few perforated spinous rods; tentacles with few rosettes in the younger individuals. Color grayish mottled to almost black, ventrum paler, tentacles dark. Shallow-water forms.

*Type species*.—*Athyonidium chilensis* (Semper).

*Remarks*.—The genus is monotypic and related to *Thyonidium* and *Euthyonidium*, but the strikingly reduced interradians give it a position almost unique among the Phyllophoridae. Very little can be said about the spicules, as they are reduced even in small individuals (5 cm. long). They may be present in still younger specimens, and one would expect them to be tables, possibly with the spire reduced.

***Athyonidium chilensis*** (Semper)

*Thyone (Stolus) chilensis* Semper, 1868, p. 241, pl. 40, figs. 3-6.—Lampert, 1885, p. 156.—Théel, 1886, p. 139.

*Eucyclus duplicatus* Lampert, 1885, p. 250.—Théel, 1886, p. 268.

*Diagnosis*.—As for the genus.

*Type*.—Possibly in Germany.

*Type locality*.—Coast of Chile.

*Distribution*.—From Chile to Ancon, Peru.

*Depth*.—Shallow water, at tidemark, in sand.

*Specimens examined*.—The following material from the Allan Hancock Expeditions:

828-38. San Juan Bay, Peru, shore, February 8, 1938, numerous specimens.

831-38. Independencia Bay, Peru, shore, February 9, 1938, 3 specimens.

Also the following specimens in the M.C.Z.: 21 from Talcahuana, Chile; 3 thrown up on the beach in Ancon, Peru, with *Pattalus mollis*.

*Remarks.*—I have ventured to transfer Semper's *Thyone chilensis* to this genus, as his description of that unusual form agrees exactly with the numerous specimens I have had occasion to examine, and the species differs distinctly from *Pattalus mollis* Selenka, of which I have likewise had the opportunity to study a long series. My results are in complete agreement with Ludwig's conclusions, that Lampert's species is a synonym of Semper's *Thyone chilensis* (and probably some or all of his *Pattalus mollis*). But contrary to Semper's and Théel's belief, the number of tentacles is constant in this species.

The inner circle of tentacles is often completely withdrawn so that only the 10 larger ones are visible. The inner tentacles become quite stout with advancing age but remain, nevertheless, always distinctly smaller than the external ones, and the inner circle is well separated from the outer one. The radials, as Semper describes them, are slipper shaped, almost rectangular, broadest posteriorly with a large depression below the attachment for the retractors; the interradials are small in the young individuals; in the older they are completely concealed in the thick tissue, and the calcareous ring appears to be composed of 5 stout radials. Semper noticed only one tuft of small accessory stone canals but may possibly have failed to examine both sides of the mesentery. The Polian vesicles are distinctly arranged in tufts, and most of them are branched.

Except for the presence of end plate and a few rosettes in the tentacles, spicules are so rare that they often are difficult to find. Semper figures a few branching rods perforated by a few holes, and such spicules have been found.

The color is strikingly different from that of *Pattalus mollis* even in preserved individuals. It is mottled gray, sometimes almost black on the dorsal side, with paler ventral side and black tentacles. In freshly collected individuals the tube feet may have a reddish tinge, possibly caused by the hemoglobin contained in the water vascular system. The skin seems never to contain a reddish pigment as *Pattalus mollis*, nor does it ever fade to that uniform dull reddish brown which is so characteristic of Selenka's species.

*Athyonidium chilensis* seems to be the most common phylloporid known from Chile. On the coast of Peru it is often known to occur in the same localities as *Pattalus mollis*, but buried in sand with the tentacle crown expanded on the surface, while the former clings to the rocks (H. L. Clark's observations).



The *Velero* material measures from 5 to 20 cm.; the largest individuals in the M.C.Z. measure more than 25 cm. in length.

The occurrence of this typical Chilean species in Peruvian waters makes it impossible to decide whether this species or *Pattalus mollis* represents Lesson's troublesome form, *Holothuria peruana*. Possibly a careful survey at Payta, the type locality for *peruana*, may show that only one of the 2 species occurs there. *Pattalus mollis* Selenka does occur in Payta (material in the M.C.Z.), but *A. chilensis* also may possibly be found there, for both species are known to occur in the same localities, i.e., at Ancon, Peru, and at Station 828-38.

### Genus 3. PATTALUS Selenka

*Pattalus* Selenka, 1868, p. 113.

*Diagnosis.*—Large form (20 cm. or more) with up to 20 large tentacles of almost equal size. Skin thick with numerous tube feet. Calcareous ring with 5 tall rectangular radials, with posterior corners rounded into low protuberances; interradials with broad low basal part and a long anterior tooth, often concealed in the thick tissue. Dorsally a long stone canal with small head; Polian vesicles numerous, hanging as a fringe around the ring canal, a few are dichotomously divided. Other anatomical features typical of the family.

Spicules a few branched rods, feet with large end plate. Color reddish brown with a pigment which is dissolved in alcohol; specimens which have been preserved in alcohol for a long time are uniformly dull brown. Shallow water.

*Type species.*—*Pattalus mollis* Selenka.

*Remarks.*—The genus is monotypic and seems not related to any other form. It has in the course of time been confused with *Athyonidium chilensis* (Semper) but is definitely different from that species. It may possibly be identical with *Euthyonidium ovulum* (Selenka), although it seems impossible that the smaller inner tentacles should ever be able to attain the size of those in the external circle. The 2 species have the same reddish color with pigment which is extracted in alcohol. They differ as far as our present material shows in the more heart-shaped interradials in *E. ovulum*, with a short anterior tooth, while *P. mollis* has a remarkably long anterior tooth on the interradials. Also *E. ovulum* seems to lack a large, dorsally attached, stone canal which is so characteristic a feature in *P. mollis*. The large *P. mollis* is extremely common in Peru and is also

known from Concha, Chile, while the smaller *E. ovulum* is known from various localities in the Panamic region and has once been reported from Lobos de Afuera Island, Peru (see above, p. 125). (The M.C.Z. has further two lots marked "locality dubious" from, respectively, Hawaii, and Mazatlan, Mexico.) If *Pattalus mollis* is assumed to represent the full-grown stage of *Euthyonidium ovulum*, it is impossible to explain how that large species could have escaped discovery in the Panamic region. (See also under *E. ovulum*.)

### *Pattalus mollis* Selenka

*Pattalus mollis* Selenka, 1868, p. 113, pl. 8, figs. 4-5.

*Thyonidium peruanum* Semper, 1868, p. 67, pl. 15, fig. 17.

*Thyonidium molle* Semper, 1868, p. 243.—Ludwig, 1874, p. 4; 1883, p. 163; 1887, p. 25.—Lampert, 1885, p. 174 (*partim*).—Théel, 1886, p. 144.

*Anaperus peruana* Verrill, 1867, p. 322.

*Pattalus peruana* Verrill, 1867, p. 376.

*Phyllophorus peruvianus* H. L. Clark, 1910, p. 351 (*partim*).

*Diagnosis*.—As for the genus. Color reddish purplish, pigment extracted in alcohol; preserved specimens usually dull brown.

*Type*.—Berlin.

*Type locality*.—Peru and Chile.

*Distribution*.—Common in Chile and Peru.

*Depth*.—Shallow water, to 25 fms., often collected at tidemark, clinging to rocks (H. L. Clark).

*Specimens examined*.—A large series in U.S.N.M. and M.C.Z. Also several specimens from the Allan Hancock Expeditions:

375-35. Independencia Bay, Peru, shore, January 13, 1935, 13 specimens.

391-35. Lobos de Afuera Island, shore, January 17, 1935, 8 specimens.

820-38. San Nicholas Bay, Peru, 10-25 fms., February 6, 1938, 4 specimens.

828-38. San Juan Bay, Peru, shore, February 8, 1938, 9 specimens.

831-38. Independencia Bay, Peru, shore, February 9, 1938, 3 specimens.

837-38. North Chincha Island, Peru, shore, February 11, 1938, 6 specimens.

844-38. Lobos de Afuera Island, Peru, shore, February 14, 1938, 2 specimens.

*Remarks.*—The species seems to be the most characteristic holothurian from the coasts of Peru and certain localities in Chile. In some cases it occurs in the same localities as *Athyonidium chilensis*, but the 2 species have an entirely different ecology. *Pattalus mollis* is found completely exposed, clinging to rocks, while *Athyonidium chilensis* is found buried in sand with its tentacles extending flatly on the surface (H. L. Clark, observed on the Hancock Expeditions in the spring of 1938). In preserved condition the 2 species are entirely unlike except in size; *P. mollis* is uniformly purplish red or faded brown, while the other species is mottled gray, sometimes with almost black dorsum, black tentacles, and more lightly colored ventrum. Internally *P. mollis* has large well-developed interradials with long anterior tooth, while *Athyonidium chilensis* has broad radials and the interradials are almost completely resorbed or hidden in the leathery tissue.

It would be tempting to select Lesson's name *peruanus* for this species so typical of Peru, especially since material in the M.C.Z. shows that *Pattalus mollis* does occur in Payta, Peru, the type locality for Lesson's species. But there is still the possibility that Lesson did have a true dekachirote form before him, with 2 smaller ventral tentacles which were overlooked, a form which has not as yet been rediscovered except possibly by Troschel. Furthermore, both *P. mollis* and *A. chilensis* often occur in the same localities, and Lesson's description and figures may refer to a composite species, the low number of tentacles—although incorrect—being taken from *A. chilensis*, while the color note "rouge violet éclatant et foncé" refers to *P. mollis*.

No other species has caused so much confusion in the literature as this species (including *A. chilensis*). It has usually been identified with Lesson's *Holothuria peruana*, although, if Troschel is correct, the latter is one of the members of the genus *Thyone* s.l.

Semper obviously referred some of his material of *A. chilensis*—those in which he observed the 10 inner small tentacles—to this species and commented on the variability of the number and size of the tentacles in this genus; Lampert did the same, as also H. L. Clark.

Verrill referred his material of *mollis* to *Anaperus peruanus* Troschel but realized the discrepancy in the number of tentacles and corrected the name to "*Pattalus peruanus*—closely related to Selenka's *P. mollis*," without indicating wherein the 2 species differed.

The reasons why *P. mollis* cannot represent the mature stage of *Euthyonidium ovulum* Selenka are mentioned above (under that species).

Genus 4. **PHYLLOPHORUS** Grube, 1840

*Phyllophorus* Auctores. Nec *Phyllophorus* Heding, 1936 (*Thyonidium* Düben & Koren).

*Thyonidium* Auctores. Nec *Thyonidium* Düben & Koren, 1844, p. 303.

*Diagnosis*.—Medium-sized forms (6-15 cm.) with feet distributed in the interambulacra. Tentacles up to 20 in number, of varying size, not sharply set off into 2 circles; the complete number is reached late in the animal's life. Calcareous ring with distinct posterior prolongations on the radials; interradials well developed, of varying shape; ring often composed of smaller pieces, mosaiclike.

Spicules 2- to 4-pillared tables, spire usually retained. Feet with large end plate; walls with or without supporting tables, or a few rods. Introvert usually with tables with low spire and numerous perforations in the disk; tentacles with either perforated plates or delicate rods; rosettes seem normally to be present in the introvert and tentacles. Shallow-water forms, tropical and subtropical.

*Type species*.—*Phyllophorus urna* Grube.

*Remarks*.—The type species is common in the Mediterranean Sea. Grube's description and figures are not particularly convincing, but an excellent account is given by Sars (1846). Unfortunately it is written in the Norwegian language and is therefore not so well known as it deserves. A number of tropical species belong to this genus. (See Engel, 1933, and Deichmann, 1930 and 1938.)

From American waters 5 species are reported from the West Indies and coast of Brazil. From the tropical west coast of America 2 species are known. One was described by Ludwig in 1894, the other by Deichmann in 1938. The latter species is closely related to one of the West Indian forms, while that of Ludwig seems completely unrelated to all other members of the genus. No true *Phyllophorus* is known from the west coast of North America, or from Chile or Hawaii.

KEY TO THE SPECIES OF *Phyllophorus* KNOWN FROM THE  
PANAMIC REGION

1. Spicules tables with oval disk with an average of 8 marginal holes; spire distinctly 4 pillared, usually with a single cross-beam and ending in a large number of spines. Feet with large end plate and numerous supporting tables with broad elongate disk with numerous holes and a huge spire ending in a conical

tooth which often pierces the skin. . . . .  
 . . . . . 1. *Phyllophorus aculeatus* Ludwig

1. Spicules tables with oval disk with 4 large and 4 smaller holes, the latter often wedge shaped; spire usually with 2 pillars and ending in 2 tufts of few spines, sometimes ending in 4 spines. Feet with large end plate and a few supporting tables with broad elongate disk with numerous holes and comparatively low spire with a single crossbeam and ending in 2 diverging spines or horns, rarely in a single point. . . . .  
 . . . . . 2. *Phyllophorus zaca* Deichmann

1. **Phyllophorus aculeatus** Ludwig

Plate 25, Figs. 1-8

*Phyllophorus aculeatus* Ludwig, 1894, p. 128, pl. 13, figs. 6-11.—Deichmann, 1938, p. 381 (*passim*).

*Diagnosis*.—Medium-sized form (type measured 6.5 cm. but was strongly contracted). Feet numerous, scattered almost uniformly over the body. Tentacles of varying size, up to 20 in number. Calcareous ring with long posterior prolongations on the radials; interradials with heart-shaped to almost rhomboid base and long anterior tooth; the basal part overlaps the radials.

Spicules numerous tables with oval disk with a varying number of marginal holes, usually 8; spire mostly with 4 pillars, a single crossbeam, and a wreath of small spines on the top. Feet with large end plate and heavy supporting tables with broad oval disk with numerous holes and an enormous spire which tapers into a conical tooth. Introvert with tables with oval, lacelike disk and spire composed of 2 to 4 pillars. Tentacles with a few rosettes and numerous delicate rods, rarely with the ends perforated. Color grayish with purplish tentacles.

*Type*.—U.S.N.M.

*Type locality*.—Gulf of Panama, shore.

*Distribution*.—Known from the type locality only.

*Depth*.—Shallow water.

*Specimens examined*.—The type, the only specimen known in existence in any collection.

*Remarks*.—The strongly contracted type measured probably more than 10 cm. in length in expanded condition. The inner organs are strongly distorted, and very little can be said about them. The gonads are well developed, forming long tubes, dichotomously divided near the base.

The spicules show some similarity to those characteristic of *Thyone strangeri* (see pl. 19), and for a while I thought that Ludwig had made a mistake in counting the tentacles. Re-examination of the type and comparison of the spicules showed beyond doubt that Ludwig was right and that the 2 species cannot possibly be confused as a glance at the figures of the spicules will show.

It is remarkable that this well-defined species has never been taken again, especially since the type locality is one of the most frequently visited collecting grounds in the Panamic waters.

## 2. *Phyllophorus zacae* Deichmann

Plate 24, Figs. 12-21

*Phyllophorus zacae* Deichmann, 1938, p. 381.

*Diagnosis.*—Medium-sized form, feet numerous scattered almost uniformly over the body, not crowded. Tentacles 15-20 in number, long, delicate, of varying size. Calcareous ring with well-developed posterior prolongations on the radials; the anterior tooth is long rectangular with a constriction at its base; the interradials are more or less heart shaped with a broad base, overlapping the radials and with a short tooth.

Spicules delicate tables with oval disk with 4 larger and 4 smaller holes, the latter often wedge shaped; spire with 2 to 4 pillars, a single crossbeam, and ending in 4 tufts of few spines, sometimes reduced to 4 undivided spines. Feet with large end plate and a few supporting tables with broad oblong disk with numerous holes; spire low or moderately high with one crossbeam, and usually ending in 2 diverging spines or horns or in a single point. Introvert with delicate tables; tentacles with delicate rods and rosettes. Color reddish to white.

*Type.*—M.C.Z.

*Type locality.*—Tangola Tangola Bay, Mex.

*Distribution.*—Ranging from L. Calif. to the Galapagos.

*Depth.*—The type came from 10 fms. depth.

*Specimens examined.*—The type, and 4 individuals from the following *Velero III* stations:

190-34. Galapagos, Lat. 0° 55' S.; Long. 90° 30' W., 58-60 fms., January 26, 1934, 2 young.

517-36. East side of San Francisco Island, Gulf of Calif., 15 fms., February 25, 1936, 1 specimen, oral end missing.

816-38. North of Hood Island, Galapagos, 50-100 fms., January 29, 1938, 1 specimen.

*Remarks.*—The species is closely related to *Phyllophorus destichadus* Deichmann from the West Indian waters. It differs in the presence of supporting tables in the feet and in minor details of the calcareous ring and the spicules.

A species with somewhat similar spicules was described from Hawaii by Fisher, 1907, and is now referred to *Neothyonidium* (Deichmann, 1938, p. 382). The Hawaiian species has tentacles in 2 separate circles and of 2 different sizes, and the calcareous ring is of another type, with long narrow interradials which are firmly joined to the radials, not overlapping them.

### Family III. *Psolidae*

*Diagnosis.*—Dendrochirota with part of the ventral side developed as a thin-walled sole, with feet along the margin and in many forms also along the odd ambulacrum of the sole. Dorsal side (including the oral and anal ends) covered more or less completely by scales; in certain genera some scales are perforated for the passage of tube feet; in one genus no feet are developed on the dorsal side. Tentacles 10 (15 in one genus), the 2 ventral ones are often smaller; in the few deep water forms the tentacles are almost finger shaped, with few or no branches. Calcareous ring simple; retractors of unequal length; gonads in 2 tufts on the dorsal side opening on a papilla behind the tentacles.

Spicules in sole, perforated plates or buttons, smooth or knobbed; in some forms the external deposits may be cup shaped, in others gradually transformed into reticulated bodies; in certain species the spicules become scarce with age. Feet with end plate and a varying number of supporting rods or plates. Dorsal side with or without a layer of spicules outside the scales, as grains, cups, hourglass-shaped bodies, plates, etc. Dorsal appendages, if present, with or without end plate and supporting rods or plates. Tentacles with or without perforated plates or rods; sometimes the spicules disappear in older individuals; a few forms have rosettes.

*Remarks.*—The family comprises about half a dozen genera and represents a rather interesting series of evolutionary steps. Of the 3 genera which are known from the Panamic waters *Thyonepsolus* represents undoubtedly the most primitive group, indistinctly separated from *Psolidium*, while the highest evolutionary stage is represented by the genus *Psolus*. The inner anatomy of the 3 genera is very similar. The most striking difference is that in the 2 first-named genera the third loop of the

intestine is attached in the left ventral interambulacrum, while in the last genus it is attached in the right interambulacrum. This may indicate that the *Thyonepsolus-Psolidium* series represents an independent branch and the *Psolus* series another, or it may simply be that the mesenterial attachment has shifted completely over in the most advanced genus. Some of the members of the genus *Psolidium* have very few dorsal feet, and these have formerly partly been referred to the genus *Psolus*.

KEY TO THE GENERA OF THE FAMILY *Psolidae* KNOWN FROM THE  
PANAMIC REGION

1. Dorsal side (including oral and anal ends) without appendages (except the anal papillae and in some forms a few abortive feet on the introvert). . . . . 3. *Psolus* Oken p. 146
1. Dorsal side with a varying number of tube feet, usually perforating the scales. . . . . 2
2. Dorsal side characterized by the presence of large hourglass-shaped bodies. Tube feet on dorsal side with walls stiffened by numerous curved squarish or circular plates, sometimes reduced to crosses (also a few oblong supporting plates may be present); towerlike deposits present in most species, often reduced with age. . . . . 1. *Thyonepsolus* H. L. Clark p. 136
2. Dorsal side without large hourglass-shaped bodies, at utmost small cups or baskets. Dorsal tube feet in some forms supported by squarish plates, in others by oblong plates or rods, in others superficial deposits seem to be entirely lacking on the dorsum; towerlike deposits sometimes present. 2. *Psolidium* Ludwig p. 141

Genus 1. **THYONEPSOLUS** H. L. Clark, 1901

*Thyonepsolus* H. L. Clark, 1901, p. 169.—Deichmann, 1930, p. 192; 1937, p. 172.

*Psolidium* Ludwig, 1904, p. 689.

*Lissothuria* Verrill, 1867, p. 322.

*Diagnosis*.—Small to medium-sized forms with 10 tentacles, the 2 ventral smaller; sole sharply set off; feet numerous in 3 crowded bands. Dorsal scales few to numerous, covering the back more or less completely; feet numerous or few; a well-developed external layer of spicules covers the scales.



Spicules in sole perforated plates, knobbed or smooth, some may form shallow baskets; feet with end plate and perforated supporting rods or plates. Dorsal side with a varying number of large towerlike deposits, reduced with age, in some species shorter, approaching the shape of grains; also hourglass-shaped bodies and curved plates. Feet with a small end plate or none, and the walls supported by curved squarish plates, sometimes reduced to crosses and rods. Tentacles with heavy perforated plates and smaller plates and rods, in some species rosettes. Shallow-water forms.

*Type species.*—*Thyonepsolus nutriens* H. L. Clark.

*Remarks.*—The genus seems to be restricted to the American waters. The type species is known from Monterey Bay, California, and southward to Santa Cruz Islands; another species is known from the West Indian seas, while 3 occur in the Panamic region and adjacent waters. Two of these are here described as new. The type species is known to be viviparous; the life histories of the other species are yet unknown.

KEY TO THE SPECIES OF *Thyonepsolus* KNOWN FROM THE PANAMIC REGION AND THE CALIFORNIAN WATERS

- 1. Dorsal scale covering incomplete in the midline (in the adult individuals). Scales numerous and small; dorsal feet numerous; external layer of spicules well developed. Sole with large perforated plates and an outer layer of flattened baskets. Perforated plates in tentacles decreasing in size, no rosettes. Viviparous; carries its large eggs in pits on the back. Californian waters (and Galapagos?). . . . . 1. *Thyonepsolus nutriens* H. L. Clark
- 1. Dorsal scale covering complete in the midline. Dorsal feet not remarkably numerous; external layer of spicules not remarkably crowded, varyingly developed. Sole without external layer of flattened baskets. Panamic waters. . . . . 2
- 2. Tentacles with rosettes and delicate rods besides heavy narrow rods; plates in sole with indented margin. Midventral band with feet crowded. . . . . 2. *Thyonepsolus beebei* Deichmann
- 2. Tentacles without rosettes and delicate rods, only heavy plates. Midventral band of feet with few feet. . . . . 3
- 3. Dorsal side with few (7-8) scales and fairly numerous feet. Hourglass-shaped bodies large, irregular. Sole with knobbed plates. (Towers were not found in the type.) . . . . . 3. *Thyonepsolus veleronis*, new species

3. Dorsal side with numerous scales (14 between oral and anal scales) but comparatively few feet, easily overlooked. Dorsal side with typical hourglasses of lacelike structure and large towers which in older individuals become shortened, so that they are thimble shaped. Sole with 4-holed buttons and plates with marginal knobs; holes comparatively small. . . . .  
 . . . . . 4. *Thyonepsolus hancocki*, new species

### 1. *Thyonepsolus nutriens* H. L. Clark

Plate 26, Figs. 1-5

*Thyonepsolus nutriens* H. L. Clark, 1901, p. 169; 1901a, p. 491, text figures.—Deichmann, 1930, p. 193 (*passim*); 1937, p. 174.

*Psolidium nutriens* Ludwig, 1904, p. 689.

*Diagnosis*.—Small form (length of sole 2 cm.); distinct sole with numerous feet in 3 crowded bands. Dorsal side with numerous small scales, lacking in the midline (except in very young individuals), feet numerous, and external layer of spicules well developed. Spicules in sole perforated plates (0.10-0.15 mm.) and smaller flattened baskets (0.06 mm.); feet with end plate and supporting rods. Dorsal side with scales and perforated plates (0.18 mm.) often slightly concave, and hourglass-shaped bodies (0.10 mm.). In most individuals a number of huge tower-like deposits (0.20-0.30 mm.) numerous in young individuals where the other types of external spicules may be scarce. Dorsal feet with rudimentary end plate and curved perforated plates or rods in the walls. Introvert and tentacles with perforated plates or buttons and rods.

*Type*.—M.C.Z.

*Type locality*.—Pacific Grove, California, in tide pools.

*Distribution*.—From the type locality southward, Santa Cruz Islands, off Santa Barbara, California.

*Depth*.—Tide pools to few fms. depth.

*Specimens examined*.—The type and about 50 from various localities.

The following material examined from the Allan Hancock Expeditions:

- 11-32. Conway Bay, Indefatigable Island, Galapagos, shore, January 12, 1932, 1 specimen.

*Remarks*.—A single specimen in the Allan Hancock Expeditions has been identified with this species, but the label says Station 11-32(?) which is Conway Bay, Indefatigable Island, Galapagos, shore.

As this discontinued distribution seems at most unbelievable, it is for the present assumed that the labeling is erroneous. The record is given here in case future investigation should prove that it is correct and a species closely related to *T. nutriens*, or identical with it, does occur in the waters around Galapagos Islands. Comparison with material from California has failed to reveal any tangible differences in the spicules.

The living animal (observed in Hopkins Marine Station) is brilliant red with a more pinkish sole. The inner anatomy is similar to that of *Psolidium*. The third mesentery is attached in the left ventral interambulacrum, close to the midventral ambulacrum. The respiratory trees are feebly branched and attached to the lateral interambulacra; the musculature is moderately developed, the retractors short and attached near the oral end. The genital organs form short tubes in 2 tufts near the oral end; they open on a papilla immediately behind the tentacles; small genital organs are present in specimens 0.6 mm. long. The eggs are huge, about 1 mm. in diameter, and reddish gray, opaque. The eggs are transferred to the back of the female and lodged in pits; about 10 eggs are hatched at a time; when ready to leave the mother in a few weeks, the young are pale rose colored and have their full number of tentacles and 6 large tube feet. Specimens 2 mm. long have developed a distinct sole; those 5 mm. long have 3 rows of feet on the ventral sole. In Monterey Bay the female has been observed brooding its eggs from March to November; very likely it broods during the remaining winter months also.

## 2. *Thyonepsolus beebei* Deichmann

Plate 28, Figs. 1-3

*Thyonepsolus beebei* Deichmann, 1937, p. 172, text figure 3, 1-10; 1938, p. 382.

*Diagnosis*.—Small form (length of sole few cm.). Exterior typical of the genus; dorsal side completely covered by scales. Ventral sole with flat plates with scalloped edge; dorsal side with large complicated lacelike hourglass-shaped bodies, towers and curved perforated plates; tube feet with end plate and curved plates with 4 central holes and numerous marginal ones. Tentacles with heavy rods in stem; branches with delicate rods and rosettes.

*Type*.—M.C.Z.

*Type locality*.—Off Arena Bank, L. Calif., 2.5 fms.

*Distribution*.—West coast of Lower Calif., Mex., Costa Rica, possibly also Panama (?*Lissothuria ornata* Verrill, 1867, p. 322).

*Specimens examined.*—From the following stations:

- 261-34. Tangola Tangola, Mexico, 15-20 fms., March 1, 1934, 1 specimen.  
283-34. Thurloe Bay, West Coast of L. Calif., 8-10 fms., March 9, 1934, 3 specimens.

### 3. *Thyonepsolus veleronis*, new species

Plate 26, Figs. 6-8; Plate 27, Figs. 8-9

*Diagnosis.*—Small form (type less than 2 cm. long); distinct sole with feet in a double row along the edge and in a scattered row along the midventral ambulacrum; dorsal side with comparatively few large scales and relatively numerous feet; external layer of spicules well developed. Spicules in sole knobbed plates; dorsally huge irregular hourglass-shaped bodies, more cup shaped and less lacelike than in the other species. (Towers were not observed in the type.) Dorsal feet apparently without end plate, walls supported by squarish curved plates of the typical structure. Tentacles with heavy plates and rods with small holes; branches with delicate rods or plates; apparently no rosettes.

*Type.*—Holotype, AHF no. 36.

*Type locality.*—Station 147-34, Tagus Cove, Albemarle Island, Galapagos, dredging south of Cove, 30 fms., January 13, 1934.

*Distribution.*—Type locality.

*Depth.*—Dredged from 30 fms.

*Specimens examined.*—The type.

*Remarks.*—The single individual measures 1.8 cm. in length (somewhat distorted). Its exterior and its spicules are very characteristic, and it cannot be confused with any of the other species of *Thyonepsolus*. The lack of towerlike deposits may be accidental—it is not uncommon in older individuals of *Thyonepsolus nutriens*.

It is a question whether this species properly belongs in *Thyonepsolus* or *Psolidium*, but the large hourglass-shaped spicules are so much more reminiscent of those characteristic of *Thyonepsolus* than of the small cups which are found in *Psolidium* that I have preferred at present, at least, to refer it to the former genus.

### 4. *Thyonepsolus hancocki*, new species

Plate 27, Figs. 1-7

*Diagnosis.*—Comparatively large form (sole up to 4 cm. long); sole sharply set off; feet in a double row along the edge and in a scattered

band along the midventral ambulacrum. Dorsal side with numerous imbricating scales, about 14 between oral and anal apertures in the largest individual. Dorsal feet few, rudimentary, easily overlooked.

Spicules in sole varying from 4-holed buttons to irregular, perforated plates with marginal knobs and occasionally a few knobs near the center. Feet with end plate and perforated rods and plates. Dorsal side with scales, delicate hourglass-shaped cups of lacelike structure and huge towers which in the older individuals are partly resorbed from the tip, so that they become shorter, thimblelike. Feet apparently without end plate; walls supported by curved squarish plates with 4 central holes and a varying number of smaller marginal ones. Tentacles with heavy plates and rods; in the branches delicate plates and rods; apparently no rosettes.

*Type*.—Holotype, AHF no. 37, 19 paratypes.

*Type locality*.—Station 521-36, Agua Verde Bay, L. Calif., north of anchorage, 5-10 fms., February 27, 1936.

*Distribution*.—Gulf of Calif. to Ecuador.

*Depth*.—From 5-165 fms.

*Specimens examined*.—The following individuals from the Allan Hancock Expeditions:

- 213-34. La Plata Island, Ecuador, dredging north of anchorage, rocky, 7-10 fms., February 10, 1934, 3 small specimens.  
 521-36. Agua Verde Bay, L. Calif., Mex., 5-10 fms., February 27, 1936, 5 small specimens.  
 529-36. Off San Francisquito Bay, L. Calif., Mex., 165 fms., March 1, 1936, 12 large specimens.  
 854-38. Gorgona Island, Colombia, north of Island, 40-60 fms., February 24, 1938, 7 large and 2 small specimens.

*Remarks*.—A well-defined species which is easily recognized.

## Genus 2. **PSOLIDIUM** Ludwig, 1887

*Diagnosis*.—Small forms (sole few cm. long); sole sharply set off; with feet along the edges and few or many in the midventral ambulacrum; dorsal side with numerous imbricating scales, and a varying number of tube feet which pass out through some of the scales. Spicules in sole plates or buttons, smooth to knobbed, usually also an external layer of small deep cups. Feet with end plate and supporting plates or rods. Dorsal side usually with an external layer of cups (possibly lacking in some species); besides grain or towers (more or less completely reduced with

age). Dorsal tube feet with or without end plate and supporting rods or plates in the walls (the type species has squarish plates of similar type as those in *Thyonepsolus*).

*Type species.*—*Psolidium dorsipes* Ludwig.

*Remarks.*—The genus comprises a number of species. A few of these have formerly been referred to *Psolus* because the few dorsal tube feet were overlooked. On the other hand, it seems as if *Psolidium convergens* Hérouard (1901, p. XXX) ought to be transferred to some other genus, judging from the description given by Perrier (1905, p. 38, pl. 2, figs. 2-4, text figures D-F).

The genus is closely related to *Thyonepsolus* H. L. Clark; actually Ludwig considered (1904) the latter as a synonym of *Psolidium*. The similarities between the 2 genera are even greater than assumed since it has been discovered that the curved plates in the type species are partly supporting plates for the dorsal tube feet and likewise that the characteristic towers also may be present (see below). Nevertheless, it seems justifiable for the present to retain the 2 genera on account of the more complex hourglass-shaped bodies which are typical in *Thyonepsolus*, while *Psolidium* has small cups or baskets.

Four species are discussed here, all represented in the Allan Hancock collections and all taken at moderate depth or even in shallow water. One is the type species, while 3 are described as new.

#### KEY TO THE SPECIES OF *Psolidium* KNOWN FROM THE PANAMIC REGION AND ADJACENT WATERS

1. Tube feet fairly numerous in the midventral ambulacrum, also numerous on the dorsal side where the scales are small and numerous. Sole with plates with fairly large holes, smooth or knobbed, and deeply convex cups. Dorsal side with numerous deep cups and often also towerlike deposits; tube feet with numerous curved squarish supporting plates, a few are narrow, rod shaped. . . . . 1. *Psolidium dorsipes* Ludwig
1. Tube feet in midventral ambulacrum few. Dorsal feet easily overlooked. . . . . 2
2. Dorsal scales with a varying number of prominent pearllike projections. Spicules in sole 4-holed buttons or plates with knobbed surface and varying from delicate to stout. Oral opening with large triangular scales; many small scales inter-

- calated between the larger scales. . . . .  
 . . . . . 3. *Psolidium ekmani*, new species
2. Dorsal scales smooth, without pearllike projections. . . . . 3
3. Dorsal side covered by numerous thimble-shaped grains with flat base (reduced towers). Sole with small flattened cups with lateral spines and a few larger plates with undulated surface or smooth. . . . . 4. *Psolidium planum*, new species
3. Dorsal side with no accessory spicules (?). Ventral side with heavy knobbed plates and buttons. . . . .  
 . . . . . 2. *Psolidium eubullatum*, new species

1. ***Psolidium dorsipes*** Ludwig

Plate 29, Figs. 1-12

*Psolidium dorsipes* Ludwig, 1887, p. 9, pl. 2, fig. 9; 1894, p. 135 (*passim*).—Perrier, 1905, p. 48, pl. 2, figs. 5-15, text figures G-H.  
 —Ekman, 1925, p. 112, text figure 26.

*Diagnosis*.—Small form (sole 1 cm. long); ventral sole sharply set off with 3 crowded bands of tube feet. Dorsal side covered by imbricating scales, about 10 between oral and anal scales; dorsal feet numerous, often 2-3 perforating a single scale; external layer of deposits well developed.

Spicules in sole plates varying from smooth to knobbed, 2 types of plates, one with few holes, smooth or with few knobs, one with large holes and numerous pearllike knobs; also an external layer of cups with 4 knobs on the strongly convex side and a marginal brim of delicate teeth. Feet with end plate and oblong supporting plates, slightly curved, often with few knobs. Dorsal side with numerous baskets or cups of same size and type as in the sole; tube feet mostly with small end plate and walls packed with curved squarish plates, a few may be oblong. In some specimens numerous towers are present.

*Type*.—Probably in Italy.

*Type locality*.—Puntas Arenas, Strait of Magellan, 15-25 fms.

*Distribution*.—Strait of Magellan and vicinity. Also Panama and Gulf of Calif.

*Depth*.—From 6-60 fms.

*Specimens examined*.—The following from the Allan Hancock Expeditions:

744-37. Near Point Piaxtla, Sinaloa, Gulf of Calif., 6-8 fms., April 1, 1937, 4 specimens (poor).

863-38. Bahia Honda, Panama, off North Island, 30-50 fms., March 1, 1938, 1 specimen (fair).

*Remarks.*—The *Velero* material differs from the material examined by Ludwig and Perrier in the presence of the numerous towers with broad smooth base. The cups or baskets agree well with Ludwig's figure; possibly Perrier's drawing is somewhat inaccurate; the marginal teeth on the cups are too few and too coarse. It was a satisfaction to discover that the tube feet actually were packed with the curved squarish plates as was to be expected, not exclusively lying free in the skin as Perrier describes it; a few simple curved oblong plates may be found in the wall of the feet as in the other species.

## 2. *Psolidium eubullatum*, new species

Plate 28, Figs. 4-7

*Diagnosis.*—Small form (type measures about 1 cm.). Sole with feet restricted to the margin and the anterior end of the midventral ambulacrum. Dorsal side with about 14 scales between oral and anal scales; dorsal feet few.

Spicules in sole heavy buttons or plates with marginal and central knobs. Feet with end plate and perforated plates. Dorsal side apparently without any spicules except the scales; even the tube feet seem to lack spicules entirely.

*Type.*—Holotype, AHF no. 38, 3 paratypes.

*Type locality.*—Station 213-34, La Plata Island, Ecuador, 7-10 fms., north of Anchorage, rocky, February 10, 1934, 3 specimens.

*Distribution.*—Known from Ecuador.

*Depth.*—From 7 to 55 fms.

*Specimens examined.*—The type and 3 specimens from the following *Velero* stations:

212-34. La Plata Island, Ecuador, dredging 45-55 fms., sand shale, rock, mud, February 10, 1934, 1 specimen.

213-34. La Plata Island, Ecuador, 7-10 fms., February 10, 1934, type and 2 paratypes.

*Remarks.*—The specimens bear some resemblance to *P. bullatum* Ohshima, (1915, p. 282) from the Alaskan waters, 54 fms., and may possibly be found to be identical with that form. The unusually low depth at which it is taken is noteworthy, and information about the hydrographic conditions at La Plata Island is most desirable.



3. *Psolidium ekmani*, new species

Plate 30, Fig. 6

*Diagnosis.*—Small form (length of sole about 1 cm.). Oral and anal openings closed by indistinct valves; stout radial teeth present inside the oral plates; about 5 scales between the oral and anal valves. Scales strongly sculptured with several pearlike projections, firmly attached; dorsal tube feet few. Sole with rows of marginal feet and a row of few feet scattered along the midventral ambulacrum. Spicules in sole delicate 4-holed buttons and plates with a larger number of holes; a varying number of knobs are present on the surface. Feet with end plate and supporting rods. Dorsal side with no other spicules than the scales (?).

*Type.*—Holotype, AHF no. 39, 1 paratype.

*Type locality.*—Station 213-34, La Plata Island, Ecuador, 7-10 fms., dredging north of anchorage, February 10, 1934.

*Distribution.*—From Ecuador to Panama.

*Depth.*—From 7-10 fms.

*Specimens examined.*—The type and one other specimen from the following Hancock stations:

213-34. La Plata Island, Ecuador, 7-10 fms., February 10, 1934, 1 specimen.

863-38. Bahia Honda, Panama, off North Island, rock, mud, sand, 30-50 fms., March 1, 1938, 1 specimen.

*Remarks.*—The species was at first assumed to represent *Psolus patagonicus* Ekman, but comparison with the latter showed clearly that the spicules were entirely different (plate 30, fig. 8). Neither could it be referred to *Psolus squamatus* (Koren), var. *segregatus* Perrier because the projections on the scales were not loose but part of the scales. Also the presence of tube feet in the midventral ambulacrum separates it distinctly from both species mentioned above. Finally a few tube feet were discovered on the dorsal scales and the generic position thereby settled. The species is named in honor of Dr. Sven Ekman, the well-known zoogeographer and student of holothurians, from Upsala, Sweden.

4. *Psolidium planum*, new species

Plate 30, Figs. 1-5

*Diagnosis.*—Small form (sole up to 1.5 cm. long), body capable of becoming extremely flattened. Sole distinct; feet marginal and present as a scattered row of much smaller appendages in the midventral ambu-

lacrum. Dorsal side with smooth imbricating scales, gradually decreasing in size around the oral and anal openings; tube feet few, small, easily overlooked. Entire dorsal surface covered by numerous large grains and other deposits, easily rubbed off.

Spicules in sole an external layer of delicate smooth 4-holed flattened cups with marginal teeth. Beneath these a few larger plates may be found with several holes and smooth to undulating surface. Dorsal side closely packed with thimble-shaped grains with flattened basal plate (i.e., short, squat towers), besides numerous small baskets with delicate teeth and 4 apical knobs, sometimes united to a ring, thus approaching the hourglass shape. Tube feet with delicate end plate and circular or squarish curved supporting plates. (Tentacles not examined.)

*Type*.—Holotype, AHF no. 40.

*Type locality*.—Station 845-38, Sechura Bay, Peru, Lat.  $5^{\circ} 39' 30''$  S.; Long.  $81^{\circ} 01' W.$ , 9.5 fms., February 15, 1938.

*Distribution*.—From Peru to Colombia.

*Depth*.—From 9-60 fms.

*Specimens examined*.—The following specimens from the Hancock Expeditions:

845-38. Sechura Bay, Peru, coarse sand, worm tubes, red algae, 9.5 fms., February 15, 1938, 3 specimens.

854-38. Gorgona Island, Colombia, north of island, mud, rocks, 40-60 fms., February 24, 1938, 1 specimen.

*Remarks*.—The species has been referred to *Psolidium* because the cups in the dorsal integument are mostly simple and the feet on the sole are few. The dorsal spicules are easily rubbed off, but the spicules in the sole are so characteristic that it seems impossible to confuse it with any other species.

### Genus 3. **PSOLUS** Oken, 1815

*Diagnosis*.—Typical psolids with distinct sole with marginal tube feet, often also a band of feet along the midventral ambulacrum. Dorsal side covered by scales, few to many; oral and anal apertures with or without an operculum of triangular scales; sometimes narrow radial teeth present inside of and between these valves. No appendages on dorsum except the anal papillae and in some forms a few tube feet on the introvert. Tentacles 10 in number, the 2 ventral may be smaller; in some deepwater forms the tentacles are unbranched, finger shaped. Inner

anatomy typical of the family; third loop of the intestine seems always to be attached in the right ventral interambulacrum.

Spicules in sole plates or buttons, smooth or knobbed, in some forms reduced with age, in others transformed into reticulated masses. Feet usually with end plate and supporting rods. Dorsal side has besides the scales often grains, rarely a few cups are present. Introvert and tentacles with or without rods or plates; sometimes spicules reduced, in older individuals.

*Type species.*—*Psolus phantapus* (Strussenfeldt).

*Remarks.*—The genus comprises about 30 different species and represents apparently the most successful and widespread of the genera included in the family. A number of the species are exceptionally large (sole more than 10 cm. long). The members of the genus occur in tropical as well as in Arctic seas.

The Hancock Expeditions have secured only one species, but 2 others are discussed below to emphasize the differences between the species. One represents a common form ranging from the Strait of Magellan to the southern part of Bering Sea; the other, although hitherto known only from the vicinity of Cape Horn, may possibly be expected in the southernmost part of the Panamic region although it is not likely.

KEY TO THE SPECIES OF *Psolus* KNOWN FROM THE PANAMIC REGION AND WEST COAST OF SOUTH AMERICA

- 1. Dorsal scales large but few (2-3 between oral and anal valves). Oral and anal valves large. Small form. Spicules in sole knobbed plates. . . . . 3. *Psolus diomedea* Ludwig
- 1. Dorsal scales more numerous. . . . . 2
- 2. Spicules in sole slightly hollow buttons and plates with small holes and large marginal knobs. Distinct oral valves. . . . . 2. *Psolus patagonicus* Ekman
- 2. Spicules in sole flat, mostly 4-holed buttons reduced with age. Dorsal side with few large round grains; oral valves indistinct. . . . . 1. *Psolus squamatus* (Koren), var. *segregatus* Perrier

1. ***Psolus squamatus*** (Koren), var. ***segregatus*** Perrier  
Plate 30, Fig. 7

*Psolus squamatus* (Koren), var. *segregatus* Perrier, 1905, p. 59.—  
Ekman, 1925, p. 136, text figure 33.

*Psolus squamatus* H. L. Clark, 1901, p. 165; 1901, p. 491.—Ohshima, 1915, p. 280.

*Psolus pauper*, Ludwig, 1894, p. 139.

*Diagnosis*.—Large form (sole up to 13 cm. long); scales thin, smoothly overlapping, about 12 between oral and anal scales. Oral and anal apertures surrounded by a number of triangular scales but not developed as regular valves, except in very young individuals. Sole thin, with marginal feet. Spicules in sole 4-holed delicate buttons (0.07-0.09 mm.) with shorter or longer marginal projections, sometimes with a few low warts; often the spicules disappear with age. Feet with end plate and few perforated rods. Dorsal scales covered by a varying number of loose grains.

*Type*.—Paris.

*Type locality*.—Patagonia.

*Distribution*.—From Cape Horn to the southern part of Bering Sea.

*Depth*.—In the Patagonian waters ranging from 7-207 fms.; in the northern waters taken between 155-603 fms.

*Specimens examined*.—About 50 in the U.S.N.M. and Hopkins Marine Station from various *Albatross* stations.

*Remarks*.—The specimens examined agree with Perrier's form *segregatus* from Cape Horn except in minor points (equal development of the gonads and slightly different position of the paired retractors, probably because of a different degree of contraction). The material has been compared with the typical form from Norway and shows the same differences as those which Ekman has tabulated.

Ludwig's *P. pauper* from the west coast of Mexico represents a small specimen of var. *segregatus* in which the spicules in the sole are unusually scarce. Ludwig's "*antarcticus*" from off Peru, which has always been regarded with suspicion, is most likely a small specimen of *segregatus* (or a specimen of *Psolus patagonicus* Ekman or of *Psolidium ekmani*). The young individuals of *P. squamatus*, var. *segregatus* may superficially resemble either of these two forms.

## 2. *Psolus patagonicus* Ekman

Plate 30, Fig. 8

*Psolus patagonicus* Ekman, 1925, p. 140, text figures 35-36.

*Diagnosis*.—Small form (sole up to 2 cm. long) with distinct oral and anal valves and radial teeth inside the valves. Few scales between oral and anal valves; often smaller scales intercalated between the pri-

mary scales. External side of scales with pearllike projections, rare or totally lacking in young individuals which may have a few loose grains. Sole distinct with 1-2 marginal rows of feet. Spicules in sole slightly concave 4-holed buttons (0.12 mm.) with relatively small holes and a varying number of knobs on the surface, sometimes the knobs are united by crossbars. Feet with end plate and perforated plates (0.18 mm.). Tentacles with broad perforated plates.

*Type*.—Hamburg.

*Type locality*.—Patagonian Bank, Lat. 46° S.

*Distribution*.—The type locality and various localities in the Strait of Magellan.

*Specimens examined*.—Various individuals from *Albatross Station* 2777, and 2 received from the Museum in Buenos Aires.

*Remarks*.—The species is mentioned because it resembles *Psolidium ekmani*. It was not secured by the Allan Hancock Expeditions and it seems not likely that it will be found in the Panamic region.

### 3. *Psolus diomedea* Ludwig

Plate 11, Figs. 9-10

*Psolus diomedea* Ludwig, 1894, p. 136, pl. 14, figures 1-3.—Fisher, 1907, p. 717 (*passim*).

*Diagnosis*.—Small form (sole less than 2 cm.) with enormous oral and anal valves; radial teeth present inside to the valves. Dorsal scales few and large, 2-3 between oral and anal valves; scales covered by few but large grains; sole with marginal feet. Spicules in sole strongly knobbed plates with 4 central holes and smaller marginal ones. (Feet and tentacles not examined.)

*Type*.—U.S.N.M.

*Type locality*.—Off Cocos Island, Costa Rica.

*Distribution*.—From Gulf of California to Ecuador including Galapagos.

*Depth*.—From 7-80 fms.

*Specimens examined*.—The type in Washington and the following specimens from the *Velero* stations:

143-34. Wenman Island, Galapagos, 100-150 fms., January 11, 1934, 1 specimen.

213-34. La Plata Island, Ecuador, 7-10 fms., February 10, 1934, 38 specimens.

- 429-35. Octavia Bay, Colombia, north end of channel, coarse sand and gravel, 35-40 fms., January 27, 1935, 1 specimen, young.
- 431-35. North of Octavia Bay, Colombia, south end of channel, 45 fms., January 27, 1935, 1 specimen.
- 529-36. Off San Francisquito Bay, Gulf of Calif., shale and gray mud, 165 fms., March 1, 1936, 1 specimen.
- 780-38. Chatham Bay, Cocos Island, Costa Rica, 40-47 fms., January 14, 1938, 3 specimens.
- 792-38. Off Daphne Minor Island, Galapagos, 70-80 fms., January 20, 1938, 1 specimen.
- 854-38. North of Gorgona Island, Colombia, 40-60 fms., February 24, 1938, 1 specimen, young.

*Remarks.*—The species is very striking and cannot be mistaken for any other Pacific form, except the closely related *P. macrolepis* Fisher from Hawaii, 154 fms. depth. The latter has almost smooth plates in the sole and small basal scales intercalated between the oral valves. The depth, 7-10 fms., for the specimens from La Plata Island, is unusually low for this species and may indicate that peculiar hydrographic conditions prevail in that locality.

## BIBLIOGRAPHY

## AYRES, W. O.

1852. Description of a new species of Holothuria. *Proc. Boston Soc. Nat. Hist.*, vol. 4, pp. 207-208.

## CLARK, H. L.

1901. The Holothurians of the Pacific Coast of North America. *Zool. Anz.*, vol. 24, pp. 162-171, 14 text figures.
- 1901a. The Holothurioidea; Synopses of North-American Invertebrates 15. *Amer. Nat.*, vol. 35, pp. 479-496, 27 text figures.
1910. The Echinoderms of Peru. *Bull. Mus. Comp. Zool.*, vol. 52, No. 17, pp. 331-358, pls. 1-14.
1923. The Echinoderm Fauna of South Africa. *Ann. South African Mus.*, vol. 13, pp. 221-435, pls. 8-23.
1938. Echinoderms from Australia. *Mem. Mus. Comp. Zool.*, vol. 55, pp. 1-596, pls. 1-28.

## DEICHMANN, E.

1930. The Holothurians of the Western Part of the Atlantic Ocean. *Bull. Mus. Comp. Zool.*, vol. 71, No. 3, pp. 43-226, pls. 1-24.
1936. A New Thyone from the West Coast of Mexico. *Proc. New England Zool. Club*, vol. 15, pp. 63-66, text figures.
1937. Holothurians from the Gulf of California. The Templeton Crocker Expedition, 9. *Zoologica, New York Zool. Soc.*, vol. 22, pp. 161-176, text figures 1-3.
1938. Holothurians from the Western Coast of Lower California and Central America, and from the Galapagos Islands; Eastern Pacific Expeditions of the New York Zoological Society, 16. *Zoologica, New York Zool. Soc.*, vol. 23, pt. 4, pp. 361-387, text figures 1-15.
- 1938a. New Holothurians from the Western Coast of North America and some remarks on the genus *Caudina*. *Proc. New England Zool. Club*, vol. 16, pp. 103-115, text figures.
1939. A New Holothurian of the genus *Thyone*. *Smithsonian Miscellaneous Collections*, vol. 98, no. 12, pp. 1-7, text figures 1-3.

## DÜBEN, M. W. v. &amp; KOREN, J.

1844. Om Holothuriernes Hudskelet. *Kgl. Vetensk. Akad. Handl.*, pp. 211-228, pls. 4-5.
- 1844a. Ofversig af Skandinaviens Echinodermmer. *Ibid.*, 1844 (1846), pp. 229-338, pls. 6-11.

## EDWARDS, C. L.

1910. Four species of Pacific Ocean Holothurians allied to *Cucumaria frondosa* (Gunnerus). *Zool. Jahrb., Abt. Syst.*, vol. 29, pp. 597-612, pl. 19.

## EKMAN, S.

1923. Ueber *Psolus squamatus* und verwandte Arten. *Arkiv f. Zoologi*, vol. 15, pp. 1-56, 37 text figures.
1925. Further Zoological Results of the Swedish Antarctic Expedition, 1901-3, vol. 1, No. 6., pp. 1-199, 37 text figures.

## FISHER, W. K.

1907. The Holothurians of the Hawaiian Islands. *Proc. U.S. Nat. Mus.*, vol. 32, pp. 637-744, pls. 66-82.

## FORBES, E.

1841. A History of British Starfishes and other Animals of the Class Echinodermata, *London*, pp. I-XX, 1-267, with text figures.

## GOLDFUSS, G. A.

1820. Handbuch der Zoologie, Pt. 1-2, pp. I-XLVI, 1-696, pls. 1-4.

## HEDING, S. G.

1936. Echinoderms, 6 & 7 Thule Expeditions. *Medd. Gronland*, vol. 108, No. 1, pp. 1-34, text figures 1-6.

## HEROUARD, E.

1901. Note preliminaire sur les Holothuries rapportées par l'Expedition Antarctique Belge. *Arch. Zool. Exp.*, notes 3, 9, pp. XXXIX-XLVIII.

## JÄGER, G. F.

1833. De Holothuriis. (Dissertation Inauguration). *Turin*, pp. 1-40, pls. 1-3.

## KOREN, J.

- Beskrivelser over Thyone fusus og Cuviera squamata. *Nyt. Mag. f. Naturvid.*, vol. 4, 1844-45, pp. 203-225, pls. 1-2.

## LAMPERT, K.

1885. Die Seewalzen, Holothurioidea, eine systematische Monographie, *Wiesbaden*, pp. 1-310, pl. 1.

## LESSON, R. P.

1830. Centurie Zoologique, *Paris*, pp. 1-244, pls. 1-80.

## LUDWIG, H.

1875. Beiträge zur Kenntniss der Holothurien mit Nachtrag. *Arbeiten aus d. Zool.-Zoot. Institut in Würzburg*, vol. 5, pp. 77-120, pls. 6-7.
1883. Verzeichniss der Holothurien des Kieler Museums. *Berlin Oberh. Ges.*, vol. 22, pp. 155-176.
1887. Die von G. Chierchia auf der Fahrt der Kgl. Corvette "Vettor Pisani" gesammelten Holothurien. *Zool. Jahrb.*, vol. 2, pp. 1-36, pls. 1-2.
- 1887a. Drei Mittheilungen über alte und neue Holothurienarten. *Sitzungsber. Akad. Berlin*, pp. 1217-1244 (reprint pp. 1-28), pl. 15.
1894. The Holothurioidea. Reports on an Exploration off the West Coasts of Mexico, Central and South America, etc. *Mem. Mus. Comp. Zool.*, vol. 17, No. 3, pp. 1-183, pls. 1-19.
1898. Holothurien. Hamburger Magelhaenische Sammelreise, pp. 1-98, pls. 1-3.
1904. Brutpflege bei Echinodermen. *Zool. Jahrb.*, suppl. vol. 7, pp. 683-699.

## MÜLLER, J.

1854. Ueber den Bau der Echinodermen. *Abhandl. Berlin Akad. Wiss.*, pl. 9, fig. 9.

## OHSHIMA, H.

1912. On the System of Phylloporinae with Descriptions of the Species found in Japan. *Annot. Zool. Japan*, Tokio, vol. 8, pp. 53-96, pl. 1, text figures 1-7.
1915. Report on the Holothurians collected by the U.S. Fisheries Steamer *Albatross* in the Northeastern Pacific during the Summer of 1906. *Proc. U.S. Nat. Mus.*, vol. 48, pp. 213-291, pls. 8-11.



## OKEN, L.

1815. Lehrbuch der Naturgeschichte, vol. 3, *Zoologie*, Jena, pp. 351-352.

## PALLAS, P. S.

1766. Zoophytorum sistens generum adumbrationes, etc., Hagae comitum, pp. 1-451.

## PERRIER, R.

1904. Holothuries du Cap Horn. *Bull. Mus. d'Hist. Nat.*, vol. 10, pp. 11-17.  
 1905. Holothuries antarctiques du Museum d'Histoire Naturelle de Paris. *Ann. Sci. Nat.*, vol. 9, pt. 1, pp. 146, pls. 1-5, text figures.

## SARS, M.

1857. Bidrag til Kundskaben om Middlehavets Littoral Fauna. *Nyt. Mag. Naturvidenskab*, pp. 57-155, pls. 1-2.  
 (Contribution to our knowledge of the littoral fauna of the Mediterranean Sea.)

## SELENKA, E.

1867. Beitrage zur Anatomie und Systematik der Holothurien. *Zeit. Wiss. Zool.*, vol. 17, pp. 291-372, pls. 17-20.  
 1868. Nachtrag. *Ibid.*, vol. 18, pp. 109-119, pl. 8.

## SEMPER, C.

1868. Reisen in Archipel der Philippinen. *Wiss. Res.*, Pt. 1, Holothurien, pp. 1-288, pls. 1-40.

## SLUITER, C. P.

1880. Ueber einige neue Holothurien von der West-Kuste Javas. *Naturkund. Tijdschr. Nederl. Ind.*, pp. 1-28, pls. 1-7.  
 1901. Die Holothurien der Siboga Expeditie. Uitkomst H. M. Siboga . . . uitgeven van Max Weber; Monograph 44, *Leiden*, pp. 1-142, pls. 1-11.

## THEEL, H.

1886. Report on the Holothurioidea. Report on the Scientific Results of the Voyage of H.M.S. *Challenger* during the years 1873-1878. Pt. 39, *Zoology*, vol. 14, pp. 1-290, pls. 1-16.  
 1886a. Report on the Holothurioidea. Report on the Results of the Dredgings by the U.S. Coast Survey *Blake*. *Bull. Mus. Comp. Zool.*, vol. 13, pp. 1-21, pl. 1.

## TROSCHEL, F. H.

1846. Neue Holothurien Gattungen. *Arch. f. Naturgesch.*, vol. 12, pt. 1, pp. 60-66.

## VERRILL, A. E.

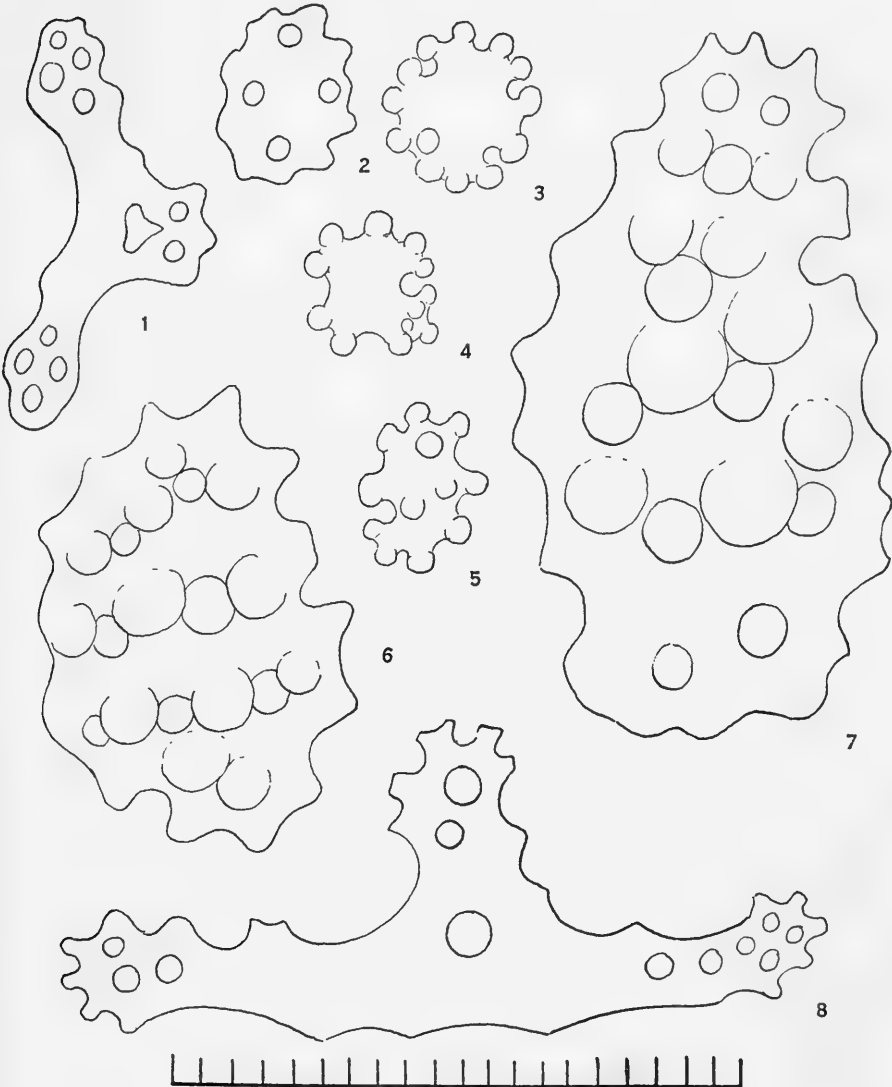
1866. On the Polyps and Echinoderms of New England. *Proc. Boston Soc. Nat. Hist.*, vol. 10, pp. 333-357.  
 1867. Notes on the Echinoderms of Panama and West Coast of America with descriptions of new genera and species. Notes on the Radiata of Yale College, etc., No. 2. *Trans. Conn. Acad. Arts & Sciences*, vol. 1, pp. 251-322.  
 1867. Supplementary note on the Echinoderms of the West Coast of America. *Ibid.*, p. 376.

## EXPLANATIONS OF PLATES

Magnification: Scale divisions indicate  $\frac{1}{100}$  mm.

## PLATE 10

- Cucumaria crax*, new species.....p. 83
1. Supporting rod from tube foot.
  - 2-5. Crackerlike button from integument.
- Cucumaria californica* Semper.....p. 79
- 6-7. Knobbed plate from integument.
  8. Supporting rod from tube foot.



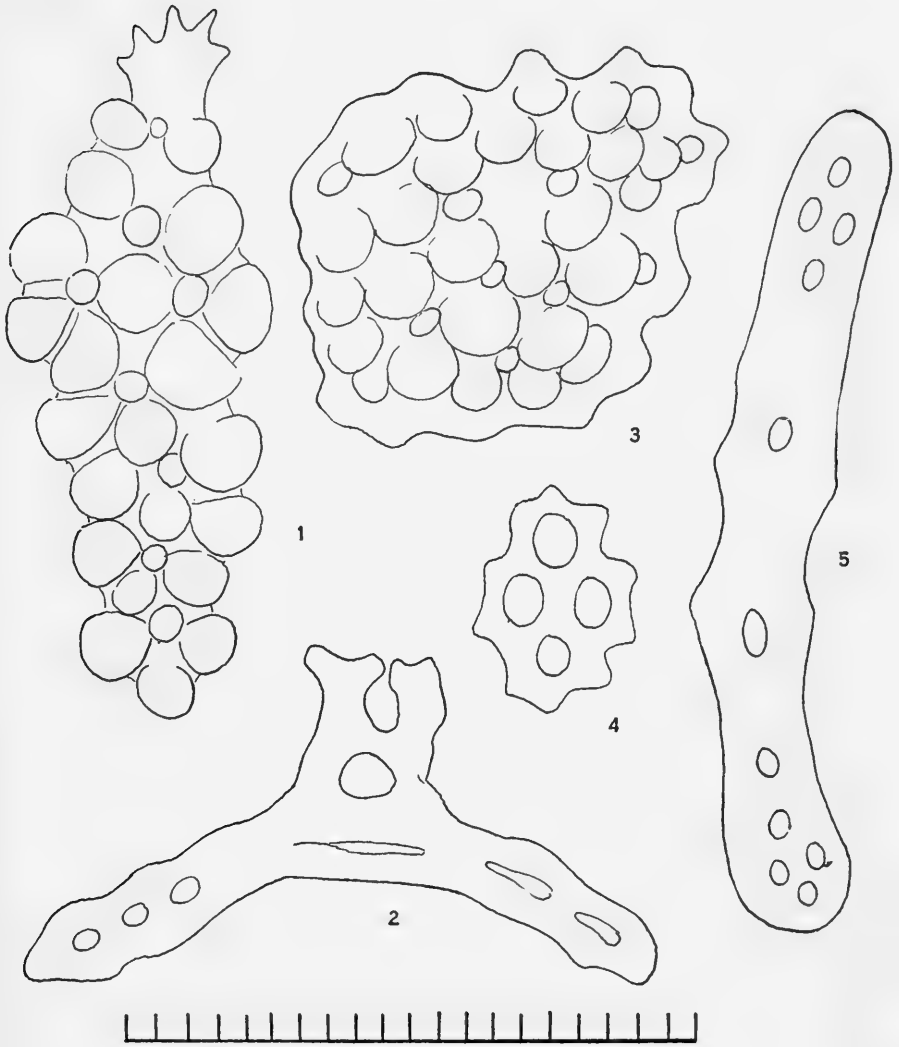
## PLATE 11

*Cucumaria dubiosa* Semper.....p. 81

1. Knobbed plate with handle from integument.
2. Supporting rod from tube foot.

*Cucumaria chilensis* Ludwig.....p. 80

3. Knobbed plate (medium sized) from integument.
4. Button from integument.
5. Supporting rod from tube foot.



## PLATE 12

*Pentamera beebei* Deichmann.....p. 86

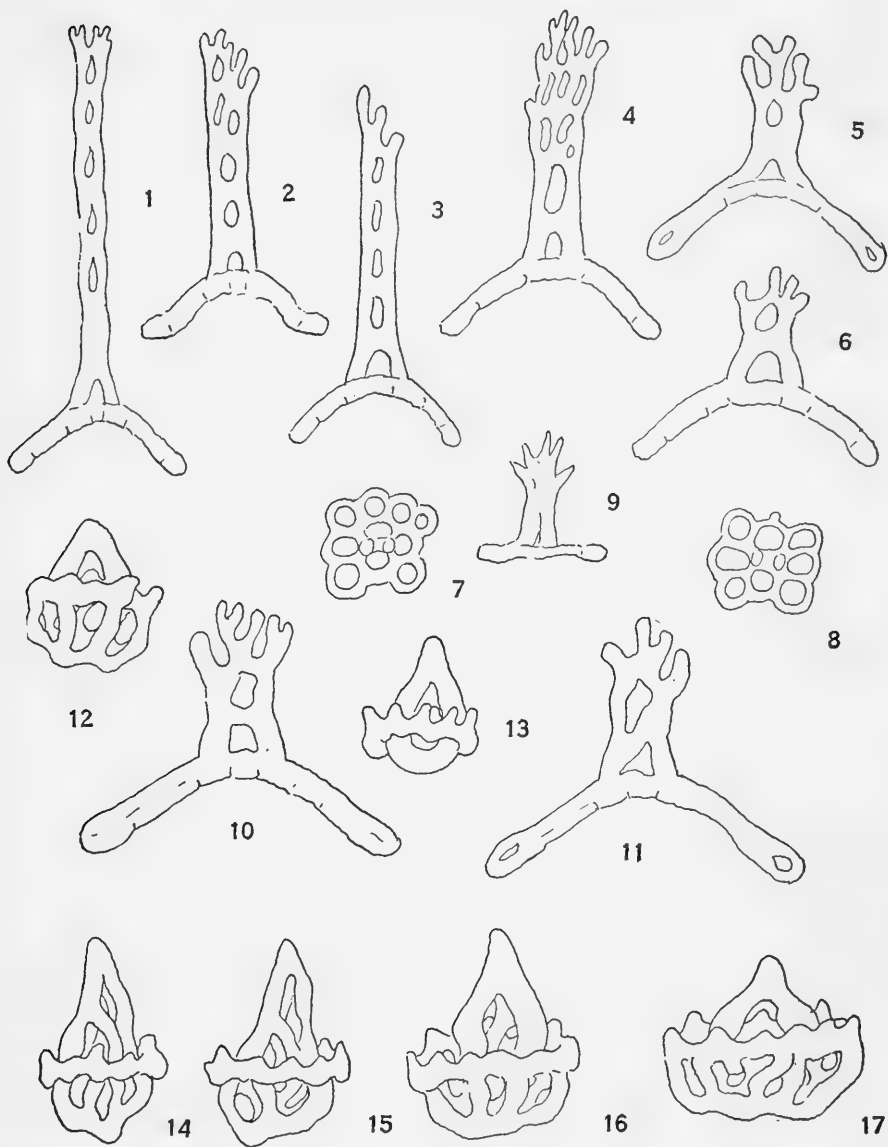
1-6. Supporting tables from feet.

7-9. Tables from integument.

*Pentamera zacae* Deichmann.....p. 85

10-11. Supporting tables from tube foot.

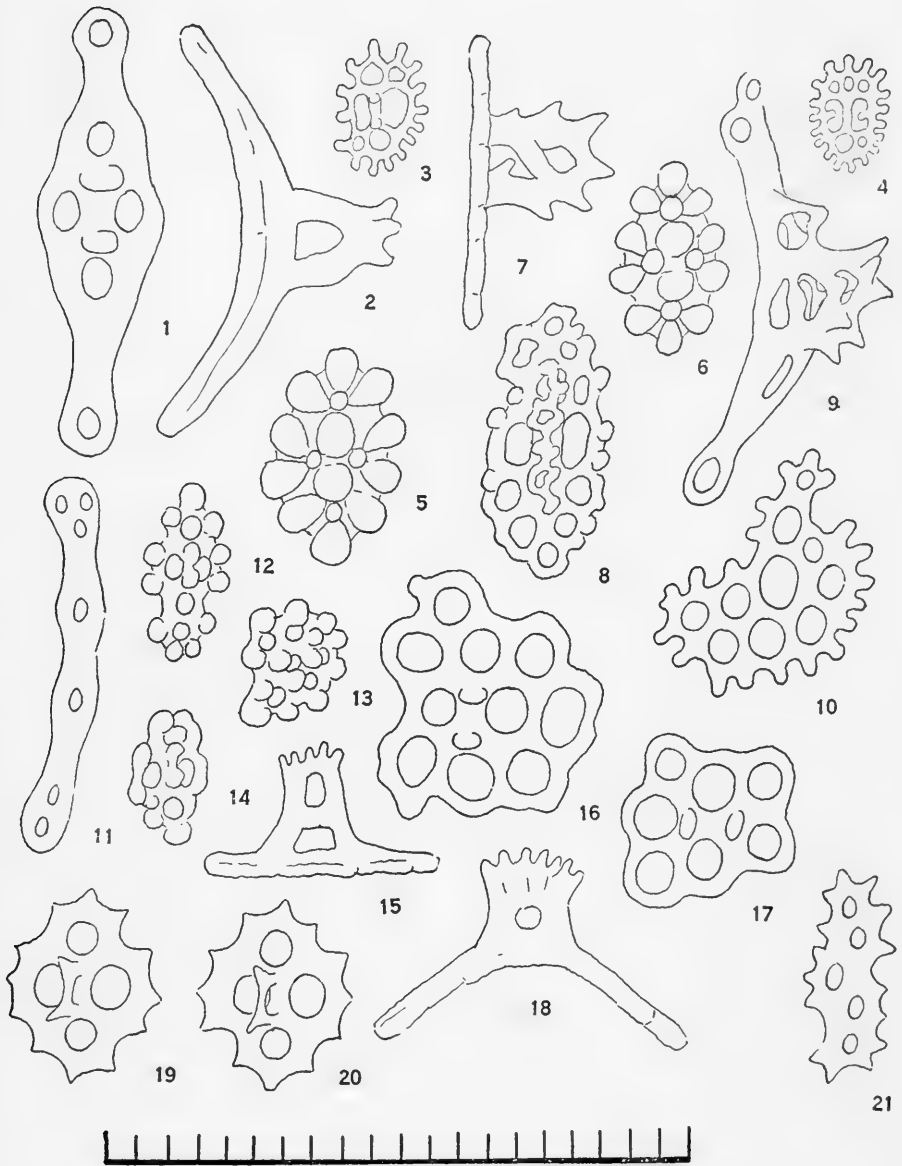
12-17. Acorn-shaped bodies from integument.



## PLATE 13

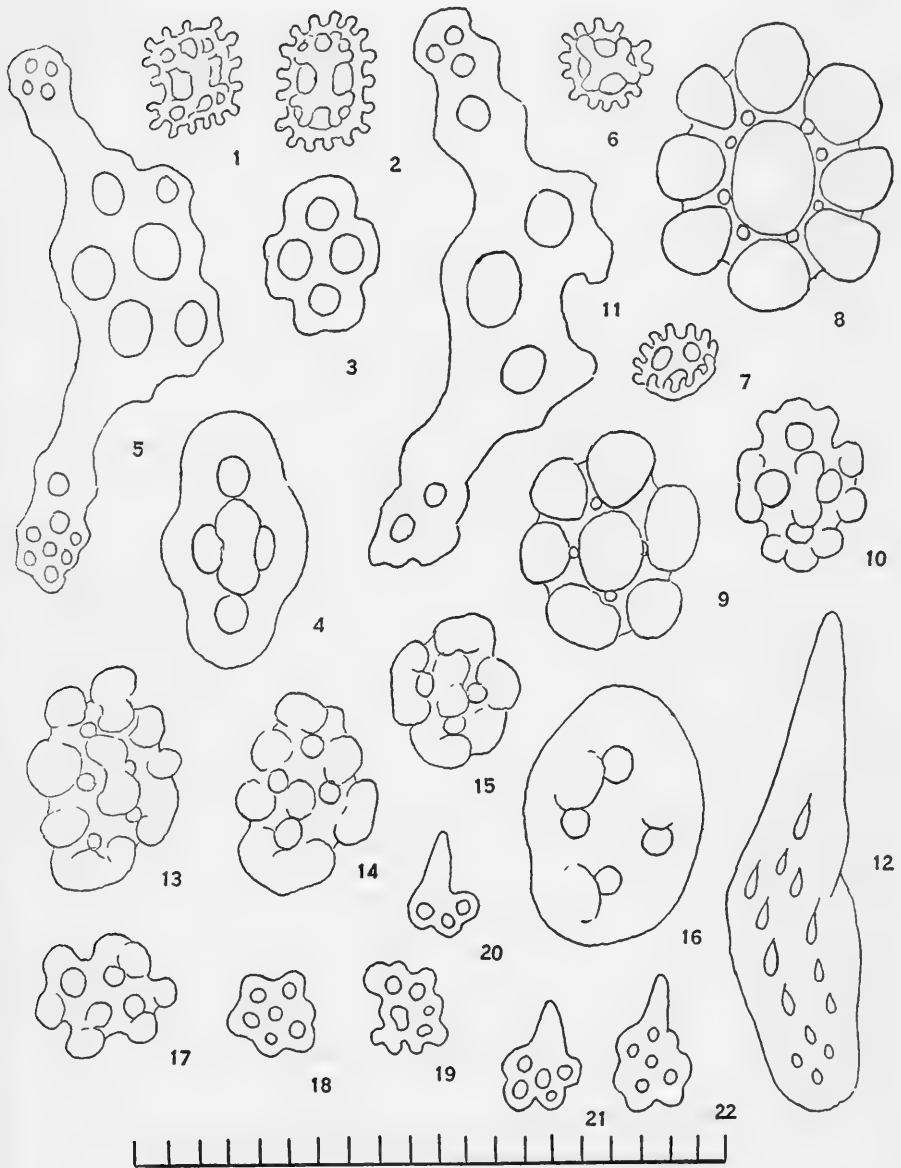
- Apentamera lepra*, new species.....p. 92
- 1-2. Supporting tables from tube foot.
  - 3-4. Rosettes (or flat baskets) from outer layer of spicules.
  - 5-6. Knobbed plates from inner layer of spicules.
  - 7-8. Tables from introvert.
  - 9-10. Rod and plate from tentacles.
- Neopentamera anexigua*, new species.....p. 90
- 11. Supporting rods from tube foot.
  - 12-14. Knobbed buttons from integument.
- Pentamera chiloensis* (Ludwig).....p. 88
- 15-17. Tables from integument, lateral view and from above (spire omitted in the latter cases).
  - 18. Supporting table from tube foot.
- Pentamera chierchia* (Ludwig).....p. 86
- 19-20. Tables from integument.
  - 21. Supporting rod from tube foot.





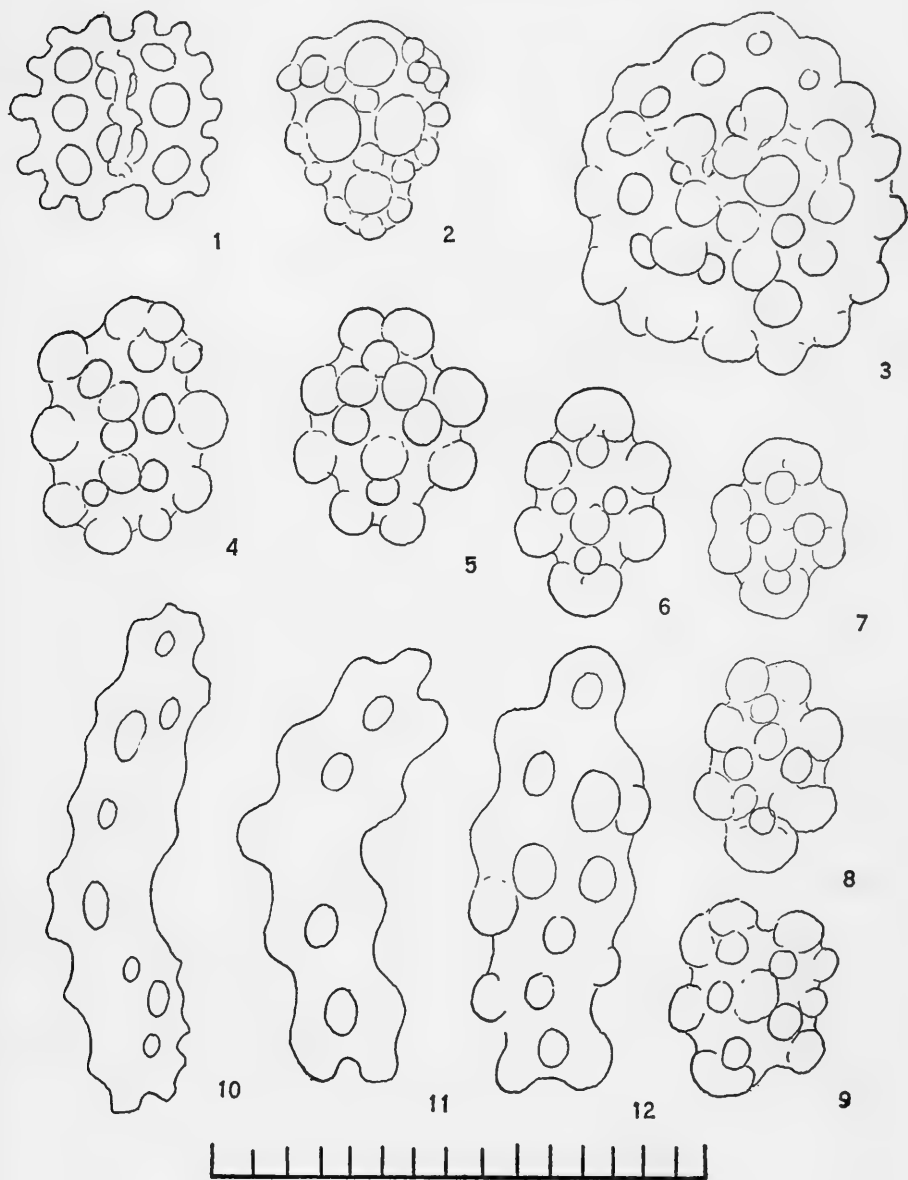
## PLATE 14

- Leptopentacta grisea* H. L. Clark.....p. 93
- 1-2. Baskets from external layer of integument.
  - 3-4. Buttons from external layer of integument.
  5. Supporting plate from tube foot.
- Leptopentacta panamica*, new species.....p. 96
- 6-7. Baskets from external layer of integument.
  - 8-10. Knobbed buttons from external layer of integument.
  11. Supporting table from tube foot.
  12. Small-holed plate with spinelike projection, from external layer of integument or wall of tube foot.
- Leptopentacta nova*, new species.....p. 95
- 13-15. Irregularly knobbed button from external layer of integument.
  16. Large swollen button from external layer of integument.
  - 17-19. Biscuit-shaped plates from external layer of integument.
  - 20-22. Biscuit-shaped plates with marginal tooth from external layer of integument.



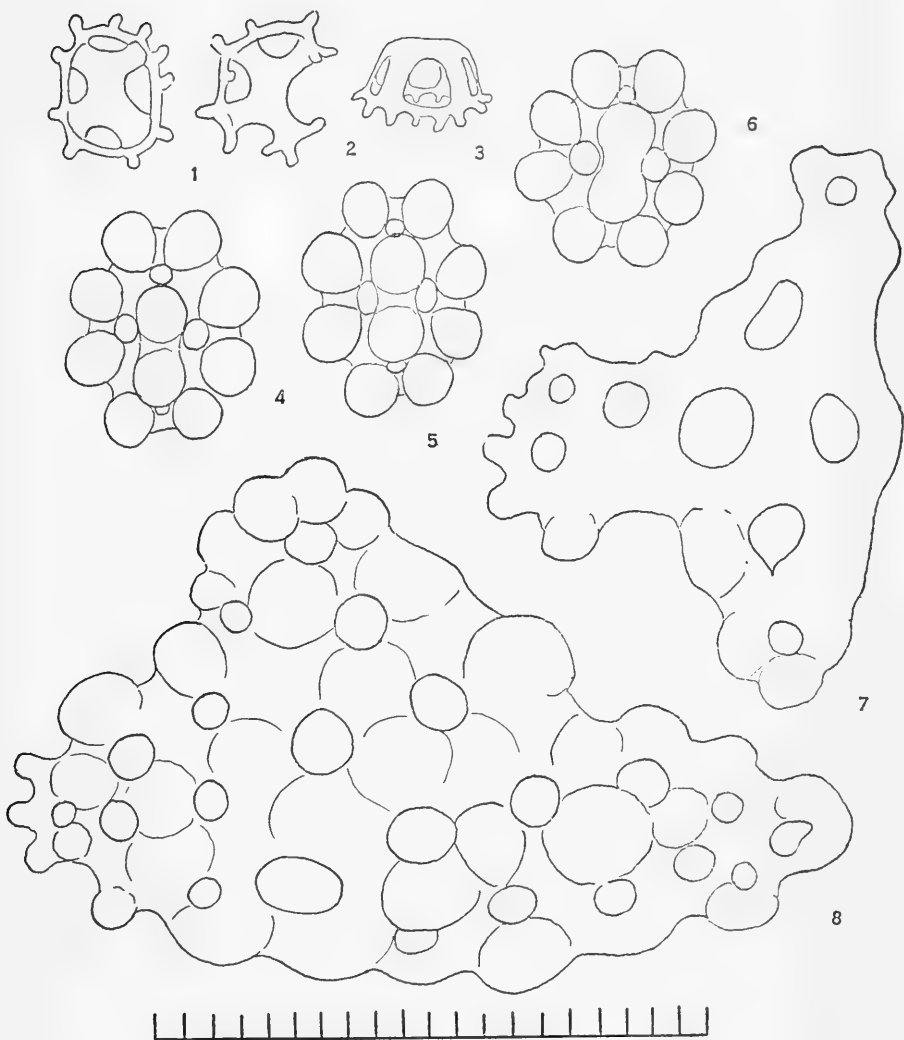
## PLATE 15

- Leptopentacta nina*, new species.....p. 97
- 1-2. Hollow plates or buttons from external layer of integument.
  3. Larger plate from external layer of integument.
  - 4-9. Irregular knobbed buttons from inner layer of integument.
  - 10-12. Supporting plates from tube foot.



## PLATE 16

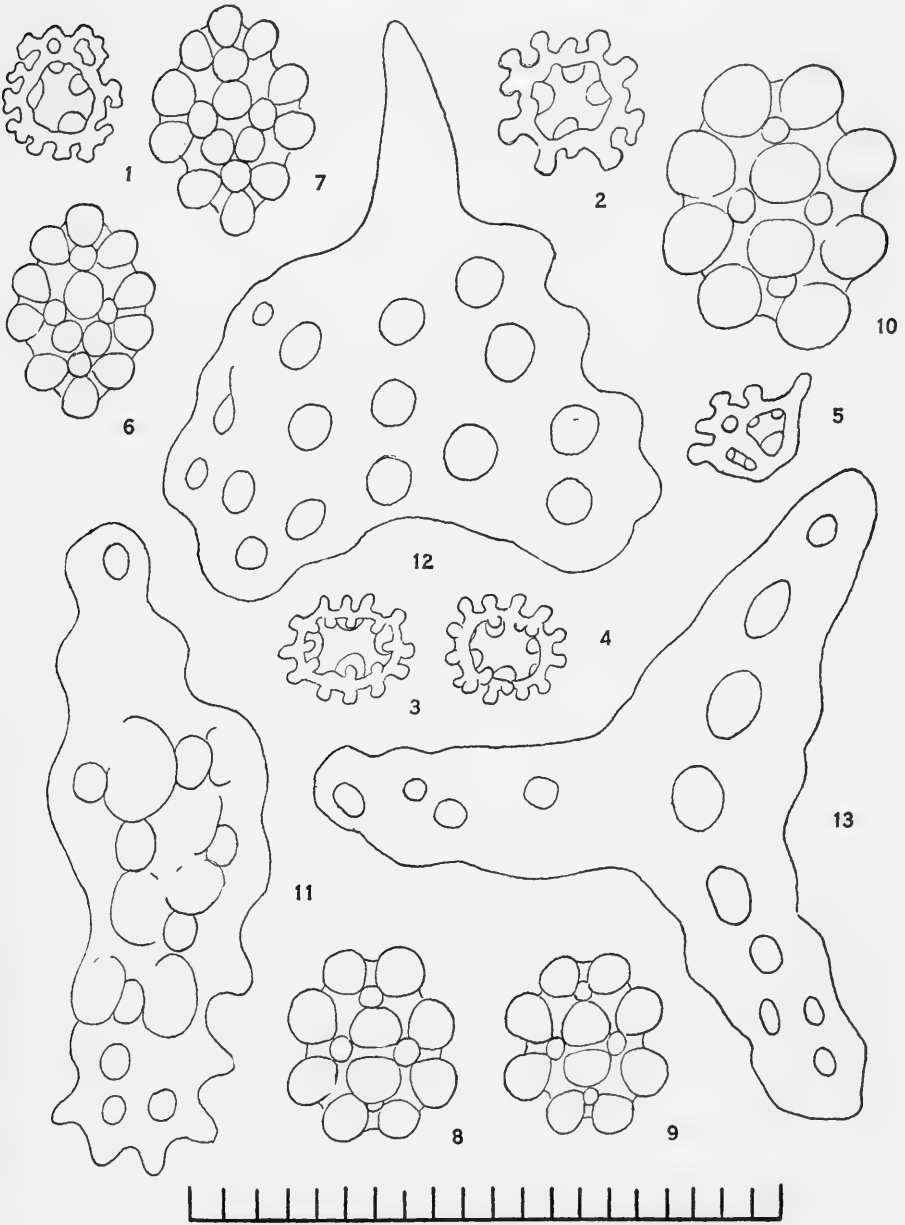
- Pentacta peruana* (Semper).....p. 97
- 1-3. Baskets from external layer of integument.
  - 4-6. Knobbed buttons from inner layer of integument.
  7. Supporting plate from tube foot.
  8. Knobbed plate from inner layer of integument near base of tube foot.



## PLATE 17

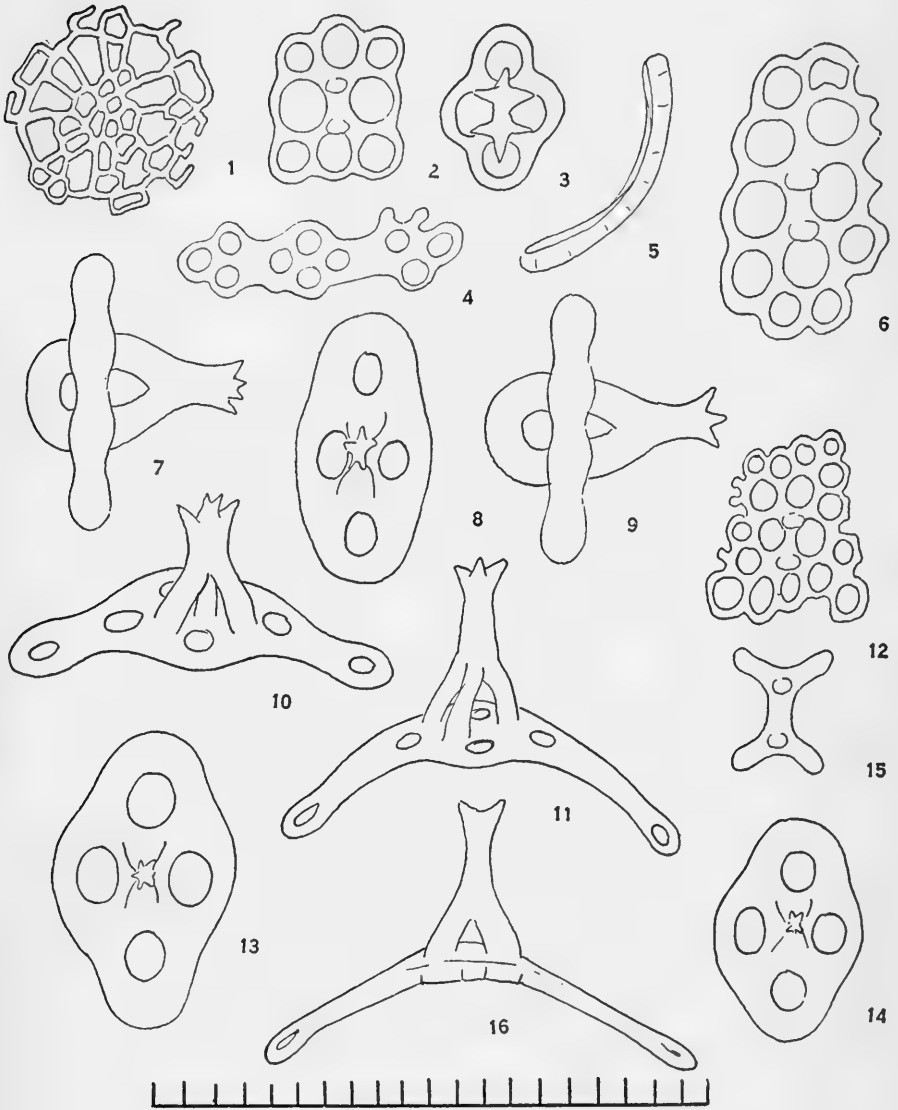
- Thyonacta mexicana*, new species.....p. 101
- 1-5. Baskets from external layer of integument.
  - 6-9. Smaller knobbed buttons from inner layer of integument.
  10. Large knobbed button from inner layer of integument.
  - 11-13. Supporting plates, knobbed and smooth, from tube feet.





## PLATE 18

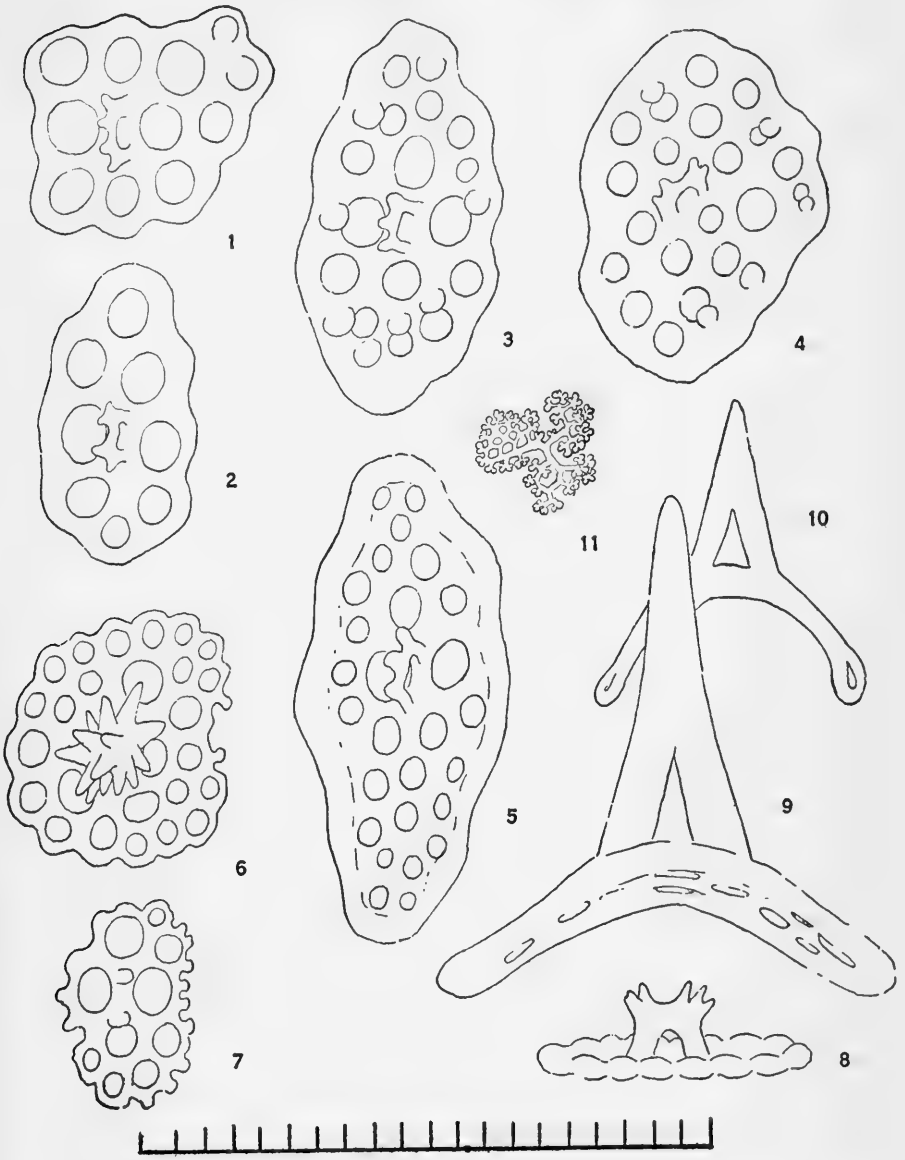
- Thyone neofusus*, new species.....p. 104
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  - 2-3. Tables from integument.
  - 4-5. Supporting tables with no trace of spire.
  6. Disk of table from introvert.
- Thyone parafusus*, new species.....p. 106
- 7-9. Oblong tables with tapering spire and "handle."
  - 10-11. Supporting tables with 3 pillars in spire.
  12. Disk of table from introvert.
- Thyone bidentata*, new species.....p. 105
- 13-14. Tables from integument.
  15. Incipient table.
- All from type.
16. Supporting table from a small individual less than 1 cm. long.



## PLATE 19

*Thyone strangeri*, new species.....p. 107

- 1-5. Tables from integument.
- 6-8. Tables from introvert.
- 9-10. Supporting tables with conical spire from tube foot.
- 11. Rosette from tentacle.

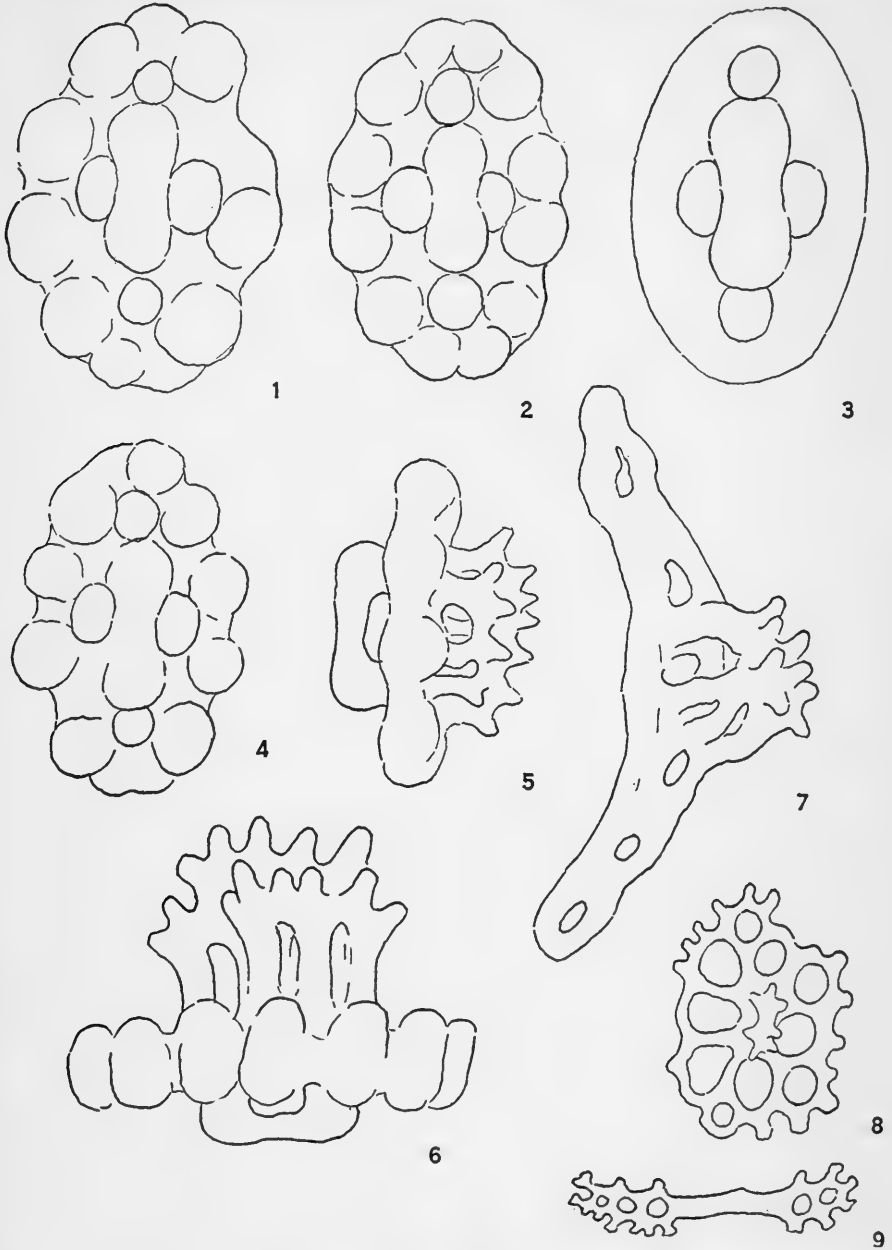


## PLATE 20

*Neothyone gibber* (Selenka).....p. 109

- 1-4. Knobbed to smooth buttons.
- 5-6. Knobbed button from external layer, lateral view showing the external cluster of spines and the inner "handle."
7. Supporting table from tube foot.
8. Table from introvert.
9. Supporting rod from tentacle.

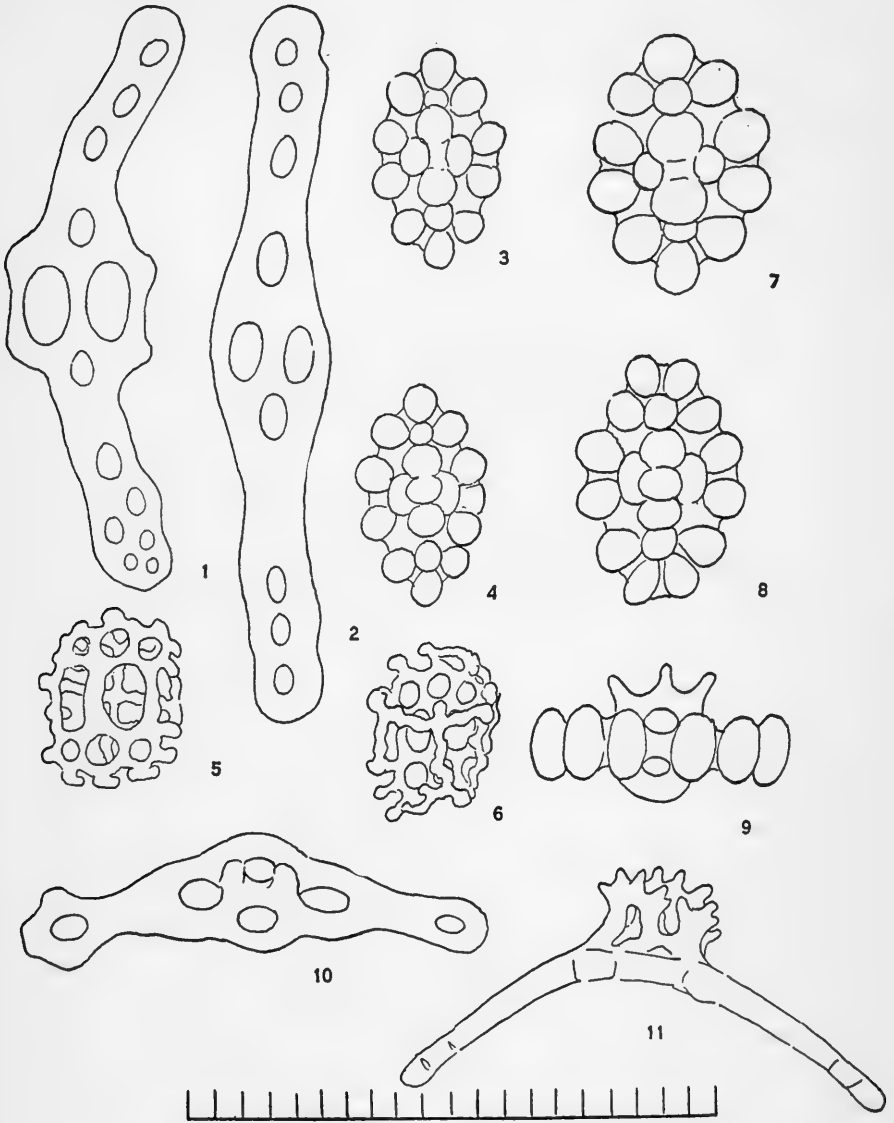
All from Selenka's type in M.C.Z.



## PLATE 21

- Neothyone panamensis* (Ludwig).....p. 112
- 1-2. Supporting plates from ventral feet.
  - 3-4. Knobbed plates from inner layer of integument.
  - 5-6. Baskets derived from buttons from external layer of integument.
- Neothyone gibbosa*, new species.....p. 113
- 7-8. Knobbed buttons (outer handle often with 3 knobs) from inner layer of integument.
  9. Knobbed button from external layer of integument, with a few spines (rare).
  - 10-11. Supporting tables from tube foot.





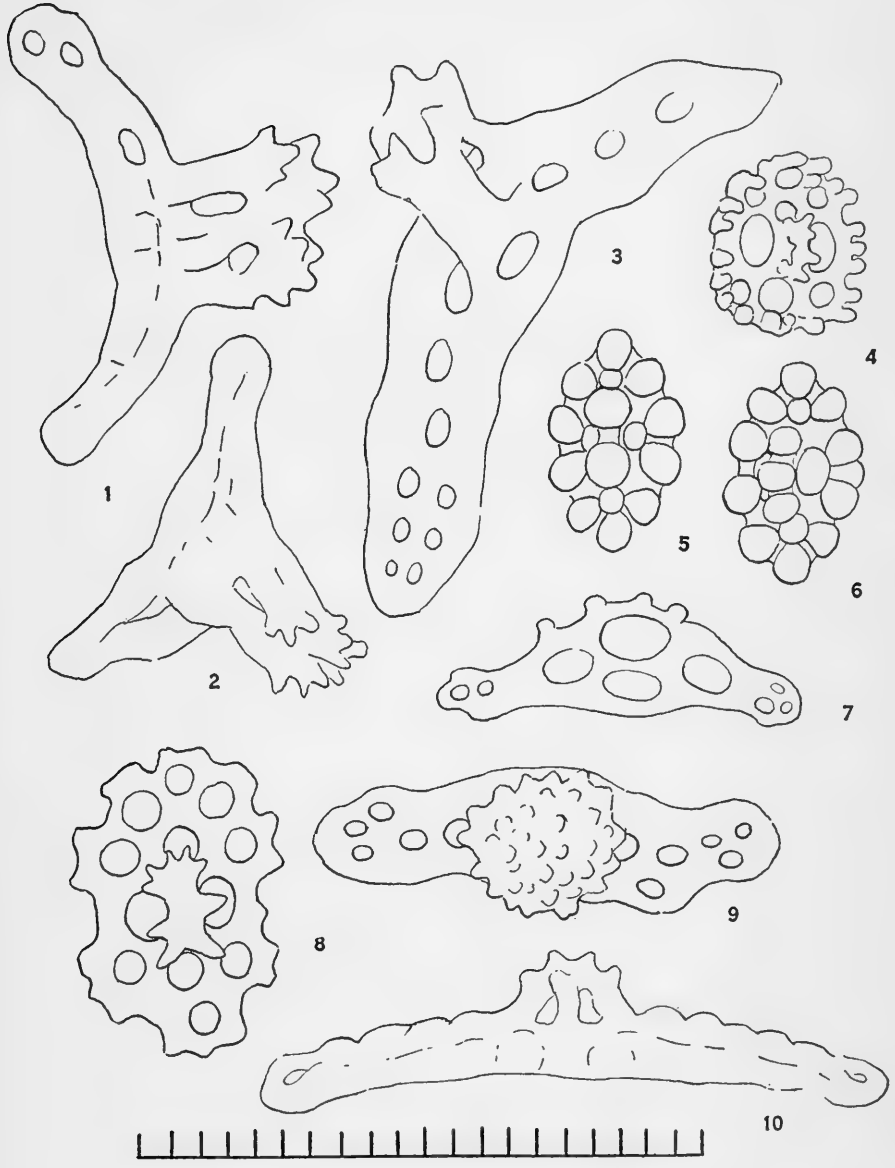
## PLATE 22

*Neothyone gibbosa*, new species.....p. 113

- 1-3. Large deformed supporting tables from dorsal feet of large individual from San Felipe, Gulf of California.
4. Basketlike buttons from outer layer of integument (rare).
- 5-6. Knobbed buttons from inner layer of integument.
7. Small smooth supporting plate from ventral tube foot.
8. Table from introvert (disk obviously somewhat reduced through reduction along the margin).

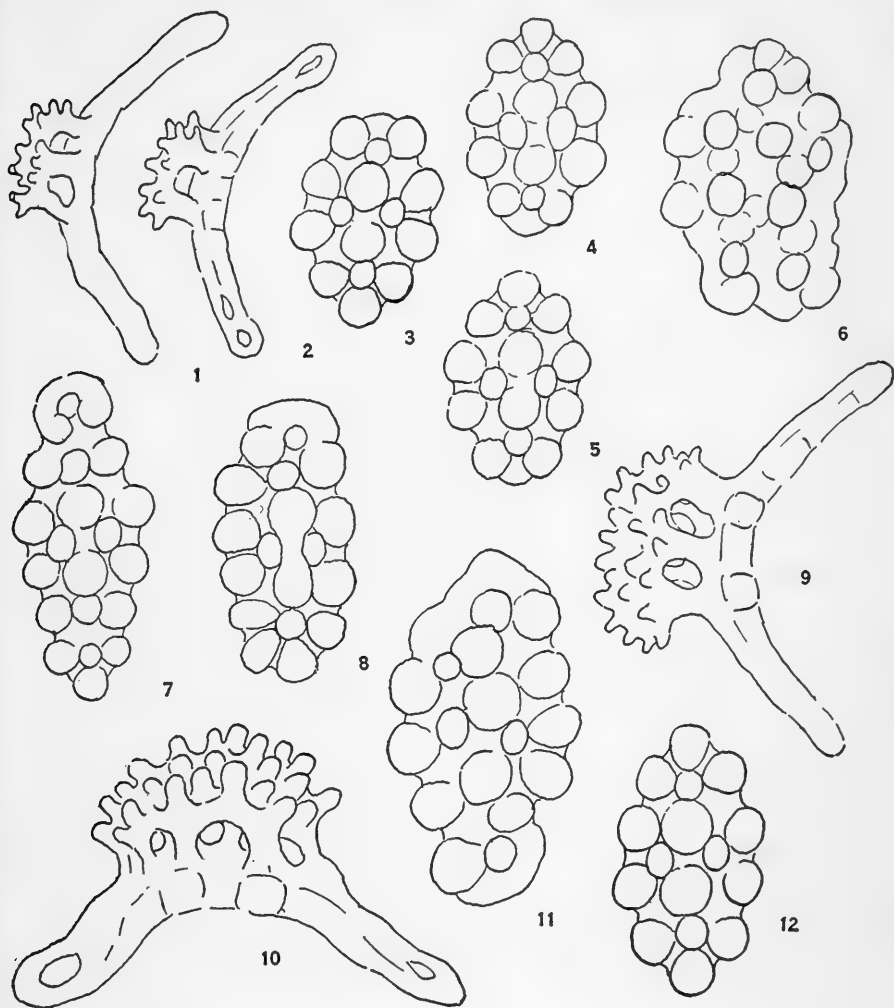
*Pachythyone pseudolugubris*, new species.....p. 116

- 9-10. Supporting tables from tube foot, dorsal and ventral, respectively, from large individuals from San Felipe, Gulf of California.



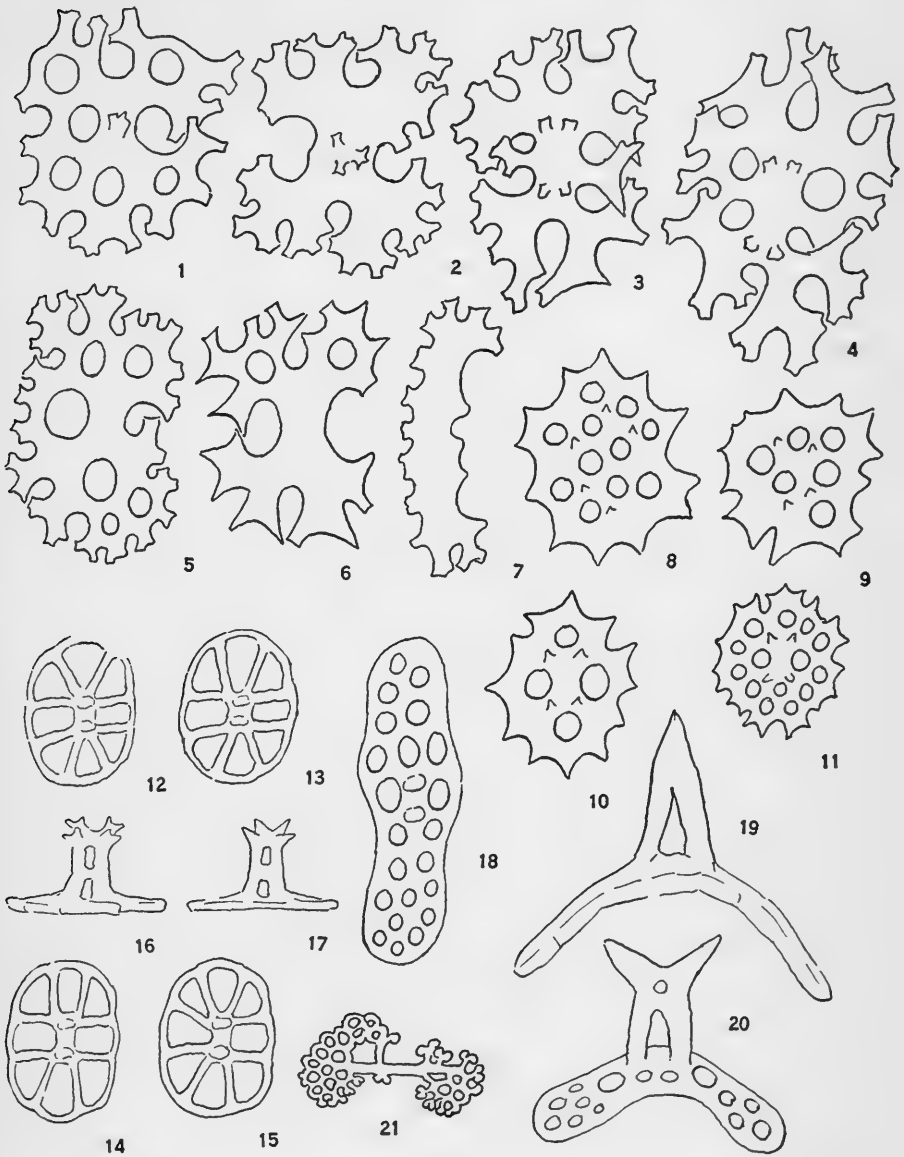
## PLATE 23

- Pachythyone pseudolugubris*, new species.....p. 116
- 1-2. Supporting tables from ventral tube feet of specimens few cm. long.
  - 3-5. Knobbed buttons from inner layer of integument.
  6. Knobbed plate from outer layer seen from the internal side (the reticulated external layer is not drawn).
- Pachythyone lugubris* (Deichmann).....p. 116
- 7-8. Elongate knobbed buttons from inner layer of integument.
  9. Supporting table from ventral tube foot.
- Pachythyone rubra* (H. L. Clark).....p. 115
10. Supporting table from ventral tube foot.
  - 11-12. Knobbed buttons from inner layer of integument.



## PLATE 24

- Euthyonidium ovulum* (Selenka).....p. 124
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  7. Supporting rod from tube foot.
- Euthyonidium veleronis*, new species.....p. 126
- 8-10. Plates with few spires, indicating traces of a spire.
  11. Plate from introvert.
- Phyllophorus zaca* Deichmann.....p. 134
- 12-15. Disks of tables.
  - 16-17. Tables, lateral view.
  18. Disk of supporting table from tube foot.
  - 19-20. Supporting tables, lateral view.
  21. Rosette from tentacle.

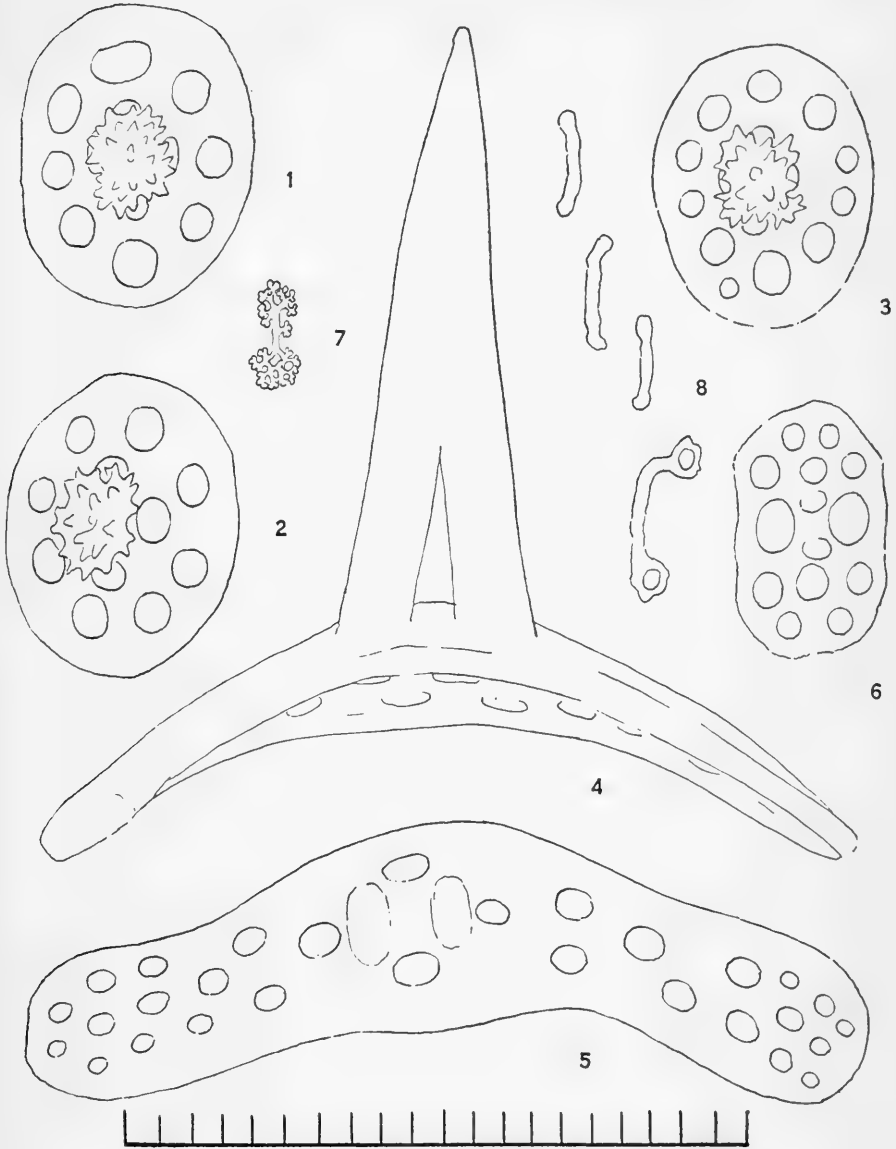


## PLATE 25

*Phyllophorus aculeatus* Ludwig.....p. 133

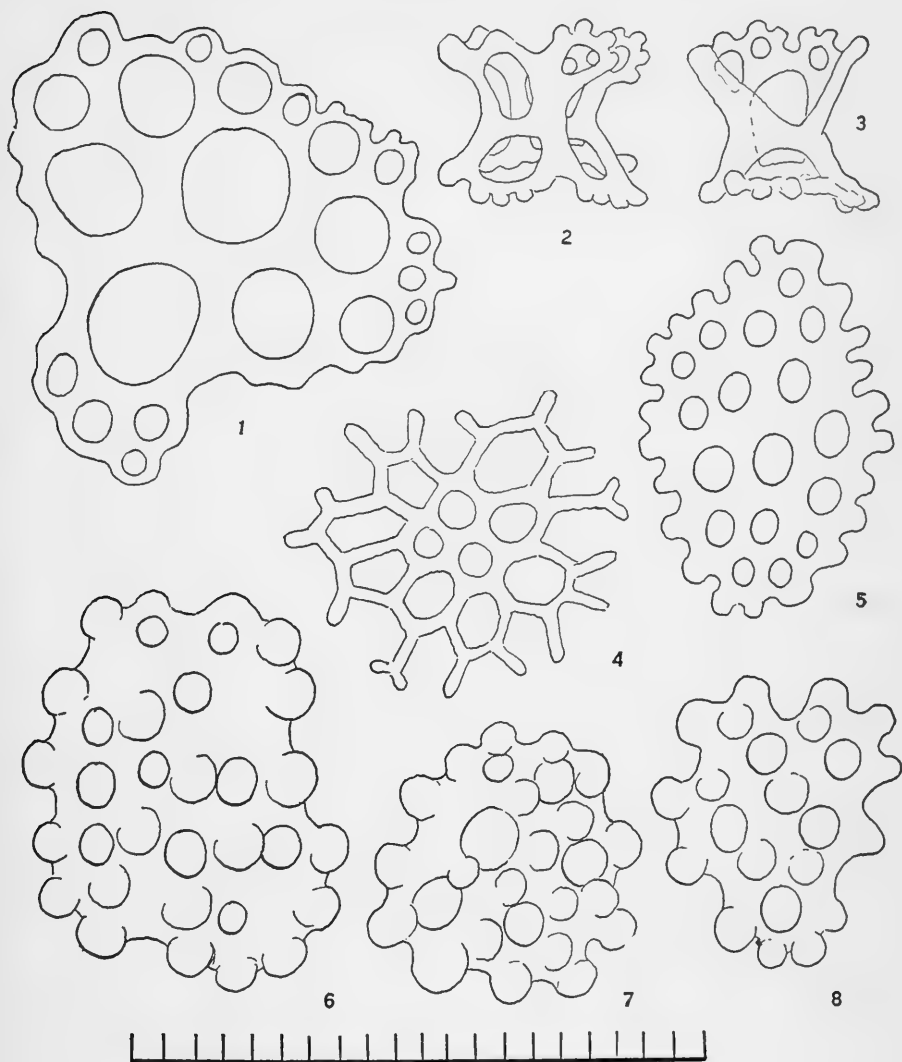
- 1-3. Tables seen from above.
4. Large supporting table from tube foot, lateral view.
5. Disk of supporting table, seen from above.
6. Disk of table from introvert.
7. Rosette from tentacle.
8. Delicate rods from tentacle.





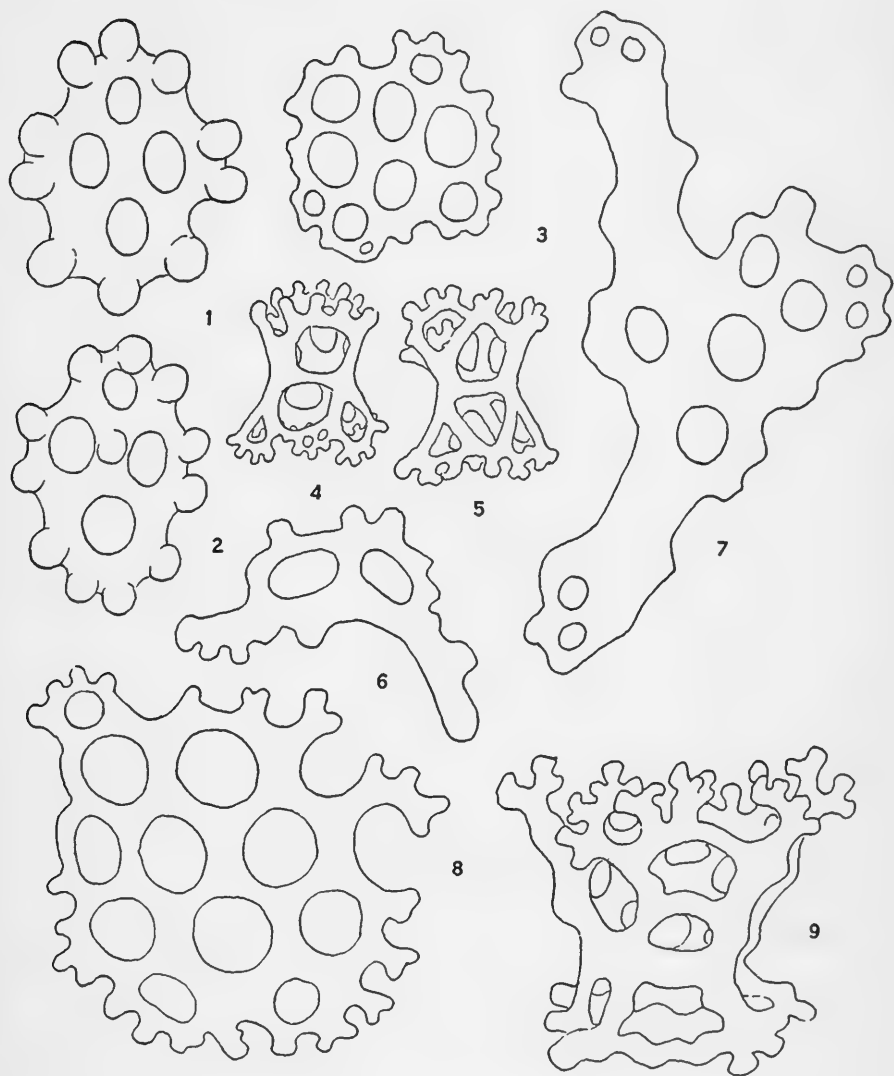
## PLATE 26

- Thyonepsolus nutriens* H. L. Clark.....p. 138
1. Curved supporting plate from dorsal tube foot.
  - 2-3. Hourglass-shaped bodies from dorsal side.
  4. End plate from dorsal tube foot.
  5. Perforated plate from ventral sole.
- Thyonepsolus weleronis*, new species.....p. 140
- 6-8. Knobbed plates from ventral sole.



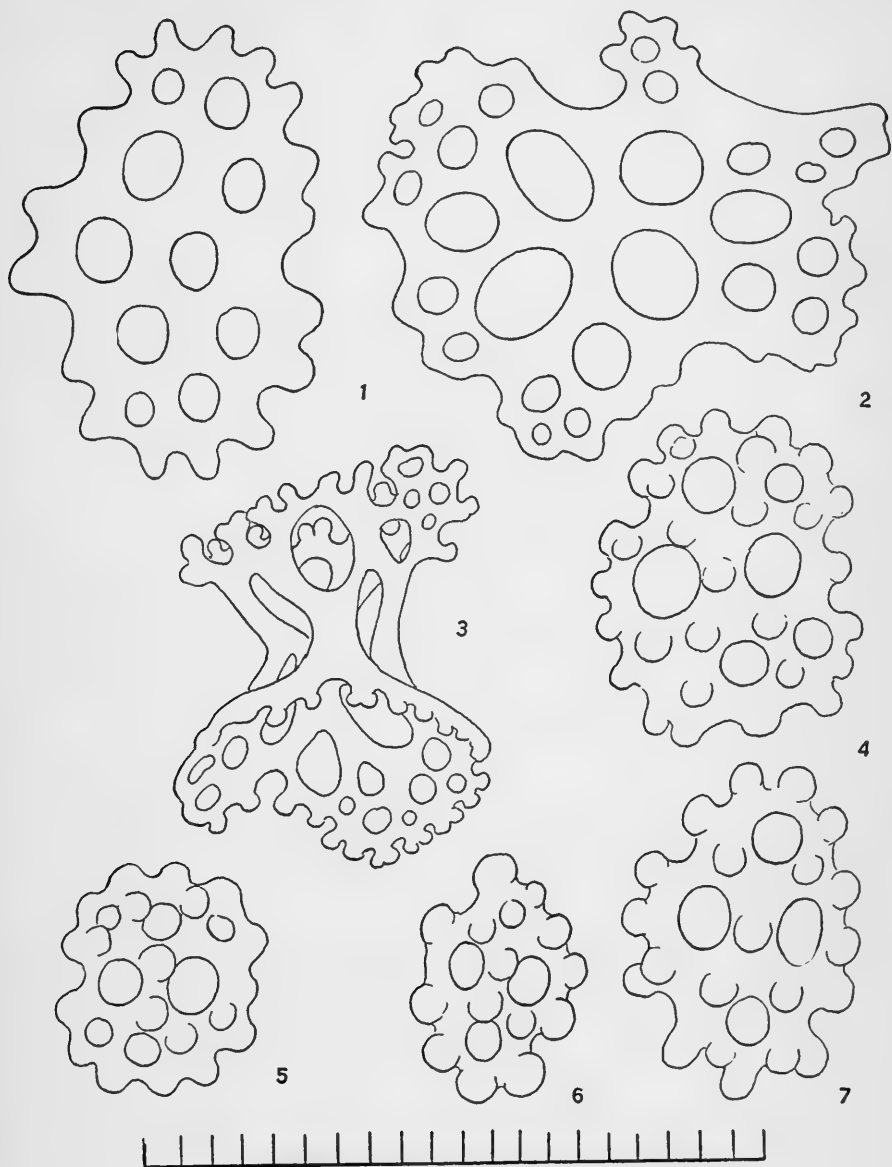
## PLATE 27

- Thyonepsolus hancocki*, new species.....p. 140
- 1-2. Knobbed buttons from ventral sole.
  3. Curved supporting plate from dorsal tube foot.
  - 4-5. Hourglass-shaped bodies from dorsal side.
  - 6-7. Perforated plates from stem of tentacle.
- Thyonepsolus wcleronis*, new species.....p. 140
8. Curved supporting plate from dorsal tube foot.
  9. Hourglass-shaped body from dorsal side.



## PLATE 28

- Thyonepsolus beebei* Deichmann.....p. 139
1. Perforated plate from ventral sole.
  2. Curved supporting plate from dorsal side.
  3. Hourglass-shaped body from dorsal side.
- Psolidium eubullatum*, new species.....p. 144
- 4-7. Knobbed plates from ventral sole.

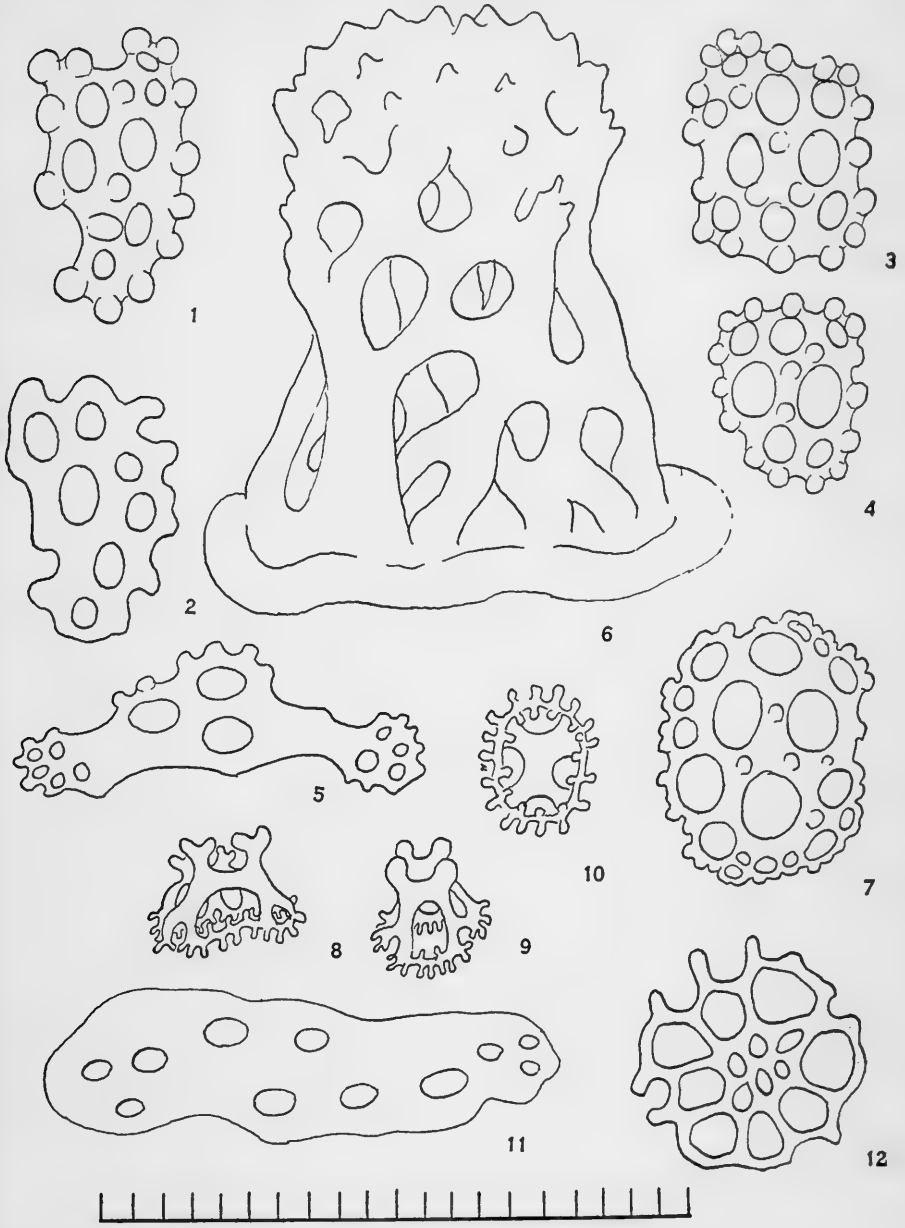


## PLATE 29

*Psolidium dorsipes* Ludwig.....p. 143

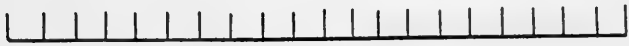
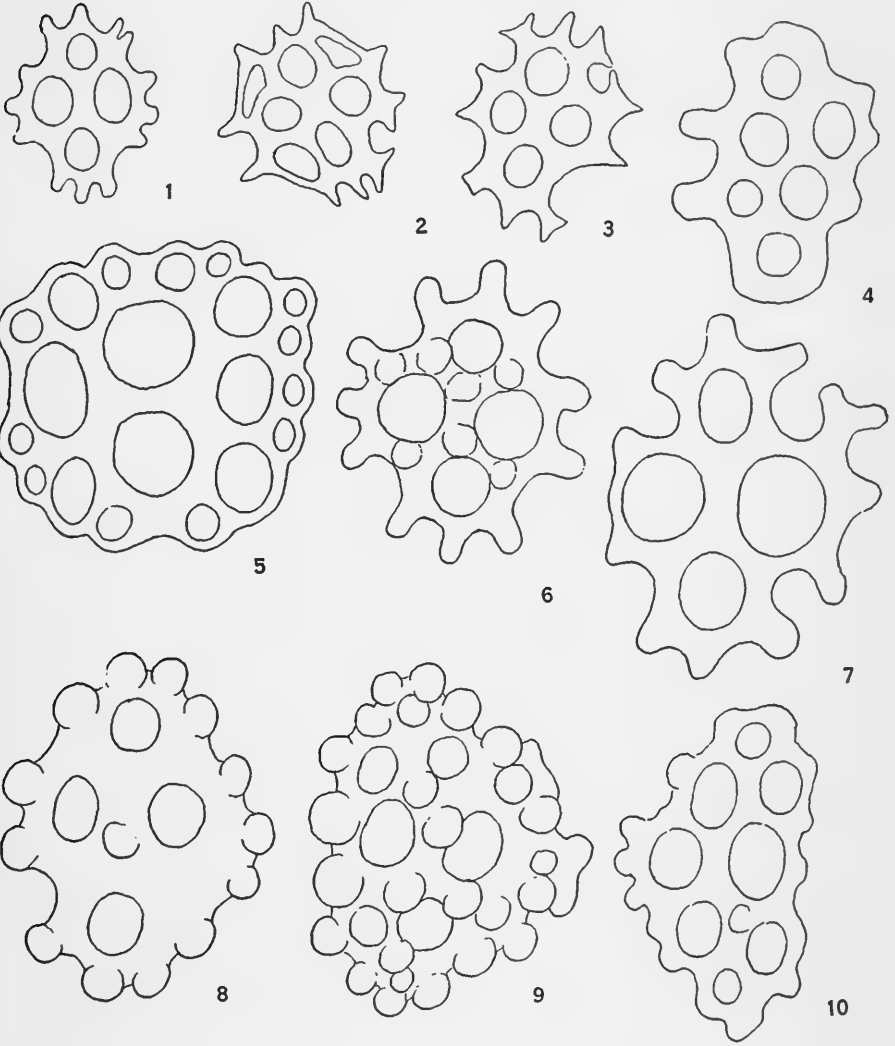
- 1-2. Knobbed and smooth plates from ventral sole.
- 3-4. Strongly knobbed plates from sole.
5. Supporting rod from ventral tube foot.
6. Towerlike body from dorsal side.
7. Curved supporting plate from dorsal tube foot.
- 8-10. Cups or baskets from external layer of sole and dorsal side.
11. Narrow, curved supporting rod from dorsal tube foot (rare).
12. End plate from dorsal tube foot.





## PLATE 30

- Psolidium planum*, new species.....p. 145
- 1-3. Shallow buttons or baskets from external layer in sole.
  4. Smooth plate in deeper layer of sole.
  5. Curved plate from tube foot in dorsal.
- Psolidium ekmani*, new species.....p. 145
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- Psolus squamatus* (Koren), var. *segregatus* Perrier.....p. 147
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- Psolus patagonicus* Ekman.....p. 148
8. Slightly hollow button with marginal knobs from sole.
- Psolus diomedea* Ludwig.....p. 149
- 9-10. Knobbed to almost smooth plates from sole.





REPORTS ON THE COLLECTIONS OBTAINED BY ALLAN HANCOCK PACIFIC EXPEDITIONS OF  
VELERO III OFF THE COAST OF MEXICO, CENTRAL AMERICA, SOUTH AMERICA,  
AND GALAPAGOS ISLANDS IN 1932, IN 1933, IN 1934, IN 1935,  
IN 1936, IN 1937, IN 1938, IN 1939, IN 1940, AND IN 1941.

## NEW EASTERN PACIFIC SEA STARS

(PLATES 31-34)

*By* FRED C. ZIESENHENNE

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# NEW EASTERN PACIFIC SEA STARS

(PLATES 31-34)

FRED C. ZIESENHENNE

*Research Assistant*

*Allan Hancock Foundation*

During the last ten years the *Velero III*, research cruiser of the Allan Hancock Foundation, The University of Southern California, on various scientific cruises to the eastern tropical Pacific and southern California waters has dredged an extensive collection of sea stars, including the following new species. In keeping with the policy of making expedition results immediately available, it has been thought advisable to publish on the new species rather than to await the final report on the Asteroidea.

The writer acknowledges his indebtedness to Dr. H. L. Clark of the Museum of Comparative Zoölogy, Harvard College; to Mr. A. H. Clark of the U. S. National Museum; and to Dr. W. K. Fisher of the Hopkins Marine Station for valuable and helpful suggestions in the preparation of the manuscript. Thanks are due Mr. Anker Petersen, staff artist of the Allan Hancock Foundation, for the drawings and recording of color notes, and Mr. G. P. Ashcraft of the Allan Hancock Foundation for the accompanying photographs.

Last, but not least, the author expresses grateful appreciation to Captain Allan Hancock for the privilege of participating in most of the *Velero III* expeditions and for the opportunity of a trip east to study and compare many of the specimens with type material of the U. S. National Museum and the Museum of Comparative Zoölogy.

## Astropectinidae

Genus **LEPTYCHASTER** Smith

Subgenus **PARASTROPECTEN** Ludwig

**Leptychaster (Parastropecten) stellatus**, new species

Plate 31, Figs. 1-3

*Description.*—Rays 5,  $R=15$  mm.,  $r=6$  mm.,  $R=2.5$  r. Width of ray at second marginal plate 6 mm. Disk moderate, rays about as long as width of disk, gradually tapering to a bluntly pointed tip; general form depressed. Abactinal paxillar areas not crowded, paxillae arranged in

regular, transverse, oblique rows at sides of ray and median interradial area; no definite arrangement of paxillae in the center of disk. Paxillae largest at base of ray and interradial areas, decreasing conspicuously in size toward the center of disk and tip of ray. Column of paxilla slightly higher than width of base, constricted at the summit. The largest bear 10 short spinelets constricted at the base and greatly enlarged into a finely serrated sphere at the tip. Each paxilla bears 1 or 2 central spinelets and up to 9 in the peripheral series; smaller paxillae carry only 4 or 5 peripheral spinelets, not reduced in size.

Abactinal plates are small, compact along the midradial line and center of the disk where papulae are lacking. The plates of the papular areas in general are circular with 4 to 6 lobes, irregular in length, thickness, and distribution. Plates of the papular areas are arranged in regular transverse oblique rows, parallel with the interradial line. There are 6, often 5, and occasionally 4 papulae around each plate, emerging from between the lobes by which the plates usually touch. Plates along the median area of the ray are even less regular, often without lobes; they are slightly smaller, and the papulae are absent from a median strip about three plates wide. Toward the center of the disk the plates rapidly decrease in size, they become more crowded, and lobes if present are inconspicuous and of irregular occurrence.

Superomarginal plates 18 from median interradial line to tip of ray, forming an arched bevel to border the abactinal area. They are rectangular, with a convex surface, about three times wider than long, largest interradially and gradually decreasing in size distally. Marginal plates of both series are separated transversely by deep, narrow, fasciolar grooves, and a deep longitudinal groove separates the supero- from the inferomarginal plates. Superomarginal plates covered with numerous, close-set, finely serrated capitate spinelets. The marginal spinelets are slightly smaller and more delicate. The heavier, coarse, median spinelets are arranged in 3 transverse rows on the interradial marginals, then 2 rows on median plates, and a single row on the most distal plates. They are about the same size as the actinal, paxillar spinelets.

Terminal plate large, conspicuous, its length equal to the width of four adjoining superomarginal plates; abactinal surface broadly convex; proximal margin with a broad concave notch; distal margin blunt, with a deep furrow groove. Distal half naked, proximal half covered with capitate spinelets, which diminish gradually in size distally, where they are only one third the size of those on the proximal margin.

Inferomarginal plates 20, of the usual form, about as wide as length of three plates interradially, whence the width rapidly diminishes toward end of ray. The outer end of the first two plates is narrower than the inner. The outer end of the plates, forming the rounded ventrolateral border of the ray, is closely covered with rather truncated capitate spinelets similar to those of the superomarginals (but projecting a little farther outward); but on the actinal surface these become slenderer, clavate, with the thorny ends sometimes obliquely pressed, or bent, toward margin of ray. There are no enlarged tubercles on any marginal plate.

Actinal interradial areas small, comprising 2 complete chevrons of plates. The inner chevron, without an odd interradial, extends to fourth inferomarginal; the second, with a conspicuous unpaired interradial, reaches to the second plate, while outside the odd plate are two others indicating a third and fourth chevron to come. The plates have a low tabulum, carrying a few capitate spinelets, like those on outer end of inferomarginals, and also usually a few slender clavate ones.

Adambulacral plates 26, with an angular furrow margin, a convex surface, and somewhat sunken transverse sutures. The first few plates are wider than long, but they continue to narrow distally until on outer third of ray they are longer than wide. Furrow spines proximally 4, but over most of ray 3, subspatulate, blunt, the median member with edge to furrow. There are proximally 9 or 10, distally about 6, clavate, thorny subambulacral spinelets a little smaller than the furrow members, arranged in about 3 longiseries proximally and 2 distally. The distal member of the longiseries often stands on the furrow margin and can reasonably be counted as a fourth or fifth furrow spinelet.

Mouth plates relatively large, the suture length about twice width of combined plates. Furrow margin more than half suture length. Furrow spines about 6, increasing in size toward apical spine, which is heavy, clavate, and blunt. There are 10 or 12 suboral spinelets along margin of median suture; 5 or 6 on margin adjacent to first adambulacral, and 4 or 5 scattered in between.

Madreporite oval, convex, diameter 1.25 mm., raised above disk plates, located in the median interradial area along the superomarginals. Striations coarse, irregular, centrifugal, arched domelike. Madreporite surrounded by 6 large paxillae, which often conceal it.

*Color.*—Dried, actinal surface is cream buff, abactinal surface and marginals yellow cream buff.

*Holotype.*—AHF no. 44; 7 paratypes.

*Type locality.*—Holotype and 2 paratypes from Station 701-37, 32 fms., sand and shell, Angeles Bay, Gulf of California, Mexico, March 20, 1937. Four paratypes from Station 650-37, 47 fms., coarse sand, off San Francisco Island, Gulf of California, Mexico, March 9, 1937. One paratype from Station 1249-41, 34-44 fms., fine white sand, one mile south of San Benito Islands, Lower California, Mexico, February 26, 1941.

*Remarks.*—The youngest specimen measures  $R=5.2$  mm.,  $r=3.2$  mm.,  $R=1.6$  r, width at base of ray (second superomarginal plate) 2.7 mm. It has 7 very large, rectangular superomarginal plates separated from one another by deep fasciolar grooves, and 14 adambulacral plates. The terminal plate is conspicuous, large and convex, raised above the abactinal surface. Anal aperture is barely visible. Paxillae bear a central and 6 or 7 peripheral spinelets. There are 3 or 4 ambulacral furrow spines. Each mouth plate bears 3 large oral spines. Actinal interradial series consists of 7 plates. The madreporite is small, partly concealed by crowded paxillae, and located in the median interradial area.

RELATIVE DIMENSIONS OF  
*Leptychaster (Parastropecten) stellatus*

<i>Station</i>	<i>R</i> (mm.)	<i>r</i> (mm.)	<i>R:r</i>	<i>Width at raybase</i> (mm.)	<i>No. of supero- marginals</i>	<i>No. of adambu- lacrals</i>
701-37	15	6	2.5:1	6	18	26
701-37	7.6	3.8	2:1	3.4	14	18
701-37	10	4.2	2.3:1	4.2	16	23
1249-41	7.8	3.8	2:1	3.4	11	18
650-37	10	5.3	1.8:1	4.6	14	20
650-37	6	3.7	1.7:1	2.8	8	14
650-37	5.2	3.2	1.6:1	2.7	7	14
650-37	5.4	3.1	1.7:1	2.7	7	14

This species is closely related to *Leptychaster (Parastropecten) inermis* (Ludwig) of the tropical Pacific but differs from it in having 6 papulae instead of 4 around each plate; proximally 4, rarely 5, and distally 3 furrow spines instead of 6 or 7; a more stellate disk, longer arms,

and very large, conspicuous terminal plate instead of a pentagonal disk and small inconspicuous terminal plates.

It differs from the northern Pacific *Leptychaster* (*Parastropecten*) *anomalus* Fisher by the following characters:

*L. (P.) stellatus*

Paxillar spinelets coarse, clavate.  
 Central paxillar spinelets 1 or 2.  
 Peripheral paxillar spinelets upward of 9.  
 Ambulacral spines proximally 4, rarely 5, distally 3.  
 Furrow margin of adambulacral plate angular.  
 Actinal spinelets clavate, less numerous.  
 Terminal plate large and conspicuous.  
 Disk stellate.  
 Adambulacral plates shorter.  
 First adambulacral plate compressed.  
 Adults have 18 superomarginals, 26 adambulacrals.

*L. (P.) anomalus*

Paxillar spinelets slender, terete.  
 Central paxillar spinelets 3 or 4.  
 Peripheral paxillar spinelets upward of 10.  
 Ambulacral spines proximally 5 or 6, distally 4 or 5.  
 Furrow margin of adambulacral plate convex.  
 Actinal spinelets slender, tapering, numerous.  
 Terminal plate small and inconspicuous.  
 Disk pentagonal.  
 Adambulacral plates longer.  
 First adambulacral plate not compressed.  
 Adults have 16 superomarginals, 29 adambulacrals.

The name *stellatus* has reference to the long, narrow rays in contrast to the usual short-rayed, pentagonal forms.

## Benthopectinidae

Genus **LUIDIASTER** Studer

**Luidiaster californicus**, new species

Plate 31, Figs. 4-5; Plate 32, Figs. 1-7

*Description*.—Rays 5, R=87 mm., r=16 mm., R=5.43 r. Breadth of ray at base 19 mm. Abactinal surface of the disk and basal portions of the rays slightly swollen. Abactinal integument composed of large circular plates interspaced with numerous small, irregular, round and elongated plates. A section of integument cleared in xylene revealed the plates as irregularly arranged and close together, but not in actual contact. The smaller plates serve as connectives between the larger ones, and the papu-

lae pass through the interspaces. As seen from the coelomic surface, on the basal part of arm and adjacent disk integument, are 3 longitudinal series of large plates, a median and 2 lateral rows, where the large plates are compacted with fewer small connectives and no intervening papulae. The plates are low and form 3 simple kinds of intergrading paxillae. The tabulum is only slightly elevated, and the smallest plates bear from 1 to 8 short, bluntly pointed, granulelike spinules. The intermediate plates bear one long, stout, tapering, movable spine and a surrounding ring of 1 to 5 sharp spinules of varying length and size, and on the base of the tabulum a circle of short granulelike spinules. The largest of the intermediate plates bear 1 to 3 equally long central spines and 1 to 6 slightly shorter secondary spines. The largest paxillar plates confined to the disk and basal ray usually bear a long, sharp, movable central spine and 4 to 9 equal or subequal spines surrounding it. There is considerable variation as to the length and density of these spines. These paxillae are free of secondary spinelets and bear comparatively few granulelike spinules on the edge of the tabulum. Dorsal spines are largest on the center of the disk, where they are about 3 mm. long and fairly stout. The paxillar armature decreases rapidly in size distally and beyond the papular areas only the small single-spinuled and granulelike spinule forms are present. The differences between the large, small, and intermediate paxillae are more distinct on the disk and papular areas of the rays than on nonpapular areas. The intermediate paxillar plates are in the process of forming large paxillar plates bearing the long primary spines.

Marginal plates of two alternate series. There is no encroaching of the supermarginals upon the abactinal area except far along the rays. Each plate is strongly convex, almost tabulate, bearing 1 or 2, often 3, movable tapering spines, the uppermost usually the largest, equal in length to the combined length of three superomarginal plates. These are surrounded by 2 to 7 secondary spines of varying length, less than one third the length of the largest spine. On the remainder of the plate, except for the naked border, are numerous, well-spaced, short, blunt, granulate spinules. The plates of both series have their raised portion separated by shallow, naked channels. The spines of the first and second superomarginal plates are shorter than the succeeding ones.

Inferomarginal plates are slightly wider than superomarginals. The central portion of each plate is elevated to form a transverse spine-bearing ridge. Each ridge bears 2 or 3, often 4, rigid but movable, tapering, pointed subequal, outstanding spines, the central or uppermost the largest.

They are stouter and somewhat longer than the corresponding superomarginal spines. There are fewer secondary spines and spinules compared with the superomarginals. The terminal plate is small, wider than long, densely covered with spinules.

Adambulacral plates more than twice as wide as long, widely separated by deep, broad, naked grooves. The center of the plate is raised in a prominent, transverse ridge bearing 3 or 4 subequal, stout, tapering spines, the longest more than the combined length of two adambulacral plates. The outermost spine slightly the longest. In addition, there may be from 3 to 9 sharply tapering spinelets on the outer edge of ridge. Furrow margin ridge prominent, bearing 2 to 4 subequal, heavy, blunt, slightly curved, capitate furrow spines, the outer two shortest, middle one or pair equal to the length of one adambulacral plate. Tube feet in 2 rows; sucking disks well developed, ampullae double.

Mouth plates oval shaped, more than twice as long as wide; actinostomial margin widest, broadly rounded; distal margin narrow, convex; actinal surface highly convex. Marginal spines, 5 or 6, broad and flattened, tapering and bluntly tipped. Innermost spine longest, about two thirds the length of oral plate, next shorter, and the remaining diminishing rapidly in size to the short, delicate outer spine. On the actinal surface are 3 to 5 large, stout, tapering, blunt spines, half the length of oral plate and 2 to 4 smaller secondary spines. Distally on each plate is a longitudinal row of 3 to 8 short, sharp spinules. Actinal intermediate plates 4 to 8, confined to the disk, oval shaped, wider than long, each bearing 3 to 5 transverse rows of 3 to 4 short, sharp, granulelike spinules.

Papulae very numerous, absent in a narrow interradiial line of the disk and the distal two thirds of the ray. They are present on the disk and basal portion of ray, where there is some semblance of 4 longitudinal rows, each with an irregular transverse series of 3 to 6 papulae. Longitudinal rows are separated by 3 longitudinal rows of loosely compacted, large paxillar plates; the two central rows consist of 2 or 3 transverse papulae, extending to the third or fourth superomarginal. Outer rows consist of 3 to 5 transverse papulae, extending to sixth, seventh, or eighth superomarginal; and in larger specimens there is a continuation of a single row of papulae, close to the superomarginals extending to the thirteenth superomarginal. In a specimen of  $R=90$  mm. each papular area contained about 260 papulae. The youngest specimen of  $R=32$  mm. contained 62 papulae in each papular area.

Pectinate pedicellariae very inconspicuous, flat, confined to the actinal surface. One or 2 pedicellariae in each actinal interradial area, and upward of 13 have been found on a ray between the adambulacral plates. The margins of 2 adjacent plates each bear a comb of 5 to 7, straight, broad, short, bluntly tipped, interlocking spinules. Pectinate pedicellariae could not be found on all of the specimens.

Madreporite body convex, striae radiate out irregularly. It is located in the interradius about its own diameter (1 or 2 plates) from the superomarginal plates; surrounded and protected by 4 or 5 large paxillae.

On the coelomic surface of the dorsal integument are 2 long, narrow, strong muscle bands, extending from the basal portion to the tip of the rays. Proximally they are separated, but on the distal third of ray they join, continuing as a single band to the tip of ray. The proximal tendon is from 8 to 10 mm. long. In the larger specimens the main portion of the tendon is attached fanwise to the proximal side of the crest of the prominent ninth or tenth ambulacral ossicle. The attachment is not noticeably fanwise in the smaller specimens. Small lateral tendons branch off and are attached to the third, fourth, fifth, and sometimes the sixth superomarginal plate.

*Color.*—In alcohol, the ground color is dull cream buff, lightly overcast with gray, papular areas slightly darker gray; spines almost white with tinges of cream buff.

*Holotype.*—AHF no. 45; 7 paratypes.

*Type locality.*—Holotype and 6 paratypes from Station 1306-41, 228-267 fms., loose rock, submarine bank 6 miles east of Long Point, Santa Catalina Island, California, May 3, 1941. An additional paratype from Station 1425-41, 280 fms., loose rock, 11.5 miles S.E. of Church Rock, Santa Catalina Island, California, September 28, 1941.

*Remarks.*—There is some variation in the length and number of spines on the paxillae; some bear secondary spines, some have just spinules surrounding the large central spines, and others, mainly on the largest specimens, have a central spine surrounded by equally large spines. There are other variations already mentioned. The youngest specimen of  $R=32$  mm.,  $r=5$  mm., had no papulae in the center of the disk, the narrow interradial area, longitudinal center of the proximal part of ray, and distal two thirds of ray. In each area there were about 62 papulae, which extend out in 2 double rows to the fifth and a single row to the ninth superomarginal. The armature of the plates and of the paxillae was essentially the same as in the larger specimens. No pectinate pedicellariae were observed.



From *Luidiaster dawsoni* (Verrill) of Alaskan waters this species differs as follows:

*Luidiaster dawsoni*

- Abactinal paxillae with short spines surrounding the central spine.
- Paxillar spinules long, sharp, distinct.
- Large, prominent, circular pectinate pedicellariae on actinal and abactinal surfaces, composed of 2 or 3 combs of 12 or less long, heavy, strongly recurved spinules, almost L-shaped.
- Adambulacral furrow spines 5-7.
- Adambulacral actinal spines 2-4.
- Actinostomial oral spines 6-8.  
Suboral spines 7-10.
- Muscle tendon attached to 7th or 8th ambulacral ossicle and 3rd superomarginal.
- Madreporite in young nearly touching superomarginal.
- Papulae absent from center of disk.

*Luidiaster californicus*

- Abactinal paxillae with long spines, surrounding the central spine and often equal in length.
- Paxillar spinules short, blunt, granulelike.
- Small, inconspicuous, flat pectinate pedicellariae confined to actinal surface, composed of 2 combs of 7 or less short, broad, blunt, straight spinules.
- Adambulacral furrow spines 3 or 4.
- Adambulacral actinal spines 2 or 3, rarely 4.
- Actinostomial oral spines 5 or 6.  
Suboral spines 3-5.
- Muscle tendon attached fanwise to 9th or 10th ambulacral ossicle and 2 or 3 lateral tendons to 3rd, 4th, 5th, or 6th superomarginal.
- Madreporite more than its diameter from superomarginals.
- Papulae present on center of disk, except young.

This species is distinct from *Luidiaster horridus* (Fisher) of the Hawaiian Islands as follows:

*Luidiaster horridus*

- No pectinate pedicellariae.
- Oral plates with 3 enlarged spinules.

*Luidiaster californicus*

- Pectinate pedicellariae present actinally.
- Oral plates with 3-5 actinal prominent spines.

Inferomarginal spines 5-8.	Inferomarginal spines 2 or 3, rarely 4.
Paxillae with accessory spines two thirds the length of central spine.	Paxillae with accessory spines often equal the length of central spine.
Actinostomial marginal spines 7.	Actinostomial marginal spines 5 or 6.
Actinal oral spines 10 or 11.	Actinal oral spines 3-5.
Papulae absent from center of disk.	Papulae present on center of disk.

The name *californicus* has reference to the known distribution of this species.

## Linckiidae

### Genus PHATARIA Gray

#### *Phataria mionactis*, new species

Plate 33, Figs. 3-4

*Description.*—Rays 5, R=50 mm., r=10 mm., R=5 r. Rays short, heavy, and bluntly pointed, more or less cylindrical and tapering slightly toward the tips. Height of ray at base 9.5 mm., at ray tip 6 mm. Width of ray at base 11 mm., midray 10 mm., ray tip 8 mm. Skeleton composed of numerous, irregular, swollen, compacted, granulated plates. The disk is covered with large and small, irregular plates; the larger plates are arranged in an irregular circle within the ray bases. Within the circle and surrounding the anal opening are about 27 irregularly shaped plates of various sizes. The plates are compactly covered with coarse, mosaiclike granulations, which are round or rectangular. The granules surrounding the anal aperture are heavier and longer.

The broad abactinal surface of the ray is covered with large and compact plates of irregular shapes and sizes, between which are often wedged smaller, irregular plates. Transversely there are about 5 plates across the arm, irregularly placed and overlapping without a definite serial arrangement. On the sides of the rays are 2 regular series of papular areas of about 20 pores each. The upper series, immediately above the superomarginal plates, averages 17 areas and extends to within 8 mm. of the ray tip. The lower or intermarginal series averages 22 areas and extends to the tip of the ray. The papular areas, which are separated one from another by a single transversely oriented plate, are reinforced by a reticulation of tiny ossicles which serves to separate the papulae and support the granules.

Marginals regularly arranged, lateral; the plates of the two series of the same size, roughly rectangular, and united in dorsoventral pairs by the secondary ossicle which separates the papular areas. The plates of each series are strongly imbricated, free edge adoral, and they also overlap the interpapular secondary plates; superomarginals about 18, inferomarginals 20.

Actinal plates abruptly much smaller than inferomarginals, in 3 perfectly regular series, with the beginning of a fourth at interradius. They also form regular transverse series of 3, two of these corresponding to an inferomarginal. Actinal granules become gradually coarser toward furrow.

Adambulacral plates compressed, somewhat crescent shaped, concave distally, the actinal aspect about as broad as the furrow length of two successive plates. Armature consists of a spatulate subtruncate furrow spine with a shorter, much slenderer aboral companion; immediately behind these (without intervening granules) stands a compressed, generally abovate spine, about as long as the major furrow spine, and a secondary aboral spinelet smaller than the corresponding one of the furrow series. Back of these the plates are granulated as the adjacent actinals. Along the margin of the extremely narrow furrow there are thus 2 series of short, compressed spines (each with an inconspicuous companion).

Madreporite subcircular, slightly concave, 2 mm. in diameter, with numerous small pores but no obvious carinae. It is in contact with 2 interradial superomarginals.

*Color.*—Dried, light vinaceous buff. Color in life, abactinal surface maroon with 2 purple longitudinal bands covering the papular areas, the upper band terminating short of the ray tip and the lower band extending to the ray tip. Actinal surface creamish buff.

*Type.*—AHF no. 41.

*Type locality.*—Station 212-34, 45-50 fms., La Plata Island, Ecuador, February 10, 1934.

*Remarks.*—The rays of this specimen are unusually short. This condition might be caused by a pathological disease or mechanical injury. Many coral-dwelling fishes, especially the parrot fishes, are known to bite off sea star rays and even stout sea urchin spines. Upon examination terminal constrictions were noted suggesting regenerating ray tips. Compared with *Pharia* and *Phataria*, specimens in which ray tips were regenerating, the type differed by having short, blunt, and less tapering ray tips, while the other specimens had longer, decidedly tapering ray tips termi-

nating in blunt points, and the regenerating ray was distinct from the older portion.

The short, robust, nontapering blunt arms, 2 regular series of marginal plates, 2 regular series of lateral papular areas, and the very broad abactinal area distinguish this species from other members of the family Linckiidae in the eastern tropical Pacific.

The type locality was again visited by the *Velero III* in 1935 and 1938 in the hope of collecting additional specimens of this unique species, but none were obtained.

The name *mionactis* (less-ray) refers to the rays that are shorter than usual.

### Genus TAMARIA Gray

#### *Tamaria obstipa*, new species

Plate 33, Figs. 1-2; Plate 34, Fig. 1.

*Description.*—Rays 5,  $R=36$  mm.,  $r=7$  mm.,  $R=5$  r. Rays slender and tapering; width at base 8 mm., midray 6 mm., ray tip 3.5 mm. Disk slightly convex, plates swollen, to one side of the central plate is the anal aperture. The plates of ray are disposed in the following series: at base of ray, 3 abactinal, 4 marginal, 6 actinal in addition to a series of secondary intermarginals; at middle of ray, 2 actinal series less; near tip of ray, 1 abactinal (carinal), 4 marginal, 0 actinal. All of the plates are covered with closely compacted, rounded or polygonal granules; those on the convex surface of the plates are larger than those in the depressed areas between the plates. There is no definite arrangement of the granules, except in the depressions between the plates where single, transverse rows often mark the margins of the plates, leaving between them a noticeable transverse furrow, especially distinct in the abactinal and marginal series.

The papular areas are arranged in 6 rows; 4 abactinal series extend two thirds of the ray; they are not continuous; often there are 2 or 3 plates in succession without papular areas. Intermarginal series regular, reaching within a few plates of ray tips. Papulae in each area vary from 6 to 24, distally some areas had as few as 3. There are no papular areas on the actinal surface.

The adambulacral plates about three times as broad as long, about 3 plates opposing 2 of the adjoining series. Each plate bears a large subambulacral and 2 smaller furrow spines in addition to numerous enlarged granules. The adambulacral armature consists of 2 distinct rows of spines, set close together; those on the furrow are small, flat, blunt, chisellike,

about as wide as long; the width is variable, often a broad spine opposing a narrow spine. They are convex on the outer side and concave on the furrow side, often with a narrow, distinct groove. The subambulacral row is composed of large, robust, spatulate, blunt-tipped spines, longer than wide, about four times as long and twice as wide as the furrow spines. Between the subambulacral spines are slightly enlarged granules, arranged in 1 or 2 series, transversely to the furrow. The mouth plates bear a prominent, enlarged, triangular, apical oral spine, 2 oral marginal spines, and a prominent, spatulate suboral spine. Granulations on the proximal half of mouth plates small; distal of the suboral spine they become enlarged and spatulate.

Alveolate pedicellariae on the abactinal surfaces; although lacking on the actinal surface of the holotype, they are abundant on the paratype. The distribution of pedicellariae, however, is of no specific importance. Abactinally the pedicellariae are well distributed; actinally they are confined to a single series of 7 to 14 along the subambulacral spines; in several cases the pedicellariae have replaced the subambulacral spine on the adambulacral plate. The shape of the jaws varies from slightly bent to bifid; they are thin, flaring widely at the tips and constricted at the base—some flare out widely and are notched to form a letter Y, while others flare asymmetrically to form a letter L. The majority resemble small socks. The sockets in which the pedicellariae lie are straight; the concavity and broad ridge of the socket face the ambulacra.

The madreporite is 2.3 mm. in diameter and is located interradially about its own diameter from the center of the disk. The surface is covered with fine, close convolutions and striations that radiate from the center. The anal aperture in the center of the disk is closed by 6 long, narrow spinelets, longer than wide and a number of elongated granules.

*Color.*—Dried from alcohol, light buff with a faint lavender hue.

*Types.*—Holotype AHF no. 42; one paratype.

*Type locality.*—Station 780-38, 40-47 fms., Chatham Bay, Cocos Island, Costa Rica, January 14, 1938. One paratype from Station 183-34, 50-70 fms., James Bay, James Island, Galapagos, January 24, 1934.

*Remarks.*—The paratype measures  $R=54$  mm.,  $r=10$  mm.,  $R=5$  r. It has fewer papular areas, which are not continuous but alternate with the plates. The alveolate pedicellariae of the actinal surface are more abundant, 7 to 14; abactinal surface, 12 to 15. The anal aperture is closed by 8 small, triangular granules of different sizes. The groove on the furrow spines is deeper and conspicuous.

This species is closely related to *T. floridae* (Perrier), the pedicellariae of which have small racquet-shaped jaws with a slender, long pedicel and a broad distal expansion with smooth, convex margin. *T. scleroderma* (Fisher) is more distantly related. It has exceedingly tiny granules, difficult to detect until the specimen is dried. The subambulacral spines are spaced from the furrow series, and the interval is thickly covered with minute granules. The proximal furrow spinelets of *T. scleroderma* have a rudimentary groove or concavity on the furrow face.

The name *obstipa* has reference to the pedicellariae, which are bent out of a straight line.

## Asteriidae

Genus **CORONASTER** Perrier

**Coronaster marchenus**, new species

Plate 33, Figs. 5-6; Plate 34, Figs. 2-6

*Description*.—Rays 11 to 17, deciduous; R=80 mm., R=8 r.

Skeleton weak, reticulate, composed of numerous 3- to 5-lobed primary plates connected by 1 to 4 slender, imbricated ossicles. Reticulum of disk irregular with much smaller meshes than that of the ray. These are very small in a zone at periphery of disk, where the plates are irregular and form a more solid framework. Between this peripheral frame and the first transverse arch of abactinal ray plates is a line of weakness where autotomy occurs. Primary plates of disk with a single acicular spine about 1.5 mm. long.

Skeleton of ray is composed of 5 radial rows of slender, 3- to 5-lobed plates connected radially and transversely by narrow, elongated ossicles, forming 4 rows of subrectangular papular areas. The carinal row consists of 9 to 12 spine-bearing plates that extend to middle of ray, beyond which degeneration takes place, leaving only the marginals. On the distal half of ray gradual degeneration of longitudinally united secondaries has occurred. The larger specimens have proximally a dorsolateral series consisting of 5 to 8 spine-bearing plates confined to the basal third of ray. The superomarginal and inferomarginal series consists of 20 to 25 spiniferous plates extending to ray tips. Each plate bears a large, acicular spine about 3 mm. long.

The adambulacral plates are long, narrow, and set at a 45° angle to the furrow; the distal half of one plate overlaps the proximal half of the next plate on the furrow side. Each plate bears an oblique series of 2

blunt, heavy, tapering spines with an enlarged bulbous base, inner spine about 1.3 mm. long, outer spine 1.7 mm. long. Alternate adambulacral plates carry on the furrow face a straight pedicellaria. Tube feet are large, in 2 rows.

Mouth plates rectangular, longer than wide; each bears a large apical oral spine and 2, sometimes 3, and often even a fourth oral spine. Inner of furrow spines shortest, 1.3 mm. long; other spines larger, about 1.8 mm. long. These spines are flattened and widely flared out at the base, then taper distally to a cylindrical blunt tip. Under high power all furrow spines are longitudinally ribbed and form a serrate edge on the spine tip.

Papular areas of the disk are small and irregular, bearing a few papulae and often free rudimentary ossicles. There are from 2 to 15 papulae in the large, rectangular-ray papular areas.

Straight pedicellariae lanceolate, slender, 0.4 to 1 mm. long, scattered rather sparsely over plates, papular areas, and along the furrow face of adambulacrals. The largest have 3 short, curved teeth at distal end, while the smaller terminate in a short hook only. There are no hand-shaped unguiculate pedicellariae such as are present in *C. volsellatus*, *C. briareus*, and *C. haliceps*.

Crossed pedicellariae of the spine wreaths vary from 0.27 to 0.45 mm. long. Each jaw is armed with 2 large terminal teeth between which are 6 small, sharp, triangular teeth about one half the length of the terminals. These teeth are curved downward and form an acute angle with the shank. The shank of the jaw is armed with a single series of 6 (varying from 5 to 7) long, sharp, downward-curved hyaline teeth. The terminal teeth of the jaw give the pedicellariae the appearance of a miniature saber-toothed tiger skull. The pedicellariae of the furrow are 0.4 mm. long; distal four fifths of jaw is serrated and terminates in one or more long, curved claws. They are found on alternate adambulacral plates.

Madreporites, 1 to 5, a large and 4 small accessory madreporites. The largest is 4 mm. long and 2 mm. wide; it is composed of 2 small madreporites fused together. The 4 smaller madreporites are 1.5 mm. in diameter. All five are located about their diameter from the edge of the disk. The striations radiate irregularly from the center, except the large madreporite, where they run parallel transversely to the long axis.

*Color*.—In life, abactinal surface creamish white with carmine striations running radially and transversely, more noticeable distally. The radial and transverse rows of skeletal plates light gray, papulae and papu-

lar areas darker gray, wreaths of pedicellariae on spines commonly buff, often varying from cream to a rich orange. Regenerating arms somewhat lighter, salmon to orange in color. Actinal surface light gray, tube feet pale yellow. When dried, ground color on abactinal surface of the disk deep walnut brown; color extends on basal half of arm and gradually fades distally to olive buff at tips; network of plates and spines olive-buff with a tinge of brown. Actinal side similar in color but lighter in tone. In alcohol, very pale purplish gray.

*Holotype*.—AHF no. 43; 33 paratypes.

*Type locality*.—Holotype and 10 paratypes from Station 310-35, 15 fms., tangles, Marchena Island, Galapagos, December 3, 1934. Twenty-three additional paratypes as follows: 2 from Station 307-35, 20 fms., tangles, Marchena Island, Galapagos, December 3, 1934; 3 from Station 308-35, 3-5 fms., sand, north bay, Marchena Island, Galapagos, December 3, 1934; 14 from Station 773-38, 31-50 fms., coralline bottom, off Nuez Island, Cocos Island, Costa Rica, January 13, 1938; 3 from Station 779-38, 30-50 fms., rock, coral, and coralline, off Nuez Island, Cocos Island, Costa Rica, January 14, 1938; and one from Station 795-38, 35-40 fms., rock and sand, Sullivan Bay, James Island, Galapagos, January 21, 1938.

*Remarks*.—That this species is fissiparous is well borne out by a study of the 34 specimens examined, in which 11 was the minimum and 17 the maximum number of rays, 13 the average per individual. Specimens with a ray length less than 50 mm. averaged 12.7 rays, while those exceeding 50 mm. ray length averaged 13.6 rays. Exclusive of the holotype, 49.3 per cent of the rays were young or regenerating rays. Madreporites ranged from 1 to 5 per individual, 3 being the average; 24 per cent of the madreporites were on young or regenerating portions of disk. In fissiparous reproduction a portion of the disk is cast away with the rays. The small madreporites and regenerating rays grow from this section of regenerating disk, which in some specimens is very distinct. There is no definite order or arrangement in the manner the new rays are added to the disk. In general, 5 or more rays of a first set grow from the regenerating disk; then at a later period a few scattered rays of a second set appear between the adult rays. In some specimens a third set of rays appears between the regenerating first set just opposite the old adult rays. The average ray length to the disk radius for 20 of the largest specimens is  $R=9.5 r$ .

These are the first *Coronasters* to be recorded from the eastern tropical Pacific Ocean and increase the number of Pacific species to 4: *Coron-*



*aster volsellatus* (Sladen) and *Coronaster halicepus* Fisher, Philippine Islands, and *Coronaster eclipses* Fisher, Hawaiian Islands.

*Marchenus*, having 2 adambulacral spines, cannot be confused with *volsellatus*. It differs from *halicepus* as well as *briareus* of the West Indies in lacking broad, unguiculate, hand-shaped, straight pedicellariae. In *C. eclipses* (described from a single ray) these unguiculate pedicellariae are also lacking; and the lanceolate type, so characteristic of *marchenus*, is found only on the furrow face of the adambulacrals. But the furrow pedicellariae of *marchenus* are similar to those of *volsellatus* and quite unlike the smaller more triangular ones of *eclipses* (see Fisher, Sea Stars Tropical Central Pacific, Bishop Museum Bulletin No. 27, 1925, p. 78, fig. 9 d, e, f). The crossed pedicellariae are essentially the same as those of *volsellatus*, with a similar wide range in size. Characteristic of *marchenus* are the fissiparous habit and the presence of upward of 5 madreporites, features which have not been reported for the other species.

The name *marchenus* has reference to Marchena Island, on whose rough lava reefs this species was taken in abundance.





## PLATE 31

*Leptychaster (Parastropecten) stellatus*, new species

FIG. 1. Abactinal view of paxillae and marginal plates x 10.

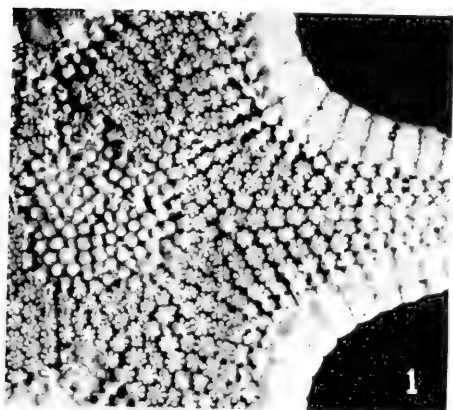
FIG. 2. Abactinal view, scale in mm.

FIG. 3. Actinal view, scale in mm.

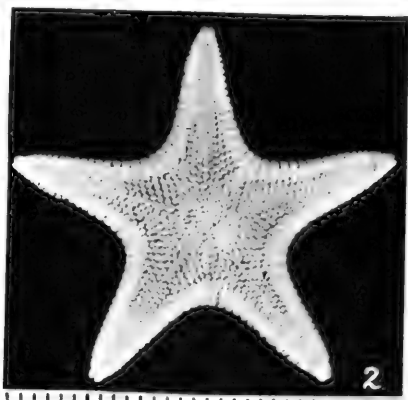
*Luidiaster californicus*, new species

FIG. 4. Abactinal view.

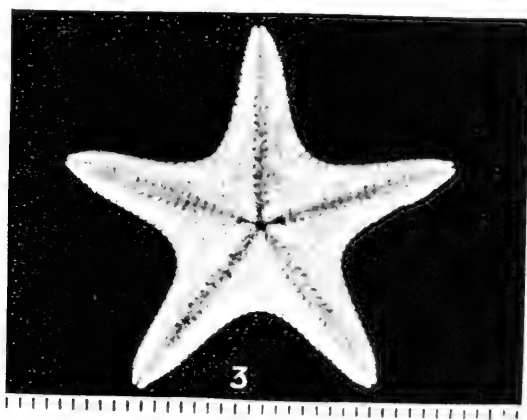
FIG. 5. Actinal view.



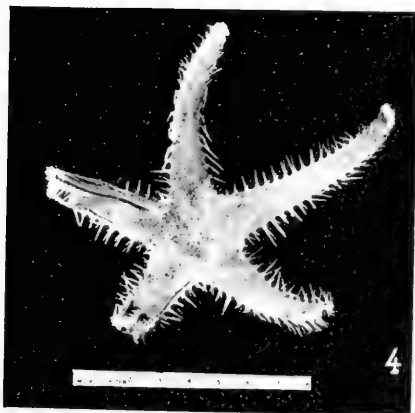
1



2



3



4



5

## PLATE 32

*Luidiaster californicus*, new species

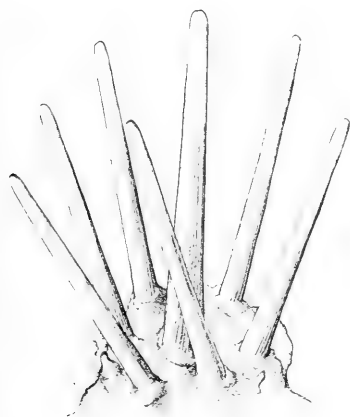
- FIG. 1. Abactinal view of dissection showing the muscle attachments of the dorsal integument to the 9th and 10th ambulacral ossicles and the side wall.
- FIG. 2. Side view of the adambulacral armature.
- FIG. 3. Side view of the most advanced and largest type of abactinal paxilla.
- FIG. 4. Actinal view of the dorsal integument, upper part cut from the center of the disk and lower part from the proximal portion of the arm, showing large and small skeletal plates and papulae distribution.
- FIG. 5. Pectinate pedicellaria from the actinal inter-radia area.
- FIG. 6. Side-actinal view of upper and lower marginal plates.
- FIG. 7. Actinal view of mouth plates showing armature.



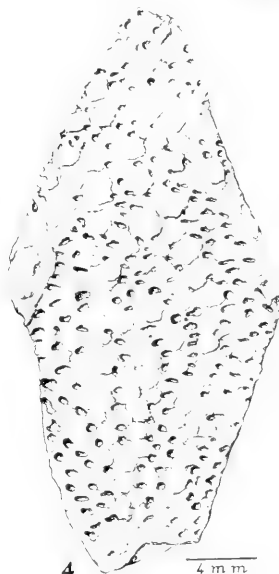
1



2



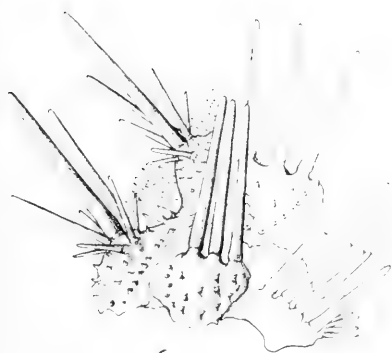
3



4



5



6



7

## PLATE 33

*Tamaria obstipa*, new species

FIG. 1. Abactinal view.

FIG. 2. Actinal view.

*Phataria mionactis*, new species

FIG. 3. Abactinal view.

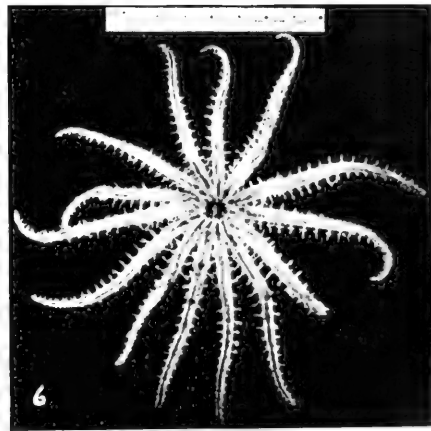
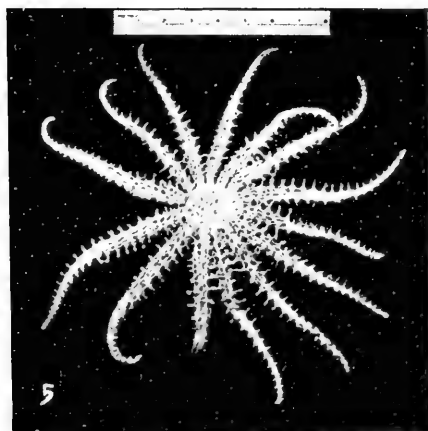
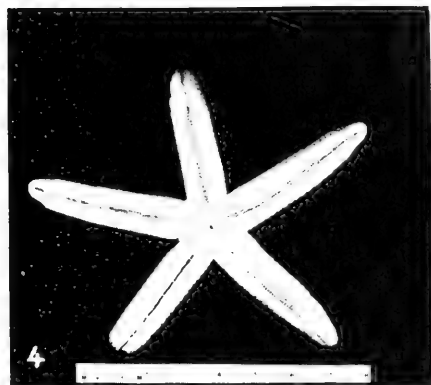
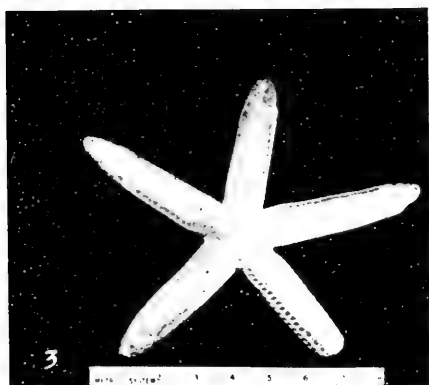
FIG. 4. Actinal view.

*Coronaster marchenus*, new species

FIG. 5. Abactinal view.

FIG. 6. Actinal view.





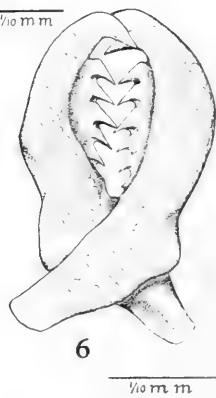
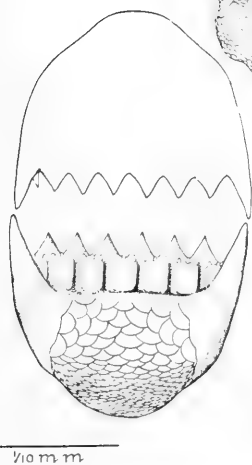
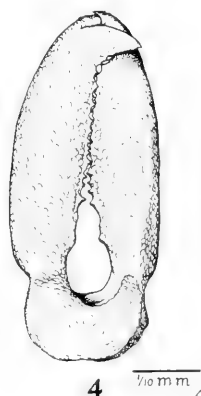
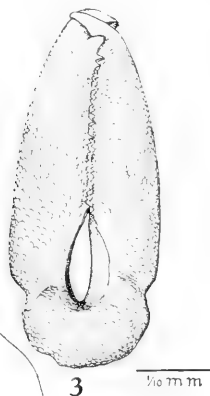
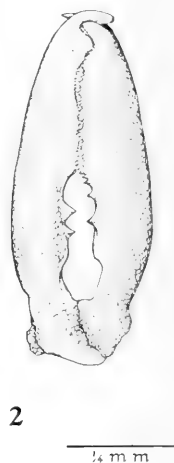
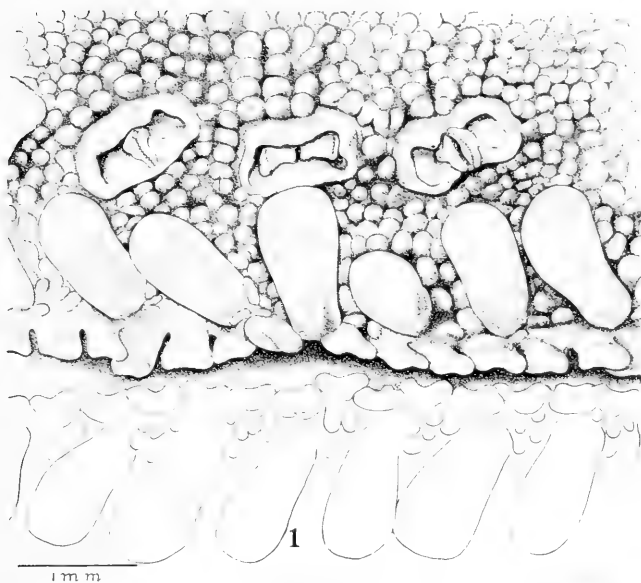
## PLATE 34

*Tamaria obstipa*, new species

- FIG. 1. Actinal view showing adambulacral armature and three pedicellariae.

*Coronaster marchenus*, new species

- FIG. 2. Large, straight abactinal pedicellaria.  
FIG. 3. Small, straight abactinal pedicellaria.  
FIG. 4. Ambulacral furrow pedicellaria.  
FIG. 5. End view of a crossed pedicellaria showing arrangement of teeth.  
FIG. 6. Side view of a crossed pedicellaria.









## HUBERT LYMAN CLARK: TEACHER AND FRIEND

January 9, 1870 - July 31, 1947

Probably the two forms of activity which Dr. Hubert Lyman Clark enjoyed above all others were teaching and dredging for marine animals. It is perhaps appropriate, therefore, that this brief note of appreciation should be offered by one of the very few students Dr. Clark was destined to have during his long tenure at Harvard University and published through the generosity of Captain Allan Hancock, who made possible Dr. Clark's many happy days of dredging aboard the *Veleo III*. No attempt is made to incorporate in this tribute an evaluation of his important contri-

butions to the study of echinoderms, indicated by the bibliography which follows; that appraisal should be reserved for other workers in his chosen field.

My association with Dr. Clark began in 1930 when he agreed to supervise my graduate studies on Crustacea. At the time, my knowledge of Crustacea was extremely fragmentary, and he readily admitted his ignorance of some of the more involved aspects of crustacean classification. Thanks to his insistence that the best way to learn the relationships of any group was by direct examination of as many of the representative forms as possible, both of us eventually gained an adequate working knowledge of this diverse assemblage of animals. As this form of training entailed the drudgery of checking identifications, relabeling specimens, and rearranging the crustacean collections in the far reaches of the catacomb-like basement of the Museum of Comparative Zoölogy, the assignment was not consistently welcomed or understood by a young taxonomist who associated systematic work with somewhat more significant tasks in a less obscure environment. Not until several years later did the value of this fundamental curatorial training become apparent to the recipient. I am sure that Dr. Clark appreciated his student's mild discomfort, and I will always be grateful that he had the courage of conviction to see to it that this apprenticeship was fully served.

In subsequent years, as a member of the staff at the Museum of Comparative Zoölogy, I became better acquainted with Dr. Clark and came to recognize his loyal friendship as one of the most important and valued associations of my life. Although he was unusually reticent about offering unsought criticism of any kind, he was always eager to be of assistance whenever his advice was solicited. His almost emotional gratitude for all favors returned in kind was a unique characteristic familiar to all who came in close contact with him.

Except for an attack of yellow fever suffered during a collecting trip to Jamaica in 1896, from which he was the only one of six victims to survive, Dr. Clark enjoyed remarkably good health until his last illness. Always one to minimize his infrequent minor indispositions, he sometimes found it difficult to appreciate the reaction of others to similar disorders. The bout with yellow fever had a profound effect upon his later life, however, for it left him with impaired hearing which showed progressive deterioraion with the passage of time. This affliction seemed to affect in no way his optimistic outlook toward life, but it did virtually force his retirement from classroom teaching, which he so enjoyed, and prevented

intimate contact with his fellow men; this, to a man of Dr. Clark's friendly disposition, must have been a heavy cross to bear, but I cannot recall that he ever referred to it with the least trace of bitterness.

His unusual robust health was reflected in his general mental outlook. Whether the activity involved was his scientific work, caring for his valuable stamp collection, playing tennis, or climbing his beloved New Hampshire mountains, all of which were indulged in until the last year of his life, Dr. Clark believed in giving the best that was in him. The only times that I have seen him violently incensed about anything were on those infrequent occasions when he discovered a typographical error he had overlooked in one of his publications or lost a point at tennis which he felt should have been his with a little additional skill or effort, and at these times his anger was always directed at himself. In his scientific work, he was prone to set goals and deadlines for himself and he did his best to adhere to these even when it meant driving himself far into the night. This is a characteristic which may seem questionable to others of us acquainted with the unpredictability of taxonomic research, but it was a fundamental part of Dr. Clark's nature and one which apparently served him well.

No insight into Hubert Lyman Clark's character would be complete without reference to his religious activities. An ardent churchman, he thoroughly believed that the Sabbath was a day to be set aside for worship and human companionship. All who accompanied him on field trips will recall how determined he was that Sunday, as far as he was concerned, was not a day for collecting, no matter how propitious the weather or the tide.

This religious nature was at the root of his entire philosophy of life. As he once expressed himself in print, he put his faith in a "confident belief in oneself, in a loving God and in our fellow men as children of one Father." Only on some such foundation as this did he feel that one could build a satisfying personal philosophy which, in his words, "must give full scope to the mind, . . . set no arbitrary limits to human knowledge, . . . encourage and stimulate the quest for truth and have no fear thereof wherever found, . . . allow full play for the emotions, . . . [and] . . . provide a fundamental motive, a driving power for an achieving life."

FENNER A. CHACE, JR.

U. S. National Museum  
July 16, 1948



# BIBLIOGRAPHY OF DR. H. L. CLARK'S ECHINODERM PAPERS

Compiled by Marjorie Pattee, Research Assistant, M.C.Z.

1896. Notes on the life history of *Synapta vivipara* Oerstedt. Jour. Jamaica Inst. July, vol. 2, pp. 278-282.  
The viviparous *Synapta* of the West Indies. Zool. Anz., September 14, vol. 19, no. 512, pp. 398-400.
1897. The viviparous *Synapta* of the West Indies. Johns Hopkins Univ. Circulars, November, vol. 17, pp. 2-3.
1898. Notes on the echinoderms of Bermuda. Ann. N. Y. Acad. Sci., September, vol. 11, pp. 407-413.  
*Synapta vivipara*: a contribution to the morphology of echinoderms. Mem. Boston Soc. Nat. Hist., vol. 5, no. 3, pp. 53-88, pls. 11-15.  
*Synapta vivipara*: a contribution to the morphology of echinoderms. Mem. Biol. Lab. Johns Hopkins Univ., vol. 4, no. 2, pp. 53-88.  
The echinoids and asteroids of Jamaica. Johns Hopkins Univ. Circulars, November, no. 137, pp. 4-6.
1899. Further notes on the echinoderms of Bermuda. Ann. N. Y. Acad. Sci., vol. 12, pp. 117-138, pl. 4.  
The *Synaptas* of the New England coast. U.S. Fish. Comm. Bull., December 13, pp. 21-31, pls. 10, 11.
1901. Bermudan echinoderms. A report on observations and collections made in 1899. Proc. Boston Soc. Nat. Hist., vol. 29, no. 16, pp. 339-345.  
The echinoderms of Porto Rico. U.S. Fish. Comm. Bull., vol. 2, pt. 2, pp. 231-263, pls. 14-17.  
The holothurians of the Pacific Coast of North America. Zool. Anz., March 25, vol. 24, no. 639, pp. 162-171.  
Synopsis of North American invertebrates: The holothurioidea. Am. Nat., June, vol. 35, pp. 479-496.  
The breeding habits of holothurians. Mich. Acad. Sci. Third Rep., pp. 83-85.  
Echinoderms from Puget Sound. Proc. Boston Soc. Nat. Hist., vol. 29, no. 15, pp. 323-337, 4 pls.
1902. Notes on some North Pacific holothurians. Zool. Anz., July, vol. 25, pp. 562-564.  
Echinodermata papers from the Hopkins Stanford Galapagos Expedition, 1898-1899. Proc. Wash. Acad. Sci., September 30, vol. 4, pp. 521-531.
1904. Echinoderms of Woods Hole region. U.S. Fish. Comm. Bull. for 1902, pp. 545-576, pls. 1-14.
1905. Fauna of New England: List of the Echinodermata. Occ. Papers, Boston Soc. Nat. Hist., February, vol. 7, pp. 1-13.
1906. List of echinoderms available for exchange in the M.C.Z. September, pp. 1-8.
1907. With A. Agassiz. Hawaiian and other Pacific Echini. The Cidaridae. Mem. M.C.Z., February, vol. 34, no. 1, 50 pp., 44 pls.  
With A. Agassiz. Preliminary report on the Echini collected, in 1902, among the Hawaiian Islands, by the U.S. Fish Commission Steamer "Albatross." Bull. M.C.Z., March, vol. 50, no. 8, pp. 231-259.  
The starfishes of the genus *Heliaster*. Bull. M.C.Z., vol. 51, no. 2, pp. 25-76, 8 pls.  
Recent literature on echinoderms. Science, July, n. s. vol. 26, pp. 12-17.  
With A. Agassiz. Preliminary report on the Echini collected in 1906, from May to December, among the Aleutian Islands, in Bering Sea, and along the coasts of Kamtchatka, Sakhalin, Korea, and Japan, by U.S. Fish Commission Steamer "Albatross." Bull. M.C.Z., October, vol. 51, no. 5, pp. 109-139.  
As to holothuria. Science, October, n. s. vol. 26, pp. 549-550.  
The Cidaridae. Bull. M.C.Z., December, vol. 51, no. 7, pp. 165-230, 11 pls.  
The apodous holothurians. Washington, January 1908, Smithsonian Cont. to Knowl., vol. 35, 231 pp., 13 pls.

1908. A brittle star new to the Woods Hole region. *Science*, January, n. s. vol. 27, p. 147.  
Some Japanese and East Indian echinoderms. *Bull. M.C.Z.*, April, vol. 51, no. 11, pp. 279-311.  
Renewed interest in recent crinoids. *Am. Nat.*, May, vol. 42, pp. 350-355.  
The type of *Cidaris*. *Ann. Mag. Nat. Hist.*, June, ser. 8, vol. 1, pp. 532-533.  
With A. Agassiz. Hawaiian and other Pacific Echini: The Salenidae, Arbaciadae, Aspidodiadematidae, and Diadematidae. *Mem. M.C.Z.*, September, vol. 34, no. 2, pp. 43-132, 17 pls.  
Les Cidaridae. *Bull. Soc. Sci. Nat. Haute-Marne*, 5<sup>e</sup> Ann., no. 22, pp. 165-228.
1909. Abstract of unpublished paper: Brood-protection and sexual dimorphism among echinoderms. *Science*, n. s. vol. 29, p. 711.  
With F. A. Bather. The type of *Cidaris*. *Ann. Mag. Nat. Hist.*, January, ser. 8, vol. 3, p. 88.  
Notes on some Australian and Indo-Pacific echinoderms. *Bull. M.C.Z.*, March, vol. 52, no. 7, pp. 109-135.  
Scientific results of the trawling expedition of H.M.C.S. "Thetis" off the coast of New South Wales, in February and March 1898. *Echinodermata. Australian Museum Mem.* 4, pt. 11, pp. 519-564, 11 pls.  
With A. Agassiz. Hawaiian and other Pacific Echini. The Echinothuridae. *Mem. M.C.Z.*, November, vol. 34, no. 3, pp. 135-206, pls. 60-89.
1910. A new ophiuran of the West Indies. *Proc. U.S. Nat. Mus.*, August 19, vol. 37, pp. 665-666.  
The echinoderms of Peru. *Bull. M.C.Z.*, October 10, vol. 52, no. 17, pp. 321-358, 14 pls.  
The development of an apodous holothurian. (*Chiridota rotifera*). *Jour. Exp. Zool.*, November, vol. 9, pp. 497-516, pls. 1, 2.
1911. North Pacific ophiurans in the collection of the U.S. National Museum. *U.S. Nat. Mus. Bull.* 75, pp. i-xvi, 1-302, figs. 1-144.  
The genera of recent Clypeastroids. *Ann. Mag. Nat. Hist.*, ser. 8, vol. 7, pp. 593-605.  
The purpose and some principles of systematic zoology. *Pop. Sci. Monthly*, September, vol. 79, pp. 261-271.
1912. Fossil holothurians. *Science*, February 16, n. s. vol. 35, pp. 274-278.  
Biotypes and phylogeny. *Am. Nat.*, March, vol. 46, pp. 139-150.  
Los equinodermos del Peru. *Anales de la Direccion de Fomento*, no. 5, May, pp. 22-72. Traducción del Boletín del Museo de Zoología comparado del Harvard College, vol. 52, no. 17, pp. 321-358, 14 pls.  
Review of Jackson's "Phylogeny of the Echini." *Science*, June 28, n.s. vol. 35, pp. 986-993.  
Hawaiian and other Pacific Echini. The Pedinidae, Phymosomatidae, Stomopneustidae, Echinidae, Temnopleuridae, Strongylocentrotidae, and Echinometridae. *Mem. M.C.Z.*, June, vol. 34, no. 4, pp. 205-383, pls. 90-121.  
Investigations on echinoderms at Montego Bay. *Carnegie Inst., Washington, Yearbook* 11, pp. 134-135.
1913. Autotomy in *Linckia*. *Zool. Anz.*, June, vol. 42, pp. 156-159.  
Echinoderms from Lower California, with descriptions of new species. *Bull. Am. Mus. Nat. Hist.*, July, vol. 32, pp. 185-236.  
Asterozoa (and) Holothurioidea. Zittel's textbook of paleontology. C. R. Eastman, editor, second edition, December, vol. 1, pp. 244-257, 312-313.
1914. Growth-changes in brittle stars. *Carnegie Inst., Washington, Publ.* 182 (March), pp. 91-126, 3 pls.  
Hawaiian and other Pacific Echini. The Clypeastridae, Arachnoididae, Laganidae, Fibulariidae, and Scutellidae. *Mem. M.C.Z.*, June, vol. 46, no. 1, 80 pp., 22 pls.  
The echinoderms of the Western Australian Museum. *Rec. W. Austr. Mus. and Art Gall.*, vol. 1, pp. 132-173, pls. 17-26.

- Review of Verrill's "Shallow-water star fishes of the North Pacific coast." Science, October 9, n. s. vol. 40, pp. 523-525.
- The classification of the regular Echini. Zool. Anz., December 4, vol. 45, pp. 171-172.
1915. Report on the work at the Torres Strait Laboratory. Carnegie Inst., Washington, February, Yearbook 13 (for 1914), pp. 200-201.
- A remarkable new brittle star. Jour. Ent. and Zool., March, vol. 7, pp. 64-66.
- The comatulids of Torres Strait: with special reference to their habits and reactions. Carnegie Inst., Washington, Publ. 212, May, vol. 8, pp. 97-125.
- The echinoderms of Ceylon other than holothurians. Spolia Zeylanica, October, vol. 10, pp. 83-102.
- Catalogue of recent ophiurans: based on the collection of the Museum of Comparative Zoology. Mem. M.C.Z., December, vol. 25, no. 4, 214 pp., 20 pls.
1916. Report on the sea lilies, starfishes, brittle stars, and sea-urchins obtained by the F. I. S. "Endeavour" on the coasts of Queensland, New South Wales, Tasmania, Victoria, South Australia, and Western Australia. Biol. Results "Endeavour," 1909-14, June 2, vol. 4, pp. 1-123, pls. 1-44.
1917. Report on studies at Tobago, British West Indies. Carnegie Inst., Washington, Yearbook 15, February 15, pp. 192-193.
- Hawaiian and other Pacific Echini. The Echinoneidae, Nucleolitidae, Urechinidae, Echinocorythidae, Calymnidae, Pourtalesiidae, Palaeostomatidae, Aeropsidae, Palaeopneustidae, Hemiasteridae, and Spatangidae. Mem. M.C.Z., vol. 46, March, no. 2, 203 pp., 18 pls.
- The habits and reactions of a comatulid, *Tropiometra carinata*. Carnegie Inst., Washington, Publ. 251 August, pp. 111-119.
- Reports on the scientific results of the expedition to the Tropical Pacific, 1899-1900. XVIII. Reports on the scientific results of the expedition to the Eastern Tropical Pacific 1904-1905. XXX. Ophiuroidea. Bull. M.C.Z., October, vol. 61, no. 12, 28 pp., 5 pls.
1918. Report on the Crinoidea and Echinoidea collected by the Bahama Expedition from the University of Iowa in 1893. Bull. Lab. Nat. Hist. Univ. Iowa, April, vol. 7, no. 5, pp. 3-37, pls. 1-5.
- Brittle stars, new and old. Bull. M.C.Z., October, vol. 62, no. 265-338, 8 pls.
1919. Review of Walter Fisher's "Starfishes of the Philippine seas and adjacent waters." Science, October 10, n. s. vol. 50, pp. 348-350.
- The distribution of the littoral echinoderms of the West Indies. Carnegie Inst., Washington, Publ. 281, November, pp. 49-74, pls. 1-3.
1920. Reports on the scientific results of the expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, by the U.S. Fish Commission Steamer "Albatross" from October 1904 to March 1905, Lieut. Commander L. M. Garrett, U.S.N., commanding. XXXII. Asteroidea. Mem. M.C.Z., February, vol. 39, no. 3, 46 pp., 6 pls.
- Echinoderms in birds' stomachs. Science, June 11, n. s. vol. 51, pp. 594-595.
- Reports on the scientific results of the expedition to the Tropical Pacific, in charge of Alexander Agassiz, by the U.S. Fish Commission Steamer "Albatross" from August 1899 to March 1900, Commander Jefferson F. Moser, U.S.N., commanding. XXII. Reports on the scientific results of the expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, by U.S. Fish Commission Steamer "Albatross," from October 1904 to March 1905, Lieut. Commander L. M. Garrett, U.S.N., commanding. XXXIII. Holothuroidea. Mem. M.C.Z., September, vol. 39, no. 4, 40 pp., 4 pls.
1921. The echinoderm fauna of Torres Strait: its composition and its origin. Carnegie Inst., Washington, Publ. 214, January, vol. 10, 223 pp., 40 pls.
- Report on the Echinoidea collected by the Barbados-Antigua Expedition from the University of Iowa in 1918. Univ. Iowa Studies, Nat. Hist., 15, March, vol. 9, pp. 103-121, pls. 1, 2.

1922. With Austin Clark. Results of the Hudson Bay Expedition, 1920. III. The echinoderms. Contr. to Canad. Biol. n. s. 1, pp. 21-25.  
The holothurians of the genus *Stichopus*. Bull. M.C.Z., February, vol. 65, no. 3, 38 pp., 2 pls.  
Review of Mortensen's "Studies of the development and larval forms of echinoderms." Science, April 21, n. s. vol. 55, pp. 431-433.  
The echinoderms of the Challenger Bank, Bermuda. Proc. Am. Acad. Arts and Sci., June, vol. 57, no. 13, pp. 353-361, pl. 1.
1923. The echinoderm fauna of South Africa. Ann. So. African Mus., May, vol. 13, pp. 221-435, pls. 8-23.  
The distribution and derivation of some New England echinoderms. Am. Nat., May-June, vol. 57, pp. 229-237.  
Some echinoderms from West Australia. Jour. Linn. Soc. London, June 5, vol. 35, pp. 229-251, pl. 13.  
Two new genera of sea-urchins. Bull. M.C.Z., July, vol. 65, no. 10, 10 pp.  
Echinoderms from Lower California, with descriptions of new species: supplementary report. Bull. Am. Mus. Nat. Hist., October 5, vol. 48, pp. 147-163.
1924. Some holothurians from British Columbia. Canad. Field Nat., March, vol. 38, pp. 54-57.  
The holothurians of the Museum of Comparative Zoology. The Synaptinae. Bull. M.C.Z., June, vol. 65, no. 13, 46 pp., 12 pls.  
Echinoderms from the South African fisheries and marine biological survey. Pt. 1. Sea-urchins (Echinoidea). Fish. and mar. biol. surv. Union South Africa, September 10, 1924. Rep. 4, Spec. Rep. 1, pp. 1-16, pls. 1-4.
1925. A catalogue of the recent sea-urchins (Echinoidea) in the collection of the British Museum (Natural History). London, 1925, 28, 250 pp., 12 pls.  
Some sea stars from the Riksmuseum, Stockholm. Arkiv for zoologi, November 16, vol. 18A, no. 8, pp. 1-8.  
A new Clypeaster from Angola. Ann. So. African Mus., December, vol. 20, pp. 317-318, pl. 33.
1926. Echinoderms from the South African fisheries and marine biological survey. Pt. 2. Sea Stars (Asteroidea). Rep. 4, Spec. Rep. 7, Fish and mar. biol. surv. Union So. Africa, May 1, pp. 1-34, pls. 1-7.  
Echinoderms other than sea stars of the Tropical Central Pacific. Bull. 27, Bernice P. Bishop Mus., July, pp. 89-112, pls. 9-11.  
Notes on a collection of echinoderms from the Australian Museum. Rec. Austr. Mus., November 18, vol. 15, pp. 183-192.
1927. With B. W. Arnold. Jamaican fossil Echini. Mem. M.C.Z., October, vol. 50, no. 1, pp. 1-84, (errata sheets), pls. 1-22.  
Review of Mortensen's "Handbook of the echinoderms of the British Isles." Science, December 23, n. s. vol. 66, pp. 625-626.
1928. The sea lilies, sea stars, brittle stars, and sea-urchins of the South Australian Museum. Rec. So. Austr. Mus., May 9, vol. 3, no. 4, pp. 361-482, text figs. 108-142.
1929. A new Miocene echinoid from California. Trans. San Diego Soc. Nat. Hist., August 5, vol. 5, no. 17, pp. 259-262.
1930. The Carnegie-Australia Harvard Expedition to Northwestern Australia. Science, February 21, n. s. vol. 71, p. 180.
1932. Echinodermata (other than Asteroidea). British Museum (Natural History) Great Barrier Reef Expedition, 1928-1929. Scientific Reports, vol. 4, no. 7, pp. 197-239, 9 text figs., 1 pl.  
The ancestry of the Echini. Science, December 23, vol. 76, no. 1982, pp. 591-593.

1933. A handbook of the littoral echinoderms of Porto Rico and the other West Indian Islands. Sci. Survey, Porto Rico and Virgin Islands, N. Y. Acad. Sci., vol. 16, no. 1, pp. 1-147, 7 pls.  
Marine collecting in Australia. Harvard Alumni Bull., June 2, vol. 35, no. 32, pp. 901-906.
1934. With B. W. Arnold. Some additional fossil Echini from Jamaica. Mem. M.C.Z., December, vol. 54, no. 2, pp. 139-156, pls. 1-5.
1935. Some new echinoderms from California. Ann. Mag. Nat. Hist., January, ser. 10, vol. 15, no. 85, pp. 120-129.  
The holothurian genus *Caudina*. Ann. Mag. Nat. Hist., February, ser. 10, vol. 15, no. 86, pp. 267-284.
1936. With Elisabeth Deichmann. On *Psolicucumis* Heding and its allies. Ann. Mag. Nat. Hist., May, ser. 10, vol. 17, no. 101, pp. 564-568.
1937. A new Eocene sea-urchin from Alabama. Jour. of Paleontology, April, vol. 11, no. 3, pp. 248-249, 3 figs.  
The echinoid name *Diadema*. Ann. Mag. Nat. Hist., December, vol. 20, ser. 10, no. 120, pp. 635-636.  
A new sea-urchin from the "Oligocene" of Oregon. Trans. San Diego Soc. Nat. Hist., December 15, vol. 8, no. 28, pp. 367-374, pl. 24.
1938. Echinoderms from Australia, an account of collections made in 1929 and 1932. Mem. M.C.Z., vol. 55, 596 pp., 28 pls., 64 text figs.  
List of Bahama echinoderms. (In W. J. Clench's report) Bull. M.C.Z., June, vol. 80, no. 14, pp. 536-537.
1939. Two new ophiurans from the Smithsonian-Hartford Expedition, 1937. Proc. U.S. Nat. Mus., May, vol. 86, no. 3054, pp. 415-418, pl. 52.  
A remarkable new genus of sea-urchin (Spatangidae). Allan Hancock Pacific Expeditions, vol. 2, no. 11, pp. 173-176, 2 text figs.  
Ophiuroidea. The John Murray Expedition, 1933-1934. British Museum (Natural History) Scientific Reports, October 28, vol. 6, no. 2, pp. 29-136, 62 text figs.  
A new *Astroconus* from South Australia. Rec. So. Austr. Mus., December 16, vol. 6, no. 3, pp. 207-208, pl. 18.
1940. Notes on echinoderms from the west coast of Central America. Zoologica, November 14, vol. 25, pt. 3, pp. 331-352, figs. 1-4, pls. 1-2.  
Revision of the keyhole urchins (*Mellita*). Proc. U.S. Nat. Mus., December, vol. 89, no. 3099, pp. 435-444; pls. 60-62.
1941. The echinoderms (other than holothurians). Reports on the scientific results of the Atlantis expeditions to the West Indies. Mem. Soc. Cubana Hist. Nat., May, vol. 15, no. 1, pp. 1-154, pls. 1-10.
1942. The echinoderm fauna of Bermuda. Bull. M.C.Z., April, vol. 89, no. 8, pp. 367-391, 1 pl.
1945. Echinoidea in "Geology of Lau," Fiji, by Ladd and Hoffmeister. Bull. 181, Bernice P. Bishop Mus., pp. 312-328, pls. 41-43.
1946. The echinoderm fauna of Australia, its composition and its origin. Carnegie Inst., Washington, December, Publ. 566, 567 pp.
1948. A report on the Echini of the warmer Eastern Pacific, based on the collections of the *Velero III*. Allan Hancock Pacific Expeditions, vol. 8, no. 5, pp. i-xii, 225-351, pls. 35-71.



## PREFACE

Mrs. *H. L. Clark* and her family have done me the great honour of asking me to edit my late friend *H. L. Clark's* Report on the Echini of the Warmer Eastern Pacific collected by the *Velero III*. In so doing I have thought it a holy duty towards my dear colleague and friend throughout nearly half a century to let his report appear in the main as it was intended by him, adding only some few remarks here and there, which I have deemed necessary. Only in his dealing with the genus *Encope* a more serious correction has been introduced. It was the idea of Clark that the genus ought to be divided in two separate genera, the species *grandis* to form a genus of its own in contradistinction to all the other species. This is in my opinion quite unacceptable. The only difference is that *grandis* is thicker and somewhat heavier than the other species; but whether the edge of the test is 5 mm or only 2-3 mm thick is certainly not a morphological difference of generic value, and there are no other differences; especially it should be emphasized that the internal structure of the test is exactly the same as in the other species. Moreover, separating *grandis* as a distinct genus from all the other species would necessitate most regrettable nomenclatorial changes. His idea that the species *emarginata* would be the genotype of *Encope* is decidedly erroneous. When establishing the genus *Encope* *L. Agassiz* (1840) named only a single species, *grandis*; accordingly *grandis* is the genotype of *Encope*. In one of his last letters to me Clark said that he would abide at the decision which I would make in this question. I wrote him at once that there could be no question at all but that *grandis* is the genotype of *Encope*, and he would certainly have changed his manuscript in accordance herewith; but he did not get the time to do so. I have thus had to change that part of his manuscript.

As for the numerous new species of *Encope* which he establishes I think he is going much too far, small individual or local variations of this prolific genus being taken to represent distinct species. A few specimens (one of each species, and some of them too young to be of any use) sent me by Professor McCulloch do not at all convince me of the value of all his species; but without having access to the rich material on which Clark based his various species it is impossible for me to decide which of his *Encope* species are of real value and which are not. I deem it therefore our duty to publish them all, as Clark meant to have it done. It must then

be left to posterity to solve definitely the question of the species to be distinguished within the forms belonging to the circle of—especially—*Encope micropora*. I cannot help also thinking how many species Clark, on the base of the study of a similar rich material of the Caribbean *Encope emarginata* might have made out of that polymorphic species.

I hope that by the few corrections and additions introduced in this manuscript I am doing justice to my late, lamented friend, the eminent echinologist, Hubert Lyman Clark.

Copenhagen, in April 1948.

TH. MORTENSEN



REPORTS ON THE COLLECTIONS OBTAINED BY ALLAN HANCOCK PACIFIC EXPEDITIONS OF  
VELERO III OFF THE COAST OF MEXICO, CENTRAL AMERICA, SOUTH AMERICA, AND  
GALAPAGOS ISLANDS IN 1932, IN 1933, IN 1935, IN 1936, IN 1937, IN 1938, IN 1939,  
IN 1940, AND IN 1941.

A REPORT ON THE ECHINI  
OF THE WARMER EASTERN PACIFIC,  
BASED ON THE COLLECTIONS OF THE  
*VELERO III*

(PLATES 35-71, TEXT FIGURES 1-3)

By HUBERT LYMAN CLARK

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# A REPORT ON THE ECHINI OF THE WARMER EASTERN PACIFIC, BASED ON THE COLLECTIONS OF THE

## *VELERO III*

(PLATES 35-71, TEXT FIGURES 1-3)

HUBERT LYMAN CLARK

The great collections of Echini (28,835 specimens, including over 11,000 young *Dendrasters*) made by the *Velero III* under the direction of Captain Allan Hancock, during the years 1931-1941, have proved a field for research as varied and interesting as it is large and illuminating. It was just eighty years ago that Verrill published his first papers on the Echinoderms of Panama and the western coast of America and for four years he continued his studies of that fauna. In 1871 there appeared (Trans. Conn. Acad. vol. 1, pt. 2, art. 5, no. 8, pp. 593-595) his list of the Echini of the Gulf of California which included 22 species. Subsequent additions and emendations enabled A. Agassiz in 1904 to list 28 species from the Panamic region and 21 more from very deep water (300-2200 fms). In recent years additional species have now and then been added or corrections made, so that Grant and Hertlein (1938) include some 47 recent species in their list. Several, however, are from very deep water and are hardly to be counted in the present fauna of the warmer Eastern Pacific.

The area thus designated may be defined as extending from the coast of Oregon at Ocean Park (Lat. 44° 50' 45" N), southward along the American coast to San Juan Bay, Peru (Lat. 15° 20' S), and westward to include the islands, Socorro, Clarion, Cocos, and the Galapagos, down to depths of 80 fms or less, very rarely to 300-400 fms. In depths exceeding 100 fms, the water is no longer warm and the bottom fauna can not be properly included as belonging to the "warmer Eastern Pacific." The great gulf of California has an interesting fauna including 22 species of Echini. Only one of these, however, is restricted to the Gulf, 8 extend their range to the north and 19 to the south. Due to certain local restrictions, collecting along the coast of Mexico and Central America did not yield so large a number of Echini as did the Gulf, and even in the Bay of Panama only 18 species were taken. Colombia yielded but 11 species while Ecuador has 14 to her credit and only 6 were recorded from Peru. North of the international boundary (United States-Mexico) some 14 species have been taken by the *Velero*. The outlying islands have proved good collecting grounds, for while Cocos yielded only 11 species, Clarion had 10, Socorro 12, and the Galapagos no few than 23, of which 4 were not found elsewhere.

The five visits of the *Velero* to the Galapagos, occupying 245 stations, have undoubtedly served the purpose of making the Echinoderm fauna of that group sufficiently well known to warrant the belief that it is essentially American and has not received any considerable influx of Indo-Pacific forms. Several of the species are, so far as we now know, endemic and warrant a belief in the long-sustained isolation of the marine fauna. In view of this it is worth while to list here the Galapagos Echini with a few words as to their occurrence:

<i>Eucidaris Thouarsii</i>	generally Panamic and western Mexico
<i>Hesperocidaris panamensis</i>	Cocos Island, Galapagos Islands and Ecuador
<i>Centrocidaris Doederleini</i>	Cocos and Galapagos Islands
<i>Centrechinus mexicanus</i>	generally Panamic, Mexico and Galapagos Islands
<i>Centrostephanus coronatus</i>	generally Panamic, Gulf of California, southern California
<i>Lytechinus semituberculatus</i>	Galapagos Islands
<i>Toxopneustes roseus</i>	Panamic, Socorro Island
<i>Tripneustes depressus</i>	Panamic, Mexican Islands
<i>Caenocentrotus gibbosus</i>	Ecuador, Peru and Galapagos Islands
<i>Echinometra oblonga</i>	Indo-Pacific to Northern Galapagos Islands and Mexican Islands
<i>VanBrunti</i>	Panamic, Western Mexico
<i>Glypeaster elongatus</i>	Galapagos Islands
<i>europacificus</i>	Panamic, Western Mexico
<i>ochrus</i>	Panamic
<i>rotundus</i>	Panamic, Western Mexico
<i>Encope galapagensis</i>	Galapagos Islands
<i>Cassidulus pacificus</i>	Panamic, Mexican Islands
<i>Agassizia scrobiculata</i>	Panamic, Gulf of California
<i>Brissopsis pacifica</i>	Panamic, Western Mexico, southern California

<i>Idiobryssus coelus</i>	Galapagos Islands
<i>Meoma grandis</i>	Panamic, Western Mexico
<i>Gonimaretia laevis</i>	southern California and Gulf of California
<i>Lovenia cordiformis</i>	Panamic, Western Mexico, southern California

Aside from the light thrown on the distribution of the known Echini in the Eastern Pacific, the *Velero* has collected an abundance of material useful in delimiting the known species, and revealing the existence of 11 forms which appear to require names as they do not fit too well into the series of species now known. One of these is a Cidarid and one a Clypeaster, but others are Scutellids of the well-known genera *Dendraster* and *Encope*. Never before have such large numbers of specimens been available for comparative study, and it is not strange that new and perplexing forms occur which require designation. Quite likely more material from the coasts of southern Mexico, Costa Rica, Nicaragua, and Panama will indicate different and more correct grouping, but it is believed that the specific limits here suggested indicate a step forward in our knowledge of these multiform genera.

The naming and describing of new species, however, is only one product of the *Velero's* extraordinary collecting. Equally important is the accumulation of immature and very young individuals showing stages in the development of the adult which throw light on evolutionary processes. The most striking of these is exhibited in the growth changes of young *Spatangus*, a genus represented by but one species in the Eastern Pacific, widely separated from its congeners in Europe, Asia and Africa. The *Velero* first met with *Spatangus* in 1936 in the Gulf of California but later collections showed that the vicinity of the Channel Islands in depths of 35-225 fms is the real home of this interesting sea-urchin. Considerably more than two hundred specimens are in the collection and quite a number are young, including some very early stages of development, only about 3 mm long. In these very small individuals there is no indication of either petals or pores. When the individuals are 8 or 9 mm long the petals are indicated by more definite outlines and slight depressions, but there are no pores. After the length exceeds 10 mm, the petals can be distinguished more or less definitely and pores are visible at the apical end of the ambulacra. But the pores are single and the petals evidently are not sunken at all. There is thus a Palaeotropus stage of development shown which is usually passed through before the *Spatangus* is 12 mm long. In some

cases, however, the growth changes are retarded and one individual caused much perplexity as it is 20 mm long and still reveals only single pores in the petals and hence was regarded as a new species of *Palaeotropus*. But the discovery of intermediate stages, showing all steps from poreless plates to normal twin-pored petals has been convincing in the demonstration of this striking example of stages in development, so ably presented by Jackson (1899).

For the opportunity to study this extraordinary collection, the writer is greatly indebted to Chancellor R. B. von KleinSmid of The University of Southern California and to Captain Allan Hancock and Professor Irene McCulloch of the Allan Hancock Foundation. Lieutenant Commander Fred C. Ziesenhenné, who played a major part in the collecting, preserving and arranging of the material, deserves high praise for the quality of his work. For the pleasure of being his co-worker in the 1938 cruise of the *Velero III*, I am deeply indebted to Captain Hancock. That was one of life's great experiences and words are quite inadequate to express my appreciation. Finally I take pleasure in acknowledging the very great debt I owe to Mrs. Ora Willett for her patient assistance in the study of the collection and in the preparation of the manuscript—assistance for which these few words of appreciation are quite inadequate.

Order **CIDAROIDA**Family **Cidaridae****Eucidaris Thouarsii** (Valenciennes)

Plate 35, Fig. 1

*Cidaris Thouarsii* L. Agassiz and Desor, 1846, p. 326.*Cidaris (Eucidaris) Thouarsii* Döderlein, 1887, p. 20.*Eucidaris Thouarsii* Mortensen, 1928a, pp. 393-400, pl. 42, figs. 5-13.

There are, in the Hancock collections, more than 1,200 specimens from 175 stations. They range in size from 3.5 to 67 mm in diameter. The largest and finest specimens are from the Galapagos Islands, particularly Darwin Bay, Tower Island, and Cartago Bay, Albemarle Island. The character of the spines, both primary and secondary, shows extraordinary diversity. The secondaries range from relatively short, truncate spines to rather long ones tapering to a chisel-like tip. The primaries show even greater diversity ranging from short, stout spines with diameter .25-.30 of length to slender terete spines with greatest diameter less than a tenth of the length. There is great diversity also as to the extent to which the spines are covered with sponges, bryozoa or calcareous algae. Occasionally these foreign growths increase the diameter of the spine (at least at its base) to one-third of its length. In other individuals of the same size, from the same station, the spines may be entirely free from any foreign growth.

The greater part of the *Velero* collection of *Thouarsii* is from the Galapagos Islands and a notable proportion of these individuals are larger and stouter than the material from the mainland coast. The specimens from Colombia, Panama, Costa Rica, and Mexico are on the whole smaller and have more slender spines than those from the islands. Occasional, sometimes conspicuous, exceptions prevent the drawing of any clear line of distinction however. Mortensen's emphasis on the "nearly black" secondary spines in *galapagensis* is misplaced as most specimens from either mainland or islands have the secondaries a deep purplish brown, the shade apparently deepening with age. On the whole, it seems to me futile to try to maintain any well-defined form as a variety or subspecies *galapagensis*.

Mortensen (1928, p. 399) has called attention to certain peculiarities in a specimen from Clarion Island which, if constant, would warrant recognition as at least a variety of *Thouarsii*. Unfortunately the present collection contains only a very few specimens from Clarion Island. While the largest of these seems to resemble the one studied by Mortensen, the others are not distinguishable satisfactorily from specimens from the mainland coast. Further collecting at Clarion Island is greatly to be desired.

*Distribution.*—This is one of the most characteristic sea-urchins of the western coast of tropical and subtropical America. *E. Thouarsii* occurs also at the outlying islands (Clarion, Socorro, Cocos and the

Galapagos), but not at great depths. Mortensen reports it in 45 fms in the Gulf of Panama, while the *Velero* took specimens at depths of 62-76 fms off Angel de la Guardia Island in the Gulf of California. The most northerly point from which it is reported is near Consag Rock in the Gulf of California. It is noteworthy that it has not been taken along the western coast of Lower California. Its southern limit, on the continental coast, is La Plata Island, Ecuador. It is very common among the Galapagos Islands where the *Velero* collected specimens at no fewer than 70 stations.

*Type*.—Paris Museum?

*Type locality*.—"Californie (Neboux.) Galapagos."

*Depth*.—Shore to 76 fms.

*Specimens examined*.—1,201 specimens from 175 stations.

### ***Hesperocidaris panamensis* (A. Agassiz)**

Plate 35, Fig. 2

*Dorocidaris panamensis* A. Agassiz, 1898, p. 73; 1904, p. 20, pls. 1-4.

*Hesperocidaris panamensis* Mortensen, 1928, pp. 73-74; 1928a, Mon. Ech. p. 416.

The material hitherto known of this sea-urchin consists of a few specimens taken by the *Albatross* in 1891 and now distributed in the U.S. National Museum, the Museum of Comparative Zoology and the British Museum. The *Velero*, however, has secured no fewer than 84 specimens, ranging from 4 to 49 mm in diameter; the height of the test is about half as much or a little more; both the upper and lower surfaces are definitely flattened. The very young individuals are white orally but more or less light coral red above; the primary spines are whitish with a tinge of red (at least basally) and have one or two ill-defined dusky bands and orange-red or flesh-red collar. In one specimen from the Galapagos Islands (Station 183-34) in 50-70 fms, the primaries are white except for more or less of the tip which is to some extent dusky or reddish; the contrast between such primaries and the dull red secondaries is striking. With increasing size, however, the primaries become unicolor, gray or brownish, save for the collar, and rapidly increase in darkness until in adults, they are deep brown or brownish purple, except where more or less incrustated with bryozoa, or other symbiotic forms. As a rule incrustation is not extensive and the primaries are slightly flattened at the tip. In young specimens the collar tends to be conspicuously orange red, but with age the color deepens and in adults is dark red or even reddish purple of a very dark shade. The secondary spines are brownish red in small specimens but become dark, almost a deep blood red in adults. A full grown specimen is thus a very striking and rather handsome urchin. In some individuals the young primaries at the upper end of each series



are uniformly more or less coral red in rather noticeable contrast to the older spines; this is particularly striking if the spine is entirely free from bryozoa or other incrustations. On the whole the coloration and general appearance of *panamensis* is remarkably uniform and makes the species easy to recognize.

*Distribution.*—The most striking fact about the distribution of this Cidarid is that it has not yet been taken at Panama or anywhere else on the coast of North or Central America. The original specimens were from the vicinity of Cocos Island, and from 85-112 fms off Galera Point, Ecuador. The *Velero* material is all from Cocos Island and vicinity, where this handsome urchin is notably common in 30-50 fms, or from the Galapagos Islands where it was taken at eight stations in depths of 30-150 fms, chiefly in the vicinity of Albemarle Island. The station numbers are: 143-34, 147-34, 155-34, 171-34, 183-34, 190-34, 324-35, 325-35, 772-38, 773-38, 780-38 and 810-38.

*Type.*—M.C.Z. no. 327 (Cotype).

*Type locality.*—"Cocos Island and Galera Point, Ecuador."

*Depth.*—30-150 fms.

*Specimens examined.*—84 specimens from 12 stations.

### ***Hesperocidaris perplexa* (H. L. Clark)**

Plate 36, Fig. 3

*Tretocidaris perplexa* H. L. Clark, 1907, p. 205; pl. 6, figs. 1, 2; pl. 7, figs. 1-4.

*Hesperocidaris perplexa* Mortensen, 1928, p. 421.

Only five specimens of this near relative to *panamensis* were known hitherto, so that the large series of nearly 500 specimens in the *Velero* collections contribute all the information needed to verify the authenticity of the species and reveal such diversity as it shows. The specimens range from 5 mm in test diameter, with spines scarcely 5 mm long to large adults with the test 43 mm in diameter and 25 mm high, with primary spines 35-43 mm long. The flattening of the distal part of the large primary spines, on which Mortensen lays great stress, is not evident until the test is 30 mm or more in diameter and even then it is not conspicuous in most specimens. In the most extreme case at hand, the test is about 37 mm in diameter and the longest primaries are about the same; the tips of ten or a dozen of these, at or above ambitus, are 3 to 5 mm wide; the distal half of each of these widened spines is very rough with crowded, more or less sharp tubercles. In most specimens the primary spines are nearly cylindri-

cal even at tip or somewhat terete, and are seldom noticeably rough. Their color is grayish or dull brownish but is frequently altered by bryozoa, sponges or other foreign growths. The striking and very constant feature of the coloration in *perplexa* is the conspicuous broad, brown longitudinal stripe which occurs on *all* the spinelets. The test itself is more or less yellowish or greenish but this shade is well shown chiefly, if not only, in the ambulacral mid-zones. The color of the basal part of the primary spines is commonly pale brown, usually greenish or yellowish just above the collar. The collar itself may have a more or less similar tint or may be more green, or yellow; in many specimens the general color of the spine is more or less dark brown, with the primary color flesh red or yellow brown. There is a great deal of variety in the shades of color in *perplexa*, some individuals being notably dark while many specimens, especially when young are definitely light. But no matter what the shades may be one feature of the coloration is remarkably constant and that is the longitudinal dark stripe found on all the secondary, and smaller, spines.

*Distribution.*—Judging from the *Velero* collections, this Cidarid is particularly characteristic of the Gulf of California, having been taken at 16 stations, as far north as 29° 39'. Off the west coast of Lower California, there are no records, save one half grown specimen in poor condition supposed to be from Station 1119-40, south of San Benito Islands, and a very young individual also in poor condition labeled as from Station 1153-40, off Santa Catalina Island, California. It is probable that these two specimens have in some way become mislabeled.<sup>1</sup> South of Lower California, no specimens were taken save at Bahia Honda, Panama, (Stations 244-34, 863-38, and 948-39) in 30-50 fms, north of Gorgona Island, Colombia (Stations 854-38 and 855-38) in 10-60 fms, and off La Plata Island, Ecuador, (Stations 212-34, 213-34) in 7-55 fms. The entire absence of *perplexa* from the Galapagos area is worthy of note and even more remarkable is its absence from the vicinity of Cocos Island, where *panamensis* is common.

*Type.*—M.C.Z. no. 188.

*Type locality.*—Gulf of California.

*Depth.*—36-39 fms.

*Specimens examined.*—487 from 25 stations.

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<sup>1</sup> There are evidences in the studies of other groups that unexpected distributional records are not uncommon. The work of the *Velero III* must be considered as the preliminary exploration of a coast involving many miles with little information concerning the fauna of the intervening areas. Ed.

**Hesperocidaris asteriscus**<sup>2</sup>, new species

Plate 36, Fig. 4; Plate 37, Figs. 5-6

Test somewhat flattened; vertical diameter about .60 of horizontal; coronal plates 6; areolae large, occupying most of plate surface; median interambulacral area narrow and fully covered with tubercles, smallest next to vertical suture which is quite indistinct; ambulacra about one-third of interambulacra in width; poriferous zones rather wide and hardly at all sunken; median ambulacral area narrow with a single row of relatively large tubercles on each margin and between these an irregular double series of much smaller tubercles which become more and more scattered and disappear entirely before the ocular plate is reached; pores rather large, horizontal or slightly oblique, nearly circular. Abactinal system about .50 h. d., rounded pentagonal, clearly defined, the anal area somewhat elevated; each of the component plates and the anal area covered (save on the margins) with flat spinelets, the larger ones on the anal system with truncate or rounded tips, the others quite acute; the genital plates carry 30-35 spine-bearing tubercles, the ocular plates about 20; genital plates distinctly longer than wide and much wider at the inner end than at the slightly convex outer end; ocular plates triangular, twice as wide as long, the margins slightly convex; both genital and ocular plates are bare, smooth and cinnamon color<sup>3</sup> on the margins (excepting the distal margins of the oculars) so that the genital plates form a conspicuous star-shaped figure; ocular plates all markedly excluded from the relatively large pentagonal anal system. Actinostome rather large, more than .40 h. d., not noticeably sunken, well covered with rather stout plates, which are hidden by the numerous spines they carry; these spines are long and narrow, with the distal end widened, rounded and curved inward very slightly. Primary spines longer than horizontal diameter of test, nearly cylindrical, fairly stout and blunt; they are densely covered with low, blunt tubercles in about a dozen more or less regular longitudinal series; collar very narrow; secondary spines flat, only a little wider near the base than at the truncate slightly rounded tip; miliary spines, few, very small, acute. No globiferous pedicellariae were found on any one of the specimens; tridentate of two kinds, one with long narrow jaws, are abundant. In color, the test is pinkish cinnamon with the median ambulacral area distinctly light yellowish olive; secondary and miliary spines brownish olive of diverse shades; young primaries Japan rose or slightly darker, in some cases with one or

<sup>2</sup> *asteriscus*—a little star, in reference to the star-like figure formed by the genital plates.

<sup>3</sup> Color names are from Ridgway Color Chart as determined at the time of this study.

two light bands near tip; mature primaries blackish brown except where covered by encrusting bryozoa or other organisms; collar very low, verona brown; primary spines of oral surface light colored, those around the actinostome may be nearly white. The holotype is 26 mm h. d., 13 mm v. d.; longest primaries 35 mm with a diameter near base of nearly 3 mm; at tip, not quite two.

Besides the holotype, there are two other Cidarids that must be referred to this species, as they agree in all essentials. One is nearly as large as the holotype but is badly damaged on one side. The primaries of the oral surface show more red in their coloration and the secondaries are a lighter shade of brown. This specimen was taken with the holotype at *Velero* Station 948-39, March 28, 1939, off Medidor Island, Bahia Honda, Panama, in 30-35 fms on a bottom of mud, rocks and corallines, in company with large numbers of *perplexa*. A third specimen, 15 mm in diameter with primaries 20-26 mm long, is supposed to be from Station 575-36, in the Gulf of California, but there is some doubt as to the reliability of the label. It is unquestionably conspecific with the specimens from Bahia Honda but shows much more red in the coloration and the primaries are not so black as in the holotype. The relationship of this species to *perplexa* is obvious, but to refer these specimens to that species would evidently be quite wrong.

*Type*.—Holotype, AHF no. 46, 1 paratype.

*Type locality*.—Station 948-39, off Medidor Island, Bahia Honda, Panama, 30-35 fms, March 28, 1939.

*Distribution*.—Type locality and the Gulf of California (?).

*Depth*.—30-100 fms (?).

*Specimens examined*.—The type, paratype and one other specimen, from 2 stations.

### **Centrocidaris Doederleini** (A. Agassiz)

Plate 38, Fig. 7

*Goniocidaris Doederleini* A. Agassiz, 1898, p. 73.

*Centrocidaris Doederleini* A. Agassiz, 1904, p. 33, pl. 14, figs. 1, 2.

Apparently this is a very rare urchin for, in all her collecting, the *Velero* has met with but one specimen—a small adult taken in the Galapagos Islands, near Barrington Island, in 48-73 fms. It is 24 mm in diameter and 13 mm high. The primaries are 20-28 mm long, exceedingly slender, and nearly cylindrical, either smooth or with low, well separated ridges. The abactinal system shows a star-like pattern, as in *Hesperocidaris asteriscus* but in *Centrocidaris* the lines are dark brown with light brown plates instead of the reverse.

*Distribution.*—Cocos Island, Galapagos.

*Type.*—U.S.N.M. No. 27348.

*Type locality.*—Albatross Station 3369, off Cocos Island, 52 fms.

*Depth.*—48-300 fms.

*Specimens examined.*—1 specimen.

Order **CENTRECHINOIDA**  
Family **Centrechinidae**  
**Centrechinus mexicanus** (A. Agassiz)\*

Plate 38, Fig. 8

*Diadema mexicanum* A. Agassiz, 1863, p. 20.

*Centrechinus mexicanus* Ziesenhenné, 1937, p. 231.

*Diadema mexicanum* Mortensen, 1940, p. 275, pl. 60, figs. 7-11.

This big black sea-urchin, with long slender, acutely pointed and very poisonous spines, is a nuisance to bathers, beachcombers and fishermen throughout the tropical Eastern Pacific. Adult specimens are 70-80 mm in diameter with the height of the test about half as much. The primary spines may exceed twice the diameter of the test but they are so very fragile that it is extremely difficult to preserve specimens with the spines unbroken. The secondary spines are very slender and acicular but not very long; when they dry they are so fragile they are easily broken and lost. The absence of spines on the peristome is a constant and striking feature. Full grown individuals are virtually unicolor, black or very dark brown; occasionally definitely brown specimens occur. As in all the species of *Centrechinus* (or *Diadema*) very young specimens have the long spines prettily banded with white and some dark shade, usually purple, but the white is sometimes tinged with brown and the purple is nearly black. With increasing size the white becomes more and more dingy and half grown specimens may have it entirely suppressed and the spines all uniformly dark. Banded spines in specimens half grown or more are common but usually only a few of the primaries show it. The poisonous character of the spines is well known and those who have once suffered the pain which even a single spine can cause, are forever after extremely careful in the vicinity of *Centrechinus*.

*Distribution.*—This species was taken by the *Velero* at 38 stations, of which the most northern was at Consag Rock in the Gulf of California, the most southern at Gorgona Island, Colombia. The absence of specimens from the western coast of Lower California is notable, since the urchin occurs at both Socorro and Clarion Islands. It is also found at Cocos Island and throughout the Galapagos Islands. It is definitely a shallow water echinoid, for, although it was taken in 40-57 fms at the island, along

\*Please see explanation on p. 243.

the mainland coast nearly all the specimens at hand were taken along shore, very rarely in more than 2 fms.

*Type*.—M.C.Z. no. 635 (Cotype).

*Type locality*.—Acapulco, Mexico.

*Depth*.—Shore to 57 fms.

*Specimens examined*.—191 specimens from 38 stations.

### ***Astropyga pulvinata* (Lamarck)**

Plate 39, Fig. 9

*Cidarites pulvinata* Lamarck, 1816, p. 59.

*Astropyga pulvinata* L. Agassiz and Desor, 1846, p. 345.

Mortensen, 1940, p. 197, pls. 20-23.

One of the characteristic Echini of the warmer Eastern Pacific, this handsome sea-urchin is well represented in the *Velero* collections. There are altogether 165 specimens, ranging in size from 5 mm h. d. with primary spines 7 mm long, to adults 100-117 mm in diameter. The diversity of color is very striking but is brightest in the young which are often very handsome and duldest in the adults. The largest specimen in the present collection is dry and measures 117 mm h. d. and about 40 mm v. d. It is uniformly dark (almost black) above save for the usual large triangular interradial spots which are light buff but were probably white in life. Apparently this represents the form collected by Mortensen at Contadora Island, Panama, which he designates as variety *venusta* Verrill. The present specimen was taken in 15-20 fms in Tangola Tangola Bay, Mexico, in company with 3 specimens 70-90 mm h. d. which are all typical, handsomely variegated *pulvinata*, as are many other Mexican specimens. A very fine specimen, however, from Tiburon Island, Gulf of California, 10 fms, is almost completely dark violet above, the interradial spots being scarcely distinguishable and the lower surface being very markedly suffused with violet. This is the most heavily pigmented specimen in the collection though only about 90 mm h.d. Young specimens (17-35 mm) from the Gulf of California, Panama, and Ecuador are very handsome in their variegated liveries of bright red, violet and yellow. It does not seem to me desirable to give varietal names to any of the varied forms, even though such extremes as *venusta* may be recognizable.

*Distribution*.—This sea-urchin was taken by the *Velero* at some 16 stations along the Mexican and Central American coasts in depths down to 20 fms though many collections were made along shore. The northern-

most stations were at Tepoca Bay, Sonora, where only two very young specimens were taken and Tiburon Island, in the Gulf of California, in 16 fms, where 74 specimens were secured. The southernmost station was at Santa Elena Bay, Ecuador, in 8-10 fms, but no specimens were taken at either Cocos or the Galapagos Islands.

*Type*.—Paris Museum?

*Type locality*.—"Habite—probablement les mers de l'Asie."

*Depth*.—Shore to 20 fms.

*Specimens examined*.—165 specimens from 16 stations.

### **Centrostephanus coronatus** (Verrill)

Plate 39, Fig. 10

*Echinodiadema coronata* Verrill, 1867, p. 295.

*Centrostephanus coronatus* A. Agassiz, 1872a, p. 97.

Mortensen, 1940, p. 314, pl. 36, figs. 7-10.

Compared with the preceding two species, this is a relatively small sea-urchin, the largest known specimens being only 63 mm in diameter. The largest of the 131 specimens collected by the *Velero* are only 45-50 mm with the primary spines about twice as much. As the spines are very brittle, especially when dry, few specimens (even in the *Velero* collections, notable for the fine condition of typical specimens in nearly every species) show the handsome appearance of this sea-urchin in life. As in *Centrechinus* the spines are finely verticillate and very acute but there is no evidence that they carry poison at the tip as do those of *Centrechinus*. A very interesting character of this *Centrostephanus* is the presence on the uppermost interambulacral plates of short claviform spinelets the tips of which are bright red purple. This color persists in most preserved specimens but may be much duller and hence less noticeable than in life. Mortensen discovered that these spinelets are never resorbed or replaced by the long primary spines but the latter grow up around them and enclose them without resorption. Young individuals of this *Centrostephanus* are so similar to young examples of *Centrechinus mexicanus* that they are often confused with them but there are three characters by which the two species may be readily distinguished. The most important of these is the presence of these brightly tipped claviform spinelets in *Centrostephanus* which are never present in *Centrechinus*. A second distinctive character is the presence of slender, blunt, light-colored spinelets on the five pairs of oral plates around the mouth (in *Centrechinus* these plates may have pedicellariae but never spinelets). The third difference is in the color of

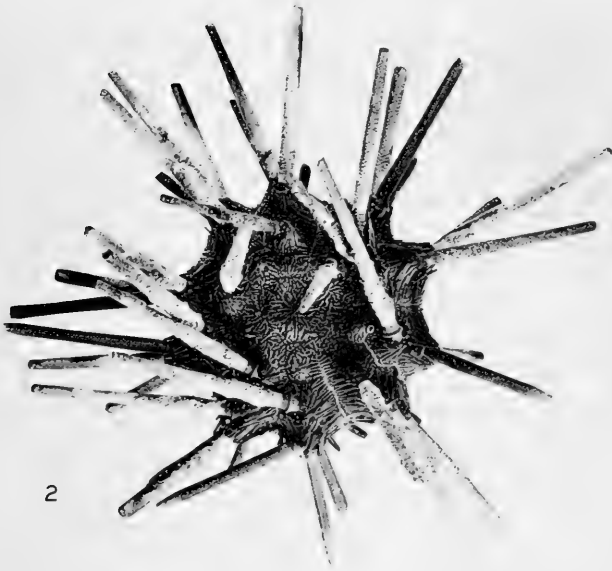
## PLATE 35

- Fig. 1. *Eucidaris Thourasii* (Valenciennes), aboral view,  $\times\frac{2}{3}$ , p. 229  
Fig. 2. *Hesperocidaris panamensis* (A. Agassiz), aboral view,  $\times\frac{2}{3}$ , p. 230

## PLATE 36

- Fig. 3. *Hesperocidaris perplexa* (H. L. Clark), aboral view,  $\times\frac{2}{3}$ , p. 231  
Fig. 4. *Hesperocidaris asteriscus*, new species, lateral view,  $\times\frac{4}{3}$ , p. 232







3



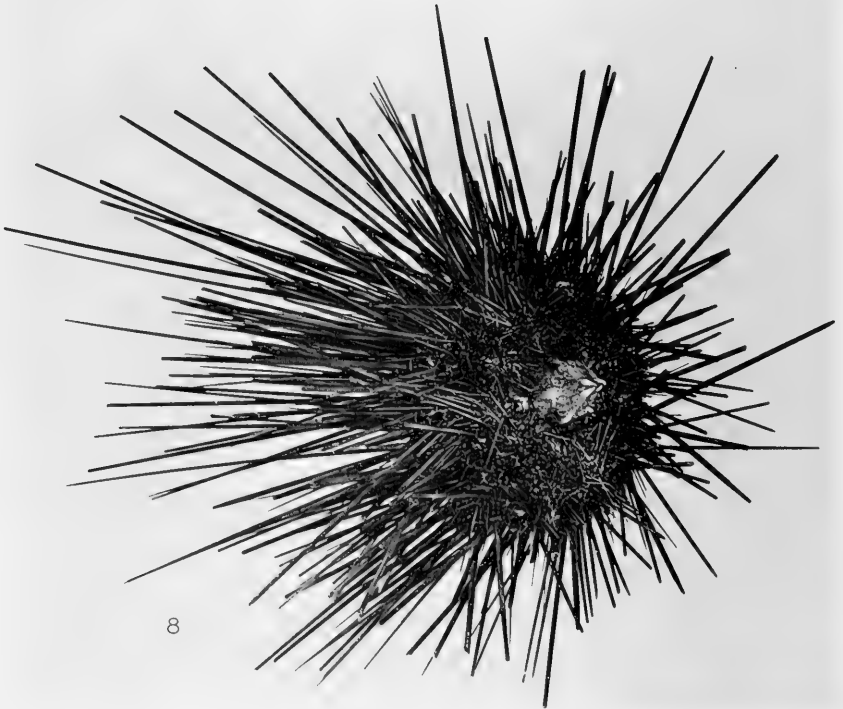
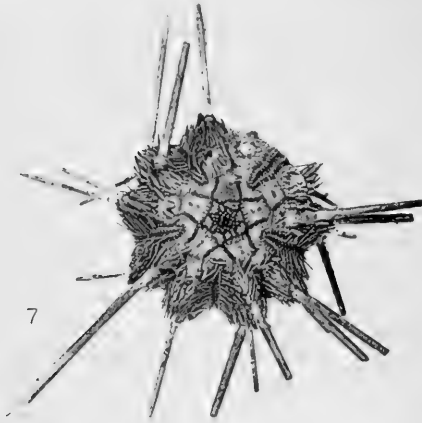
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6



## PLATE 37

Fig. 5. *Hesperocidaris asteriscus*, new species, aboral view,  $\times\frac{4}{3}$ , p. 232

Fig. 6. *Hesperocidaris asteriscus*, new species, oral view,  $\times\frac{4}{3}$

## PLATE 38

Fig. 7. *Centrocidaris Doederleini* (A. Agassiz), aboral view,  $\times 1$ , p. 234

Fig. 8. *Centrechinus mexicanus* (A. Agassiz)\*, oral view,  $\times\frac{1}{2}$ , p. 235

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\*In a recent letter from Th. Mortensen he states that The International Commission on Zoological Nomenclature meeting in Paris this summer (1948) rendered an Opinion which codified the name *Diadema* as a *nomen conservandum*.

This species is, therefore, *Diadema mexicanum* A. Agassiz, order Diadematoida, family Diadematidae. These corrections replace corresponding names used on p. 235 of the text.

the primary spines; in young *Centrechinus* the spines are banded bluish or purplish and white, in *Centrostephanus* dull purplish brown and light yellow. With increasing age and size, the colors become duller until the mature primaries are uniformly black in *Centrechinus*, dark brown in *Centrostephanus*. It is unusual for banded spines to be evident in adults of either genus but carefully preserved alcoholic specimens of *Centrostephanus*, even when full grown, commonly show the banding on some primaries at least, though faintly. Most dry specimens, however, appear to be more or less uniformly dark brown or quite black. On the contrary, very young specimens (less than 10 mm in diameter) are unusually pretty objects, the test and small spines deep brown, the dull yellow primaries more or less evidently banded with purplish brown, and five or more claviform spinelets, with bright rose-purple tips around the apical system.

*Distribution.*—This species of *Centrostephanus* is definitely a shallow water Mexican sea-urchin but the *Velero* took it at five stations in the Galapagos Islands. At Albemarle Island it was found in shallow water but off James Island it occurred in 36-60 fms. It was not met with at either Cocos or the more northern islands (Socorro and Clarion), or on the west coast of Lower California. Yet it is frequently found at Newport and Corona del Mar, California, near low water mark. It has yet to be taken on the mainland coast south of the Gulf of California but in the Gulf it has been found as far north as Rocky Point, Sonora, and Consag Rock, in depths down to 45 fms.

*Type.*—Peabody Museum, Yale University, no. 964.

*Type locality.*—Cape San Lucas, Lower California.

*Depth.*—Shore to 60 fms.

*Specimens examined.*—131 specimens from 37 stations.

### Family **Arbaciidae**

#### ***Arbacia incisa*** (Blainville;? Gmelin)

Plate 40, Fig. 11

*Echinocardis incisa* A. Agassiz, 1863, p. 20.

*Arbacia incisa* H. L. Clark, 1913, p. 220.

*Arbacia stellata* Mortensen, 1935, p. 575, pl. 70, figs. 6-9.

This is one of the commonest sea-urchins of the Gulf of California and was taken by the *Velero* at many stations there. Along the coast southward it seems to be less common and relatively few specimens were secured but unmistakable examples were collected as far south as Peru. Indeed one of the largest specimens in the collection, 47 mm h.d., was taken nine miles south of Zorritos Light, in shore collecting; from tip to

tip of the extended spines it measures 120 mm. Mortensen refers to the "largest size recorded for this species is 60 mm diameter" but he does not give his authority for this giant.<sup>4</sup> Only a very few of the *Velero's* 1,121 specimens exceed 35 mm h. d. (the largest is 56) and a very large number are less than 20 mm across. Very young specimens (2-8 mm h. d.) are as a rule light colored more or less flesh red, becoming red brown, or violet or deep purple, until finally they are nearly or quite black. A few dry specimens are more or less definitely gray. One curious variety has some of the primaries, or at least portions, quite pink or white in striking contrast to the black of the remaining spines and test. Mortensen (p. 566) makes the "conspicuous red spots in the interambulacra on the aboral side" the distinguishing mark of the species and the *Velero* collection confirms his judgment. Even in the most nearly black adults, careful examination in good light will show at least faint indications of the tell-tale red blotches. Young individuals with the test flesh color or red and the red spines with one or more whitish bands are so different from the more mature specimens, it is hard to believe they can ever become as dark colored as they do, but the present large series compels the acceptance of the fact. In one or two of the very black specimens there is real difficulty in seeing any red, but such individuals cannot be distinguished satisfactorily as anything other than excessively pigmented *incisa*.

Mortensen's (1935, p. 577) plea for the specific name *stellatus* is inadequate, and if we once let such arguments control our decisions we shall have more disagreements and resulting confusion than we have had hitherto. Nobody knows to what sea-urchin the name *stellatus* was first given. Everyone knows what *Echinocidaris incisa* was at the start and there has never been any confusion about it, so I have no hesitation in continuing the use of the name here.

*Distribution.*—The *Velero* collections show that this is essentially a species of the Gulf of California. It ranges north to the southern United States as shown by Zicsenhenne (1941, pp. 117-120). There are 6 very fine adult specimens in the *Velero* collection from Newport Harbor, California, but the *Velero* has taken no other specimens north of Lower California, nor along its western coast. South of the Gulf, *incisa* does not appear to be very common though there are specimens at hand from Bahia Honda, Panama; Gorgona Island, Colombia; Santa Elena Bay and La Plata Island, Ecuador; Zorritos Light, South Bay, Lobos de Afuera,

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<sup>4</sup> The authority for this giant is Clark himself, who says in his *Echinoderms of Peru*, p. 345, that "large specimens may be 60 mm in diameter." TH. MORTENSEN

and Middle Chincha Island, Peru. The last is the farthest south for *incisa*, 13° 39' 15" S. All stations are in shallow water, less than 50 fms and almost always less than 20. A very small specimen is labeled as from Station 1105-40 in the Gulf of California, with a depth of 113-127 fms. It is probable that this individual was actually dredged at Station 1101-40, but was lost in the meshes of the dredge until the careful search after a deep water haul. It is notable that no specimens of *incisa* were taken at the Galapagos Islands, Cocos, Clarion or Socorro Islands, nor along the Costa Rican coast, though it has been previously recorded from the Galapagos.

*Type*.—M.C.Z. no. 467 (Cotype).

*Type locality*.—Guaymas, Lower California, Mexico.

*Depth*.—Shore to 50 fms.

*Specimens examined*.—1,121 specimens from 82 stations.

### *Arbacia spatuligera* (Valenciennes)

Plate 40, Fig. 12

*Echinus (Agarites) spatuliger* Valenciennes, 1846, pl. 5, fig. 2.

*Arbacia spatuligera* A. Agassiz, 1872a, p. 93.

H. L. Clark, 1910, p. 346, pl. 10, fig. 2.

Mortensen, 1935, p. 577, pl. 70, figs. 1-5.

Adult specimens of this rather handsome sea-urchin are said to reach a test diameter of 70 mm but the finest of the 15 specimens secured by the *Velero* are barely 50 mm h. d. and the longest spines scarcely exceed 40 mm. These large specimens (30-50 mm h. d.) are brown, very dark on the test but with the spines much lighter, a real fawn brown. Small specimens (15-25 mm h. d.) are dark; the smaller has the interambulacra definitely tinged with green and the spines are dull pink or rose, brightest on the lower surface; the larger (25 mm h.d.) has the dark interambulacra scarcely tinged with green and the primary spines dark violet. A series of 5 very small *Arbacias* from Sechura and Independencia Bays, Peru, are pale gray or whitish or reddish brown, with the primary spines either colorless or with one or two light red bands. While it is not certain that these little *Arbacias* are young *spatuligera*, there is little reason to doubt it.

*Distribution*.—Even including the very small *Arbacias* just mentioned, the *Velero* material throws no new light on the distribution of *spatuligera*. The largest specimens are from San Lorenzo Island, Peru in 5 fms. The remaining material is from Sechura and Independencia Bays in water 10 fms deep or less. So far as the *Velero* collections are concerned this *Arbacia* is found only in Peru.



Other records, however, extend its range to Ecuador and Chile.

*Type*.—Unknown.

*Type locality*.—"Carthagena on the west side of the Isthmus of Darien." (Panama)

*Depth*.—Shore to 10 fms.

*Specimens examined*.—16 specimens from 6 stations.

### **Tetrapygyus niger** (Molina)

Plate 40, Fig. 13

*Echinus niger* Molina, 1782, p. 200.

*Tetrapygyus niger* A. Agassiz and H. L. Clark, p. 73.

H. L. Clark, 1910, p. 345, pl. 10, fig. 1.

Mortensen, 1935, p. 582, pl. 70, figs. 10-12.

This is one of the most characteristic of the sea-urchins of the South American Pacific coast for it is primarily a Peruvian species and has not yet been found north of the equator nor at the Galapagos Islands. The *Velero* collection contains 274 specimens. Over 250 of these were found along shore and are for the most part adult; few are less than 15 mm h. d. Only at Fronton Island, near Callao, in 5 fms, were specimens of *niger* dredged. The color of the adults is dull black; small specimens (under 25 mm) tend to be more brownish but not markedly so. South of Peru, *niger* ranges far down on the Chilean coast but its northern limit is near Payta, Peru. At the Lobos de Afuera Islands it is very common. Other authors include Chile and Patagonia in the range.

*Type*.—Unknown.

*Type locality*.—Chile.

*Depth*.—Shore to 5 fms.

*Specimens examined*.—274 specimens from 9 stations.

### Family **Echinidae**

#### **Lytechinus anamesus** H. L. Clark

Plate 41, Fig. 14

*Lytechinus anamesus* H. L. Clark, 1912, p. 254, pl. 107, figs. 7-11.

Mortensen, 1943, p. 452, pl. 23, figs. 33-40.

Apparently the commonest sea-urchin in moderate depths off the southern California coast, this rather attractive small species was taken by the *Velero* at no fewer than 155 stations at depths of 8 to 160 fms. Altogether 5,090 specimens were secured, the largest 37 mm in diameter. When very young it is light colored, often quite white, more often cream

color, but by the time it is 8-10 mm across, spots and blotches of gray or dull green have begun to appear and in mature specimens, 20-30 mm across, the upper surface may be more or less dull colored with spots or blotches of cream color. The slender, more or less acicular, spines are unicolor, generally cream color or even white, but the smaller ones are often gray. In many specimens, however, the primary spines are yellowish brown or even rust color, and in others they are dull gray. From some stations the specimens are so dark as to be easily confused with *pictus*. This is most apt to be the case with material from the deeper water stations, much of the test and most of the spines being dull greenish gray; in such specimens the spines are apt to be shorter and blunter than usual, and the resemblance to the following species may be confusing. The differences will be emphasized under *pictus*. Very young specimens of *anamesus* are almost pure white or very pale yellow and the primary spines are often conspicuously long and acicular. Before the test is 10 mm in diameter, a dull colored spot begins to appear at the upper end of each interradial area and these are soon followed by others until in adult specimens the whole upper surface of the test is conspicuously blotched with the darker shade. At the same time primary spines also take on the dull color, in more or less marked contrast with their fellows. As already stated some individuals, and at some stations all, are so dark as to be difficult to recognize as *anamesus*. Occasionally individuals are met with of so dark a brown as to make identification difficult but the relatively long acicular spines are distinctive in most of such cases. Not rarely specimens 12-15 mm in diameter are met with which have developed no pigment but are uniformly white or cream color. As a rule, however, pigmentation begins very soon after the test is fully formed.

*Distribution.*—The remarkably limited range of this sea-urchin is notable for the thousands of specimens taken by the *Velero* are convincing proof that it is a very common species off the coast of southern California and the adjoining islands, as far south as Station 283-34 off Thurloe Head, Lower California ( $27^{\circ} 37' 30''$  N). It was not taken north of Station 1410-41 ( $34^{\circ} 53' 35''$  N), 3 miles east of the southern point of Santa Rosa Island, in 17-20 fms. It was seldom taken in less than 20 fms, the least depth being in 8-10 fms, at the southernmost station, off Thurloe Head. The greatest depth was at 160 fms at Station 1182-40, near Catalina Island. This distribution is strikingly similar to that of the 414 specimens on which the species was based. The *Albatross*

took them at 25 stations between 28° 12' N and 34° 24' 30" N at depths of 20-113 fms, including Guadeloupe Island.

*Type*.—U.S.N.M. No. 32660.

*Type locality*.—Albatross Station 2930, off San Diego, 60 fms.

*Depth*.—8-160 fms.

*Specimens examined*.—5,090 specimens from 155 stations.

### **Lytechinus pictus** (Verrill)

Plate 41, Fig. 15

*Psammechinus pictus* Verrill, 1867, p. 301.

*Lytechinus pictus* H. L. Clark, 1912, p. 258, pl. 107, figs. 12-14.

This species has undoubtedly been confused with the preceding and the suggestion has been made that the two are identical but show great diversity. The thousands of specimens of *anamesus* taken by the *Velero* are supplemented by some 488 specimens of *pictus*, ranging from 2 to 38 mm in diameter. When young the two species are so different they could not be confused but mature specimens may look very much alike. Young *anamesus* are pure white with long, acicular white spines. As they mature the color becomes more yellowish, and blotches of gray or dull purple appear on the upper side of the test, but there is no hint of red or violet on either test or spines. When adult, the slender, acute, unbanded spines are quite different from the relatively short, rather thick, blunt spines of *pictus*. In specimens of *pictus* less than 8 mm in diameter the primary spines of the oral side at least are definitely reddish, ranging from dull pink to a clear rose purple, with one or more definitely white bands. In some cases the bands are not evident but there is more or less red or rose purple evident on at least the distal part of the spines, but after the test is more than 10 mm in diameter the spines are unicolor, gray, brown or red purple. Often the basal half is nearly white, the distal half more or less dull rose or dull yellow. In young specimens there is usually rose purple or violet evident on the abactinal system but this soon disappears and the whole system becomes a dull gray. Young *pictus* with banded rose purple spines may be easily confused with young *Strongylocentrotus purpuratus*, but in *Lytechinus* the color is much more pink than in *purpuratus*. In *anamesus* there is never any pink or rose purple shade in the coloring of the spines but yellow, yellow brown or dull orange may be marked; usually the shades are dull gray or olive when not yellowish or brown; on the oral surface the spines are commonly white. In *pictus* there is usually no white on the oral side but some individuals are as white as any *anamesus*.

## PLATE 39

- Fig. 9. *Astropyga pulvinata* (Lamarck), aboral view, x approx.  $\frac{2}{3}$ , p. 236  
Fig. 10. *Centrostephanus coronatus* (Verrill), aboral view, x approx.  $\frac{1}{2}$ , p. 237

## PLATE 40

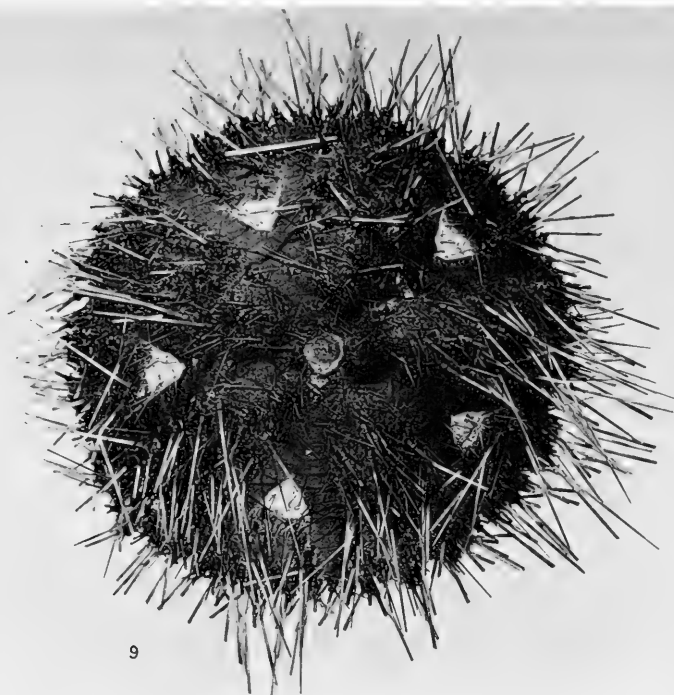
- Fig. 11. *Arbacia incisa* (Blainville, ? Gmelin), aboral view, x $\frac{2}{3}$ , p. 244  
Fig. 12. *Arbacia spatuligera* (Valenciennes), aboral view, x $\frac{2}{3}$ , p. 246  
Fig. 13. *Tetrapygyus niger* (Molina), aboral view, x $\frac{2}{3}$ , p. 247

## PLATE 41

- Fig. 14. *Lytechinus anamesus* H. L. Clark, aboral view, x1, p. 247  
Fig. 15. *Lytechinus pictus* (Verrill), aboral view, x1, p. 249  
Fig. 16. *Lytechinus semituberculatus* (Valenciennes), aboral view, x1, p. 261

## PLATE 42

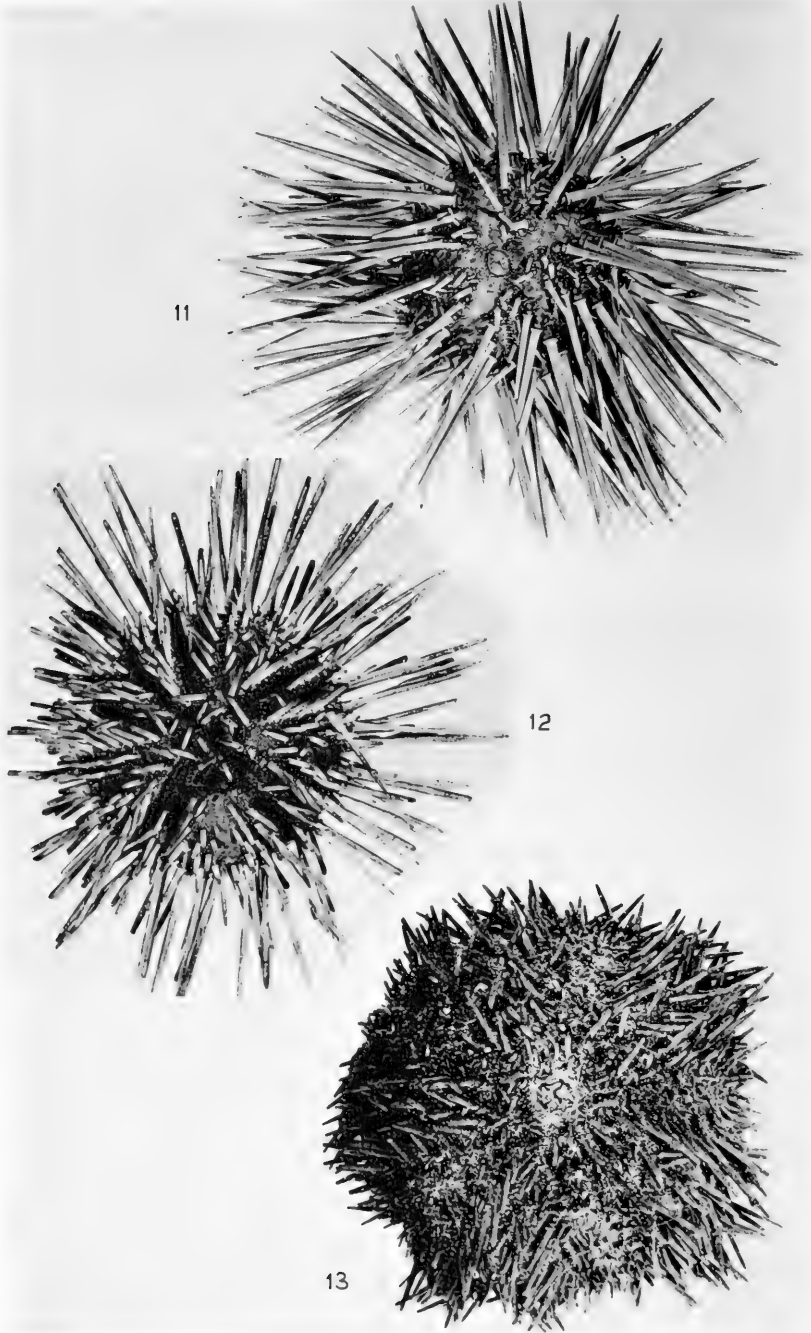
- Fig. 17. *Toxopneustes roseus* (A. Agassiz), aboral view, x1, p. 262  
Fig. 18. *Tripneustes depressus* A. Agassiz, aboral view, x $\frac{2}{3}$ , p. 263

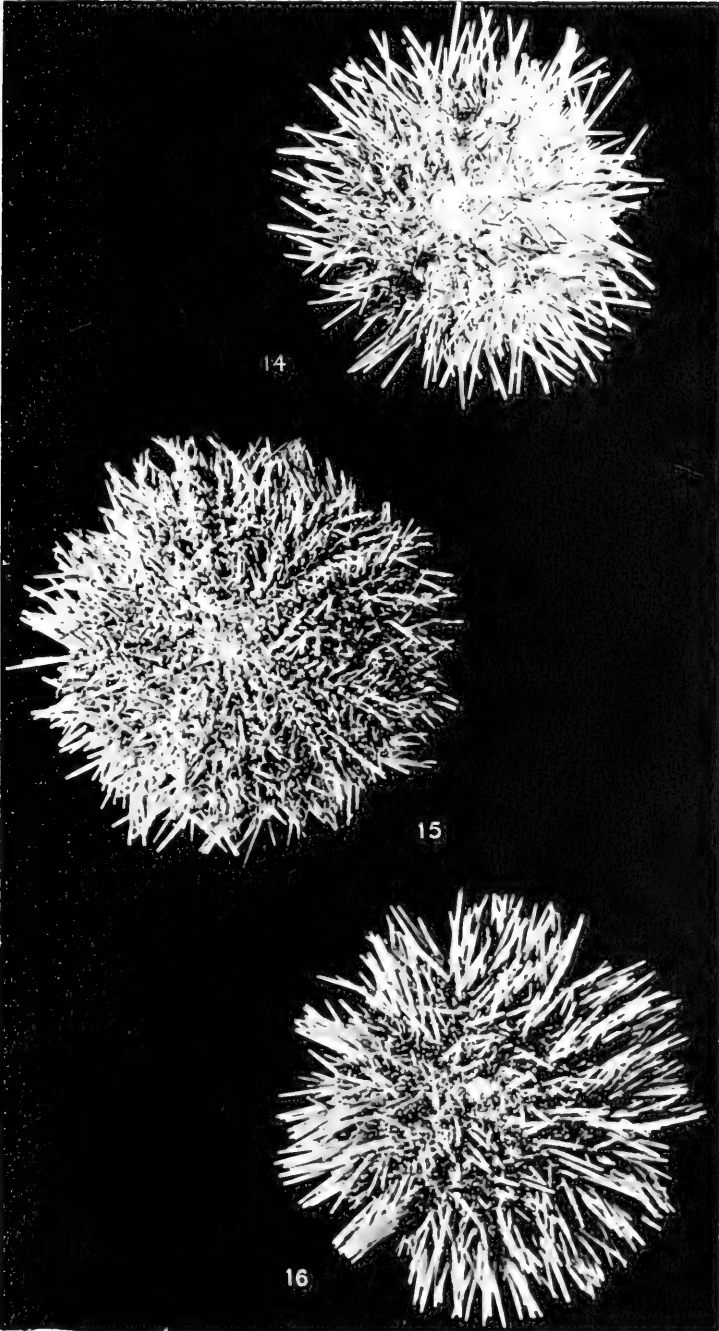


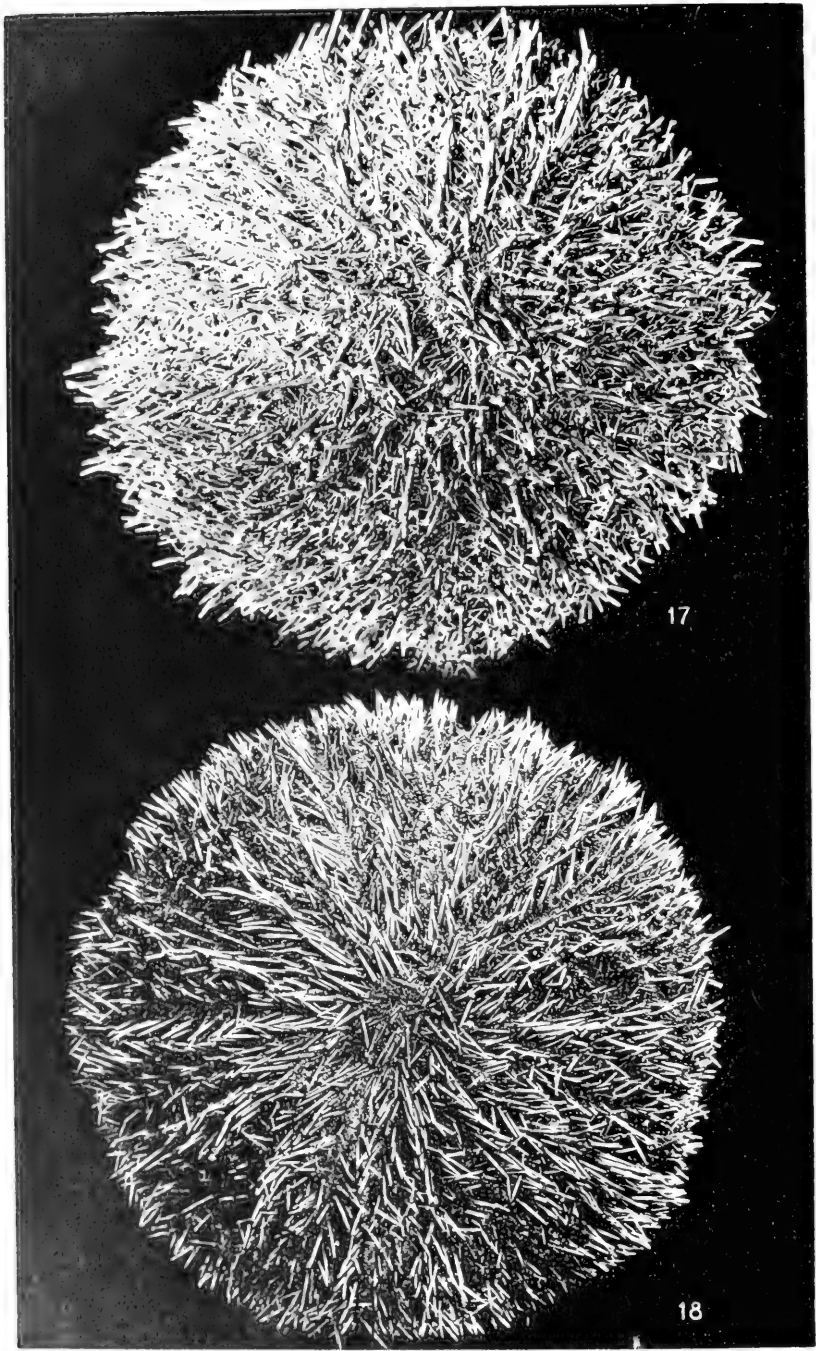
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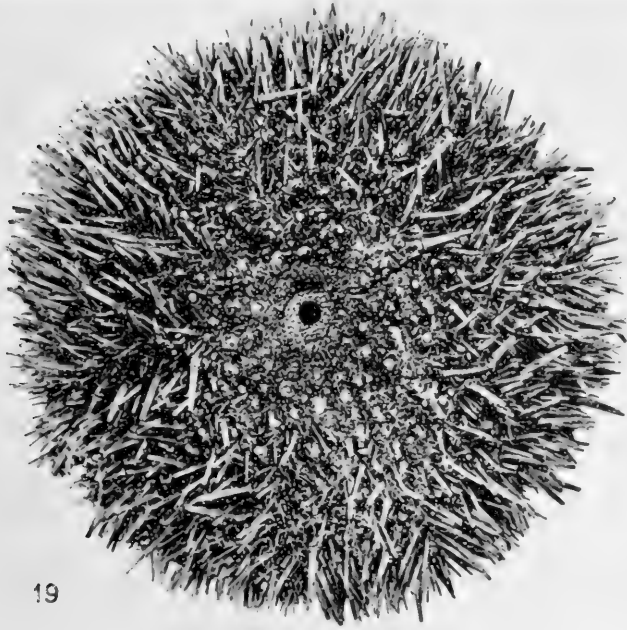


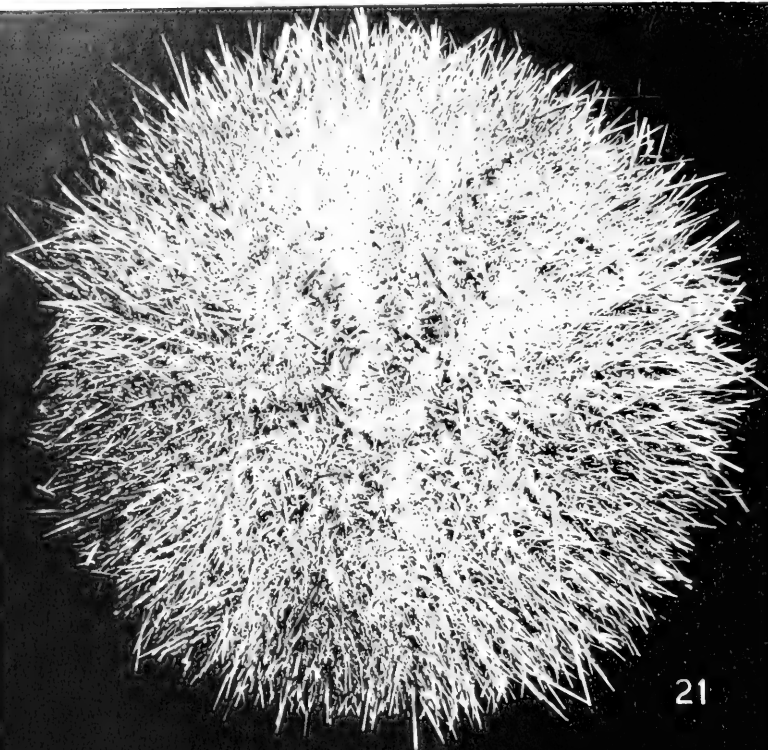


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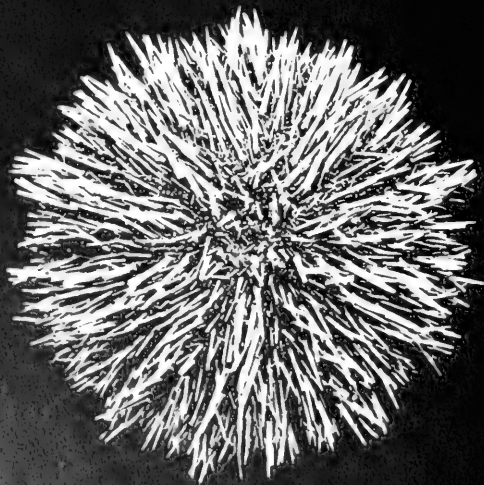
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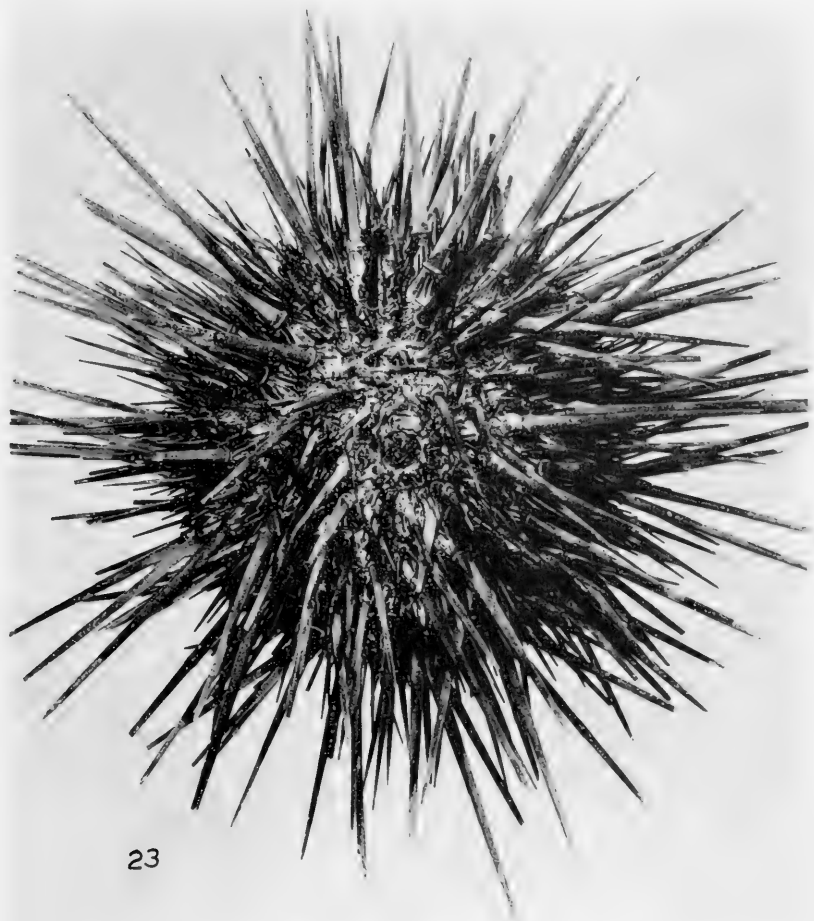




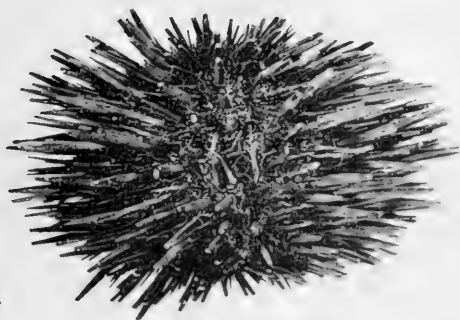
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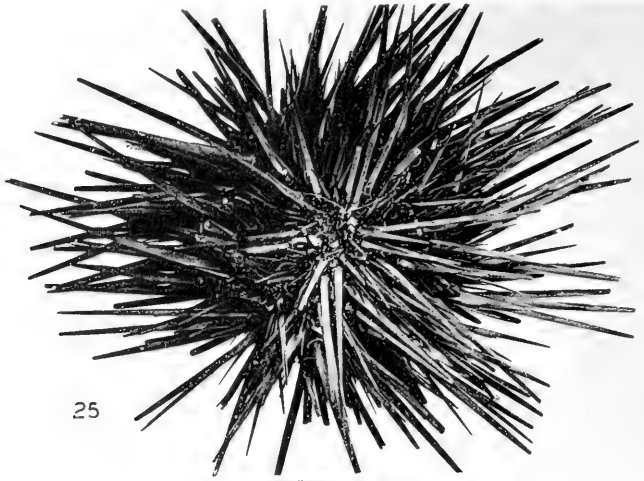
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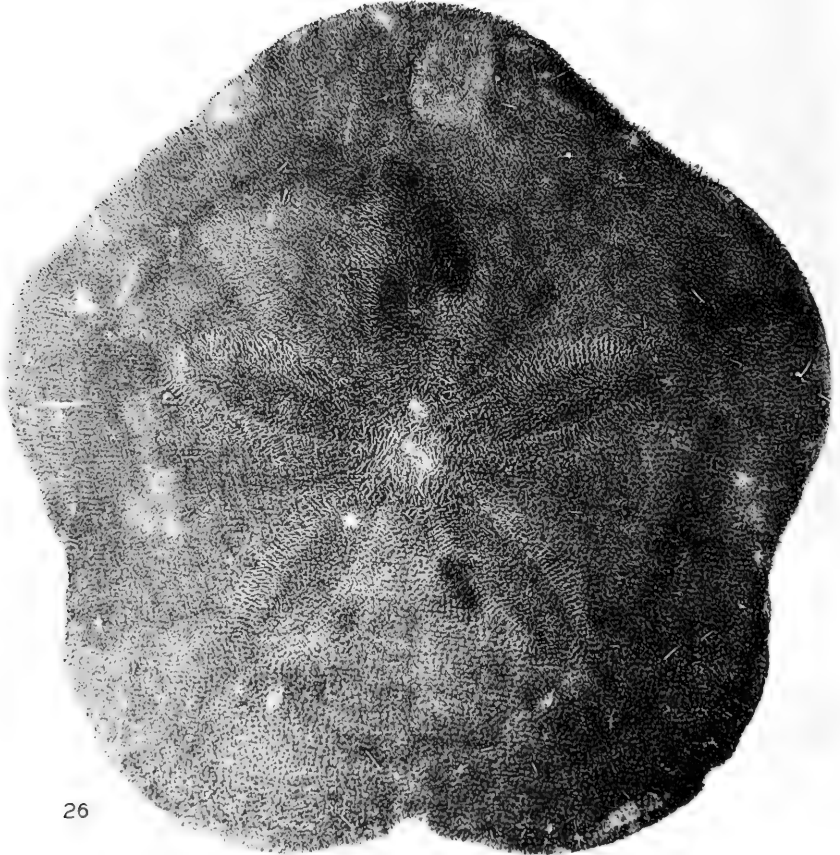
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## PLATE 43

- Fig. 19. *Loxechinus albus* (Molina), aboral view, x1, p. 265  
Fig. 20. *Caenocentrotus gibbosus* (L. Agassiz and Desor), aboral view, x1, p. 265

## PLATE 44

- Fig. 21. *Alloccentrotus fragilis* (Jackson), aboral view, x1, p. 276  
Fig. 22. *Strongylocentrotus purpuratus* (Stimpson), aboral view, x1, p. 279

## PLATE 45

- Fig. 23. *Strongylocentrotus franciscanus* (A. Agassiz), aboral view,  $x\frac{1}{6}$ , p. 278  
Fig. 24. *Echinometra oblonga* (Blainville), aboral view, x1, p. 281

## PLATE 46

- Fig. 25. *Echinometra VanBrunti* A. Agassiz, aboral view,  $x\frac{2}{3}$ , p. 293  
Fig. 26. *Clypeaster europacificus* H. L. Clark, aboral view,  $x\frac{2}{3}$ , p. 294

Aside from color and character of the spines, it is hard to find any very tangible differences between the two species. On the whole the number of coronal plates and of large tubercles is greater in *pictus* than in *anamesus*. Specimens 25 to 30 mm h. d. having about 20 interambulacral plates in a column, have in *pictus*, 27 or 28 ambulacrals, in *anamesus* about 20 or 21. In the same specimens, *pictus* has 4 large primary tubercles on each coronal plate just below the ambitus, while in *anamesus* there are but 3 tubercles. Furthermore, the interambulacral areas above the ambitus obviously carry fewer tubercles in *anamesus* than in *pictus*. Mortensen (1943, pp. 437, 450) had no specimens of *pictus* available for critical study but saw Verrill's type and cotype at New Haven. He describes them as "light purple with radiating whitish bands, the spines bright purple, more or less distinctly banded." In all the hundreds of *Lytechinus* from the southern California coast, no specimen with any definitely purple tint has been seen. Neither has any individual with "spines bright purple, more or less distinctly banded" been detected. The difficulty is probably due to misunderstanding in the use of color terms. Mortensen's "purple" is probably what to me is "rose violet," but none of the *Lytechinus* at hand could by any possibility be called "bright" colored.

*Distribution.*—The 42 stations at which *pictus* was taken by the *Velero* are widely scattered and show a perplexing distribution. Some of the best material has been secured at Newport, Balboa, and Corona del Mar, California, at or near low water mark and a few specimens have been taken at or near the Channel Islands in moderately deep water, 3-39 fms. But most of the specimens are from stations in the Gulf of California usually in rather deep water, 40-95 fms. Much further south some very small Echini have been taken which are best treated as *pictus*. Half a dozen were secured at La Plata, Ecuador, 7-10 fms, which may possibly be Mortensen's *panamensis* but their very small size prevented satisfactory determination. A single specimen from Gorgona Island, Colombia, in 20 fms and one from Bahia Honda, Panama, 5-8 fms offer the same difficulty. They may possibly be *panamensis* but it is not wise to assert that they are.

*Type.*—Peabody Museum, Yale University, no. 961.

*Type locality.*—"Cape San Lucas, California" (Grant and Hertlein, 1938, p. 25).

*Depth.*—Shore to 95 fms.

*Specimens examined.*—488 specimens from 42 stations.

**Lytechinus semituberculatus** (Valenciennes)

Plate 41, Fig. 16

*Echinus (Psammechinus) semituberculatus* L. Agassiz and Desor, 1846, p. 368.

*Lytechinus semituberculatus* Verrill, 1867, p. 301.

Mortensen, 1943, pp. 456-459, pl. 26, figs. 5, 6.

This well marked species is represented in the *Velero* collection by 863 specimens, but it should be stated at once that 570 of them are bare tests from a sand beach adjacent to lava rock at Bindloe Island, Galapagos Islands. The largest specimen at hand is 43 mm in diameter but most of them are considerably less than that. The yellow green color of the primary spines is very characteristic of well grown specimens, but very young individuals, 5 mm or less in diameter are bright vermilion red or paler, even a simple cream color with the median interambulacra apically deep green. Individuals 8-15 mm h. d. are often very handsome with the test deep green above and more or less pure white beneath; the dorsal half of each interambulacrum may be deep red in sharp contrast with the vermilion red and white of the ambulacra. The apical system in such specimens is greenish with a few vermilion red spots. In some young individuals the red may be very pale except orally, and in others it may be wholly wanting, the resulting green and white livery being soon replaced by the brownish test and long green spines of the adult. In youth the green shades are rich and rather dark and more or less mixed with white but with increasing size the white as well as the red tends to disappear. It is hard to believe that the really beautiful red, green, and white young urchins can so soon and so completely lose their beauty and become the uniformly dull brown or blackish adult covered with uniformly yellow-green spines. Some adults have the spines tinged at the tip with yellow brown and rarely the color of a dried specimen may be definitely brown with little indication of green. In the great majority of museum specimens, however, the characteristic yellow green or light green shade of the primaries is unmistakable.

*Distribution.*—This urchin is one of the most typical of Galapagos echinoderms. The *Velero* took it at 43 stations in the archipelago; 10 times near Charles Island, 8 near James, 6 at Albemarle, 5 at Hood, 4 at Indefatigable, 3 near South Seymour, 3 at Barrington and one each at Bartholomew, Bindloe and Tower. Not a specimen has been secured at Cocos

Island or anywhere along the American coast. Mortensen reports it "with full certainty" from Clarion Island<sup>5</sup> but the *Velero* visited that isolated island twice and made 17 hauls of the dredge, besides two collecting trips along shore, and failed to find a single specimen. Certainly it should be found on the rich collecting ground at Cocos Island, if it occurs north of the Galapagos. If it is found on the American coast anywhere it is strange that the *Velero* has not met with it. It may be added that Dr. Coker did not find it on the Peruvian coast during his stay there (1907-1908) nor did the Templeton-Crocker Expedition secure any specimens at Clarion Island in 1936. There seems no adequate reason for doubting that this sea-urchin occurs only at the Galapagos Islands.

*Type*.—Paris Museum.

*Type locality*.—Galapagos Islands.

*Depth*.—Shore to 73 fms.

*Specimens examined*.—863 specimens from 43 stations.

### **Toxopneustes roseus** (A. Agassiz)

Plate 42, Fig. 17

*Boletia rosea* A. Agassiz, 1863, p. 24.

*Toxopneustes roseus* Mortensen, 1903, p. 111.

Grant and Hertlein, 1938, p. 26, pl. 17, figs. 1, 2.

Mortensen, 1943, p. 483, pl. 31, figs. 1-5.

Not a very common sea-urchin of the Panamic region, this large and striking species was not often secured by the *Velero*; only in 1933-34, 1934-35, 1938 and 1939 were specimens taken. Of the 22 specimens at hand, 14 are from Panama, near Secas Islands, in 3 fms. Of the remaining 8, 3 are very small (15-23 mm in diameter) and only one is more than half grown. Even the smallest is easily distinguished by the relatively huge and commonly widely open globiferous pedicellariae. The extraordinary appearance of the living sea-urchin is admirably shown in Mortensen's figures of the closely related species, *pileolus* (1943, pl. 26, fig. 3 and pl. 27, fig. 2). No other sea-urchin gives any such display of pedicellarian power as does *Toxopneustes*. The western Pacific species of

<sup>5</sup> The expression "with full certainty" quoted from my Monograph (p. 459) refers to the identification of the specimens of *L. semituberculatus* from Clarion Island mentioned by Clark in his catalogue of Recent Sea-Urchins in the Coll. of the British Museum, p. 120, the identification of other specimens being uncertain, as pointed out both by Clark and myself. The locality Clarion Island of the specimens in the British Museum may be erroneous.



the genus are also interesting for their coloration which is notably varied and inconstant, but the Panamic species is unicolor, more or less rose or, according to Mortensen "light purple." Preserved specimens are dull yellowish brown or the test may show a definitely purplish tint. Very young specimens are yellowish, with spines and the big widely opened pedicellariae, white. So far as preserved material is concerned the name *roseus* is most inappropriate.

*Distribution.*—The *Velero* took *Toxopneustes* at only 7 stations. The northernmost was at Port Culebra, Costa Rica, in 3-10 fms. The southernmost was at La Plata Isle, Ecuador, in 4 fms. The young specimens referred to above, 15-23 mm in diameter, were found at Port Utria, Colombia. A small adult was found at Braithwaite Bay, Socorro Island, in 20 fms and a somewhat larger individual was collected at Sullivan Bay, James Island, Galapagos Islands, at the same depth. This is the only record from the Galapagos Islands but there is apparently no doubt about either the locality or the identification. It is remarkable that *Toxopneustes* has not been taken on the Mexican coast or at Cocos Island. It is difficult to see why it does not occur north of Costa Rica but except for the *Velero's* specimen from Socorro Island and Mortensen's statement of its occurrence at La Paz, there are no records from the Mexican coast or islands. Neither the *Velero* nor the Templeton-Crocker Expedition found even one specimen in the Gulf of California.

*Type.*—No type.

*Type locality.*—Acapulco, Mexico.

*Depth.*—2-30 fms.

*Specimens examined.*—22 specimens from 7 stations.

### ***Tripneustes depressus* A. Agassiz**

Plate 42, Fig. 18

*Tripneustes depressus* A. Agassiz, 1863, p. 24.

Mortensen, 1943, p. 498, pl. 35, figs. 1, 2; pl. 38, fig. 9.

The largest regular sea-urchin of the western coast of tropical America this species reaches a horizontal diameter of 150 mm. There is great diversity in form, for while the height is usually a little more than half the diameter, the specimen 150 mm horizontally is only 72 mm vertically, and a specimen 138 mm across is only 65 mm high. On the other hand a specimen 127 mm across is 83 mm high. The height of the test thus ranges

from 47 to 65 per cent of the diameter. Growth changes from 30 mm h. d. to 150 mm are chiefly in the number of secondary and miliary tubercles (and spines, of course). In the young individuals, there are two columns of primary tubercles in the ambulacra and two in the interambulacra, with secondary and miliary tubercles present between them in the interambulacra in not very well-marked series. On the ambulacra there are few tubercles of any importance in the interporiferous area save for one column on each side. In an adult, 100 mm or more in diameter, there are 10-12 well-spaced columns of primary tubercles and many well-scattered smaller tubercles in the interambulacra. The ambulacra have undergone a more marked change; 4-6 imperfect columns of primary tubercles occupy the interporiferous area, and the poriferous areas have themselves widened markedly and carry 3 or 4 columns of tubercles mixed with irregularly scattered tube-feet between an inner and outer column of tube-feet which sharply delimit the area. The scattered tube-feet are much more numerous on the inner side of the area than on the outer. As for color, the dry specimens are very unattractive, as they were obviously prepared in haste. The test is almost black but with purple tinge more or less evident, and the spines are pale brown or brownish-white. One small adult in alcohol gives a better idea of the color in life. The test is purple, lightest on the poriferous areas, darker and duller on the interambulacra and on the interporiferous areas of the ambulacra. The spines are white in marked contrast to the test.

*Distribution.*—The 63 specimens of *depressus* brought in by the *Velero* are, with only two exceptions, from outlying islands. The exceptions are from the shores of Secas Islands, Panama. Of the other 61 specimens, 7 are from the Galapagos Islands (Albemarle, Tower, Chatham, Charles, and Gardner), all from along shore except the half grown specimen from near Gardner Island which was dredged in 12 fms. Of the remaining specimens 43 are from Socorro and 11 from Clarion, all secured by collecting along shore. The type locality is said to be Guaymas, Mexico, but it is notable that neither the *Velero* nor the Templeton-Crocker Expedition found any *Tripneustes* in the Gulf of California nor on the Mexican coast.

*Type.*—No type.

*Type locality.*—Guaymas, Mexico.

*Depth.*—Shore to 12 fms.

*Specimens examined.*—63 specimens from 10 stations.

Family **Strongylocentrotidae**  
**Loxechinus albus** (Molina)

Plate 43, Fig. 19

*Echinus albus* Molina, 1782, p. 200.

*Loxechinus albus* Desor, 1858, p. 136.

*Strongylocentrotus albus* H. L. Clark, 1910, p. 347, pl. 12, fig. 1.

This large sea-urchin of the western coast of South America is extensively used for food along the Chilean coast as *Tripneustes* is in the West Indies. In both cases it is the voluminous gonads which are eaten, commonly roasted in the "half-shell." The largest specimen taken by the *Velero* is somewhat less than 100 mm h. d. but specimens 120 mm in diameter are reported. Altogether only 23 specimens were taken. The smallest is 16 mm in diameter, the largest 84. The parasitic crab, (*Pinnaxoides*), which so often lives in the periproct of this sea-urchin and the following, *Caenocentrotus gibbosus*, is evidently present in at least 9 cases. The color is pretty uniformly green in spite of being often more or less bronzed over with red-brown. In specimens less than 20 mm h. d. the tips of the spines may be quite red. But in none of the specimens that I have ever seen is there any obvious reason why the specific name *albus* should have been attached to this sea-urchin.

*Distribution*.—The *Velero* met with this urchin only three times—first in 1935 along the shore in Independencia Bay, again in 1938 in San Juan Bay and Independencia Bay, and thirdly, a few days later further north, among the Lobos de Afuera Islands. This extends the range from the Lobos de Afuera Islands, northern Peru ( $6^{\circ} 53' 50''$ ), southward to the Straits of Magellan.

*Type*.—Unknown.

*Type locality*.—Chile.

*Depth*.—Shore to 40 fms.

*Specimens examined*.—23 specimens from 6 stations.

**Caenocentrotus gibbosus** (L. Agassiz and Desor)

Plate 43, Fig. 20

*Echinus (Toxopneustes) gibbosus* L. Agassiz and Desor, 1846, p. 367.

*Caenocentrotus gibbosus* H. L. Clark, 1912, p. 348.

Grant and Hertlein, 1938, p. 29, pl. 10, figs. 3, 4.

Mortensen, 1943, p. 321, pl. 34, figs. 3, 4; pl.

63, figs. 7, 8, 11, 13, 19.

This is another South American urchin which has not followed the coast north of the equator but unlike the preceding species it has followed

## PLATE 47

- Fig. 27. *Clypeaster ochrus* H. L. Clark, aboral view,  $\times\frac{2}{3}$ , p. 297  
Fig. 28. *Clypeaster rotundus* (A. Agassiz), aboral view,  $\times\frac{2}{3}$ , p. 296

## PLATE 48

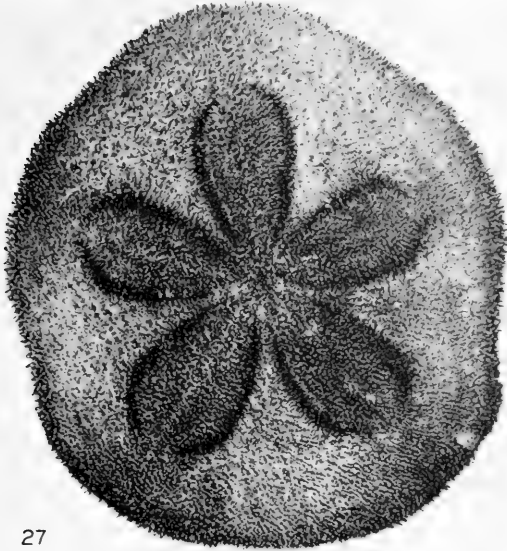
- Fig. 29. *Clypeaster speciosus* (Verrill), aboral view,  $\times\frac{2}{3}$ , p. 308  
Fig. 30. *Clypeaster elongatus*, new species, aboral view,  $\times\frac{2}{3}$ , p. 308

## PLATE 49

- Fig. 31. *Clypeaster elongatus*, new species, oral view,  $\times\frac{2}{3}$ , p. 308  
Fig. 32. *Dendraster excentricus* Eschscholtz, aboral view,  $\times\frac{4}{5}$ , p. 310

## PLATE 50

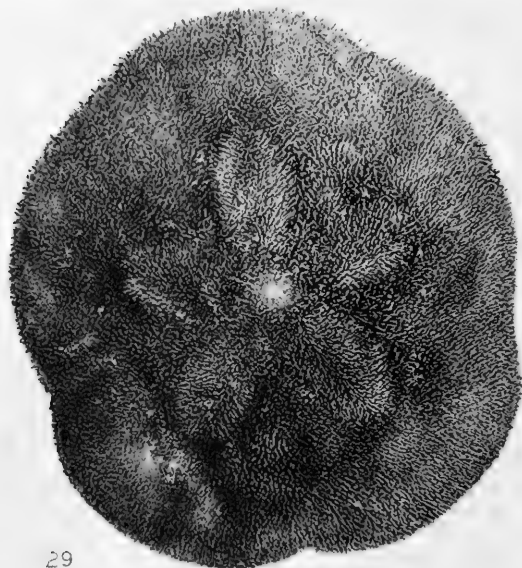
- Fig. 33. *Clypeaster elongatus*, new species, lateral view,  $\times\frac{2}{3}$ , p. 308  
Fig. 34. *Dendraster laevis*, new species, aboral view,  $\times\frac{2}{3}$ , p. 312  
Fig. 35. *Dendraster laevis*, new species, oral view,  $\times\frac{2}{3}$   
Fig. 36. *Dendraster laevis*, new species, aboral view, smooth surface,  $\times\frac{2}{3}$



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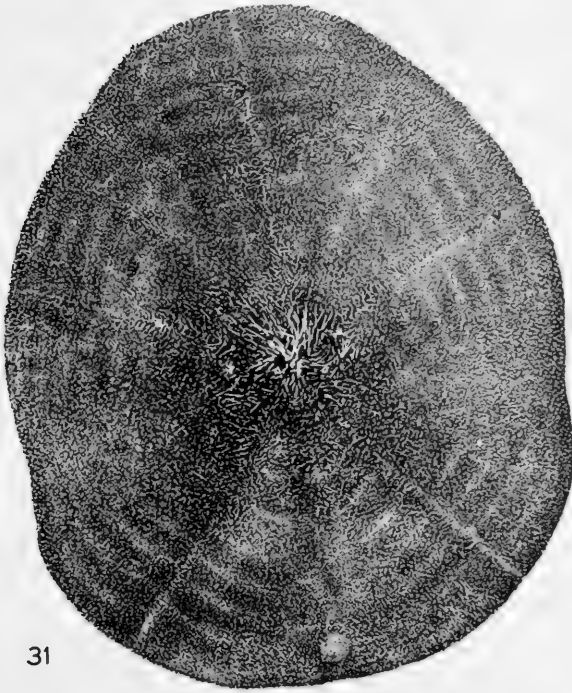
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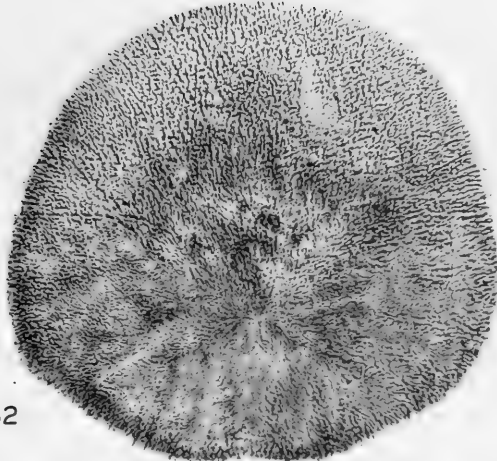
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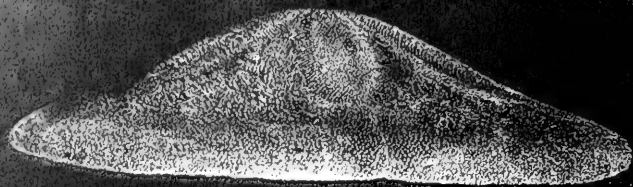
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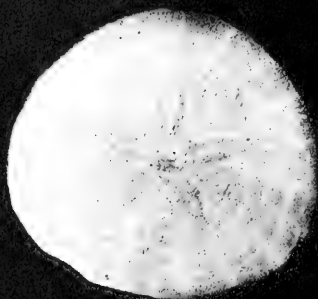
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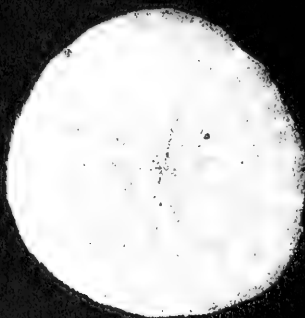
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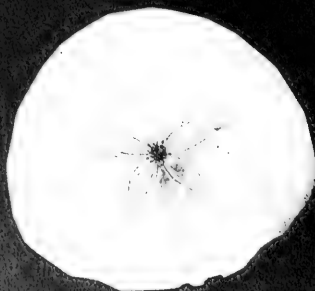
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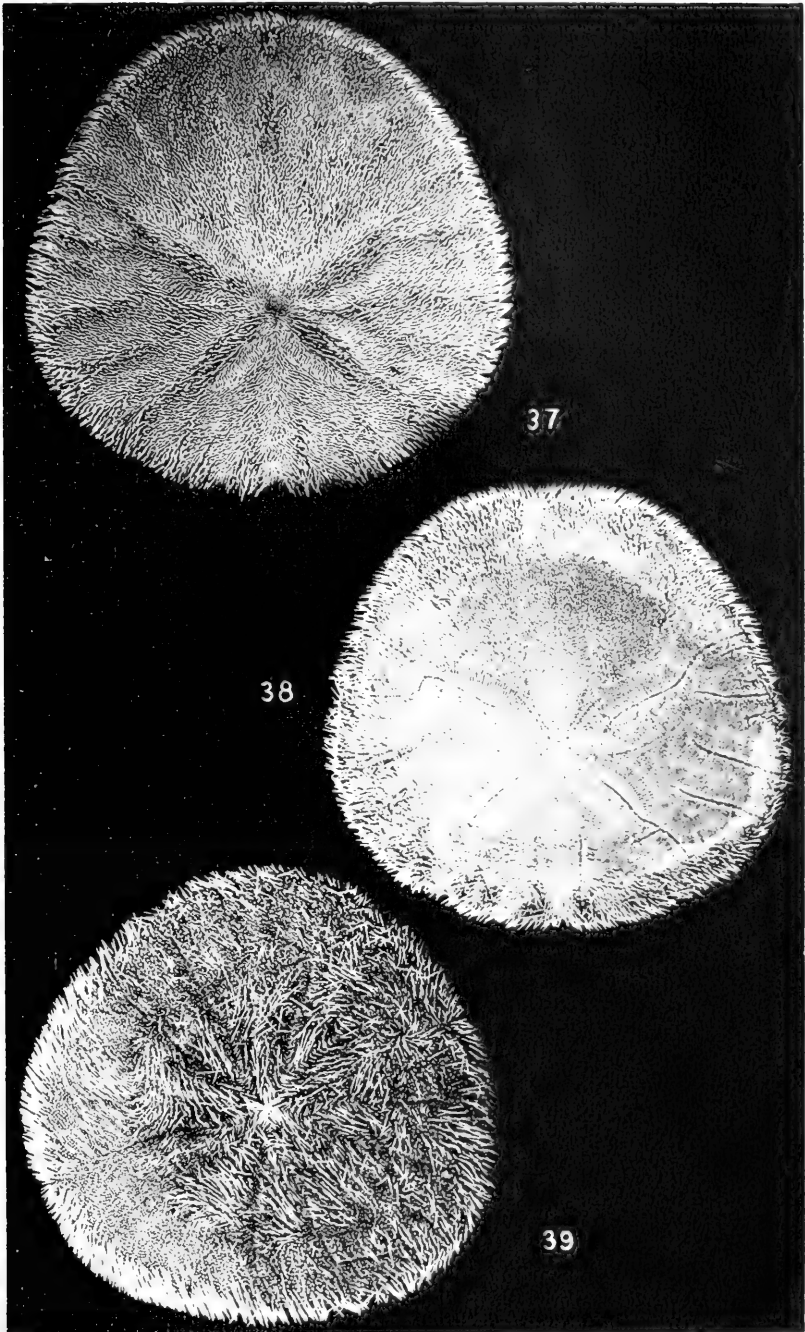


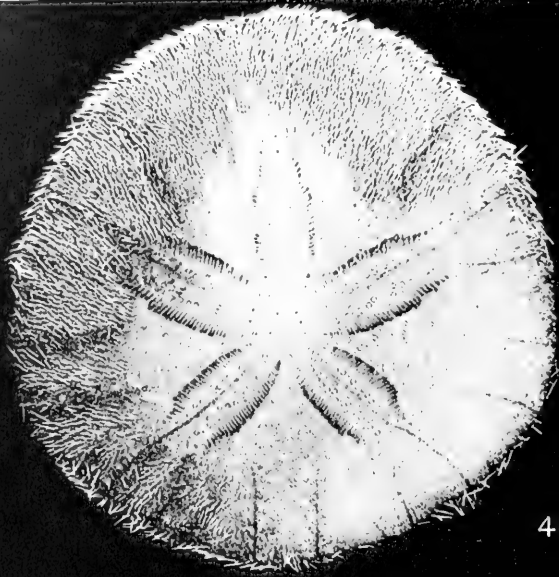
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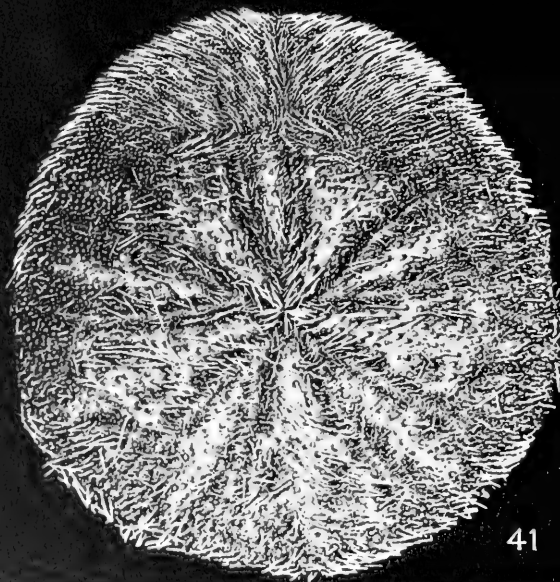
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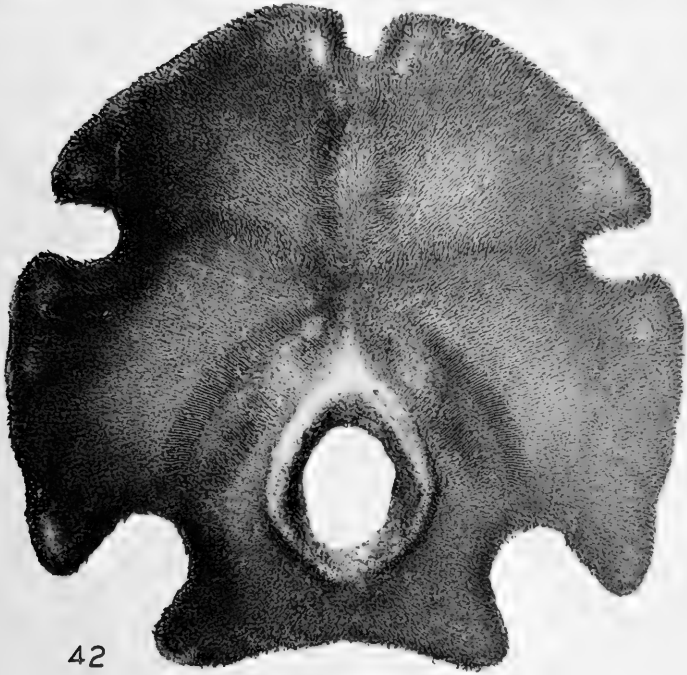




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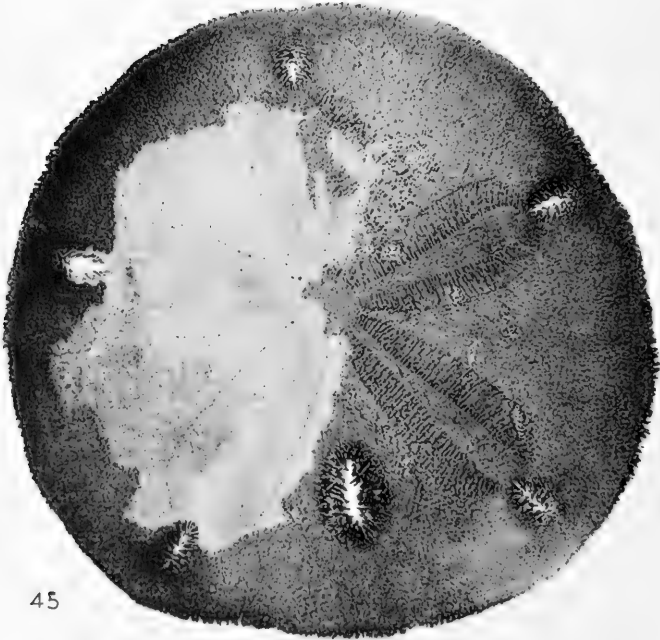
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## PLATE 51

- Fig. 37. *Dendraster mexicanus*, new species, aboral view, rough surface, x1, p. 313  
Fig. 38. *Dendraster mexicanus*, new species, aboral view, smooth surface, x1  
Fig. 39. *Dendraster mexicanus*, new species, oral view, x1

## PLATE 52

- Fig. 40. *Dendraster rugosus*, new species, aboral view,  $x\frac{4}{6}$ , p. 318  
Fig. 41. *Dendraster rugosus*, new species, oral view,  $x\frac{4}{3}$

## PLATE 53

- Fig. 42. *Encope grandis* L. Agassiz, aboral view,  $x\frac{4}{6}$ , p. 325  
Fig. 43. *Encope perspectiva* L. Agassiz, aboral view, x1, p. 326

## PLATE 54

- Fig. 44. *Encope wetmorei* A. H. Clark, aboral view,  $x\frac{2}{3}$ , p. 326  
Fig. 45. *Encope laevis*, new species, aboral view,  $x\frac{2}{3}$ , p. 327

the equator to the Galapagos Islands. Just how it reached the islands cannot be said but judging from the material at hand conditions are not as favorable for it there, as the Peruvian specimens are conspicuously larger and more robust than those from the islands. Of the 82 specimens in the *Velero* collection, 69 are from the Lobos de Afuera Islands, Peru. They range from 30-68 mm in diameter. The tests are usually brown with the spines a deep bronze-green, their tips more or less reddish, but some individuals are distinctly greenish rather than brown. All are more or less deformed at the abactinal system by the presence of the parasitic crab, *Pinnaxoides*. Of the remaining 13 specimens, 2 small individuals are from the northernmost station known for *Caenocentrotus*, the shore of La Plata Isle, Ecuador. They are about 25 mm h. d. and have notably long primary spines. Both are infested with the parasitic crab. Another pair are from Fronton Island, near Callao, Peru, one a mere fragment, the other a good adult, like those from Lobos de Afuera. The other 9 specimens are from the Galapagos Islands, 6 from the reef north of Tagus Cove, Albe-marle Island, one from Tagus Cove, one from Academy Bay, Indefatigable Island, and one from Sullivan Bay, James Island. They range from 24 to 41 mm in diameter, the primary spines are relatively stout, and apparently none are infested with the crab, *Pinnaxoides*. It should be added, however, that other specimens of *Caenocentrotus* from the Galapagos have shown the presence of the crab. Except for the smaller size and shorter spines, the Galapagos *Caenocentrotus* is very similar to the Peruvian.

*Distribution*.—Guayaquil, Ecuador to northern Chile; Galapagos Islands.

*Type*.—Paris Museum.

*Type locality*.—Galapagos Islands.

*Depth*.—Littoral.

*Specimens examined*.—82 specimens from 8 stations.

### *Alloccentrotus fragilis* (Jackson)

Plate 44, Fig. 21

*Strongylocentrotus fragilis* R. T. Jackson, 1912, p. 128.

H. L. Clark, 1912, p. 354, pl. 113, figs. 3-6.

*Alloccentrotus fragilis* Mortensen, 1942, p. 232.

Mortensen, 1943a, pp. 254-255, pl. 30, figs. 10-17.

If a sea-urchin could ever be called a "beautiful" creature, there is no doubt that this species would be a first choice for the title. The delicacy of its test and spines is remarkable and the beauty of their coloring is indis-

putable. Although large and strikingly colored, no specimens seem to have been collected until well into the twentieth century. It is probable that specimens secured accidentally by dredge or trawl were so badly damaged that they were not brought ashore, and the few that escaped that fate were not attractive enough to lead anyone, not a specialist in sea-urchins, to give them any attention. The urchin is so common in the limited area it inhabits that the *Velero* has brought in altogether 240 specimens from 59 stations, ranging in horizontal diameter from 2 mm to just over 100. The height of the low test is usually less than half its diameter, a specimen 80 mm h. d. having a height of about 35 mm. Young individuals are quite flat, a specimen 30 mm across being only 11 mm high. The test is remarkably fragile, only a millimeter thick in a well-grown adult. As a rule the colors are light and often bright. A normal specimen has the test rose red or pink with a more or less violet cast on the upper side, becoming more and more violet orally. The small spines are much the same color but the larger ones are orange or vermilion at base becoming very light, almost white on the distal part. The conspicuous pedicellariae are nearly white. Occasional specimens are much darker, with test dusky purple and dull orange, and the spines dull gray or violet or even brown. When freshly caught or well preserved, either in alcohol or dry, the slender, delicate spines varied, more or less bright colors compel admiration.

*Distribution.*—The *Velero* has taken this fine sea-urchin at 59 stations in depths of 39-380 fms off the coast of southern California. The material collected by the *Albatross* on which the species was based, was taken between northern Washington ( $47^{\circ} 46' N$ ) and the Mexican boundary ( $32^{\circ} 32' 30''$ ) in depths of 48 to 417 fms. The *Velero* took no specimens at any station north of  $34^{\circ} 06' 30''$  or south of  $32^{\circ} 34' 50''$ , in depths of 40 to 380 fms, except one half grown specimen labeled as from Station 1246-41, which is off Cedros Island, Lower California, in 81-83 fms. (There is no good reason for doubting the label with this specimen but it is odd that no other specimens of *fragilis* have been taken in waters south of the United States.) It may properly be considered a definitely North American sea-urchin. According to other authors the range is from Vancouver Island to Lower California.

*Type.*—R. T. Jackson Collection No. 838.

*Depth.*—39-640 fms.

*Type locality.*—Catalina Island.

*Specimens examined.*—240 specimens from 59 stations.

**Strongylocentrotus franciscanus** (A. Agassiz)

Plate 45, Fig. 23

*Toxocidaris franciscana* A. Agassiz, 1863, p. 22.*Strongylocentrotus franciscanus* A. Agassiz, 1872a, p. 163.Mortensen, 1943a, p. 242, pl. 28, figs.  
1-7; pl. 29, figs. 1-4.

There are in the *Velero* collection 343 specimens of *Strongylocentrotus* from 24 stations which are here referred to this conspicuous sea-urchin. In point of size it rivals *Triploneustes*. The latter reaches perhaps a greater diameter of the test, 150 mm as against 146 for the present species but the latter has such long, heavy spines, 50 mm or even more in some individuals, it is evidently the largest of the west coast Echini. Young individuals with a test diameter of 10-15 mm have the relatively slender spines about two-thirds as much, while adults with a diameter of 100 mm or more are satisfied with spines only a third of that. In two specimens at hand from Point Vicente, California, which are rather more than 100 mm in diameter the number of coronal plates (and hence the number of primary spines) is considerably more than normal and the length of the primaries is markedly less, only 20-30 mm. The appearance of these specimens is thus strikingly different from normal specimens but the differences are probably associated with some unusual feature of their habitat, such as excessively strong surf or tidal currents. Further collecting at Point Vicente and study of local conditions might explain this curious anomaly.

The color of normal *franciscanus* when young is a light fawn brown but with growth the color darkens and in most individuals it becomes a very deep purple or even almost black. Curiously enough many individuals instead of becoming very dark remain light colored until half grown and are then a dull and pale "old rose" or pale violet. With increased age and size the dark color becomes predominant and the big adults are nearly if not quite black. Other individuals never become black at all but even when full-grown are light-colored, a peculiar shade of brown, lightest at the base of the spines, darkest near the tips. Curiously enough such specimens if placed in a dilute solution of formalin (4 per cent) to which a pinch of corrosive sublimate has been added turn bright green, strikingly different from any normal shade of the living urchins. On being dried, the green disappears more or less and the urchin becomes brown once more but darker, especially on the distal portion of the spines. It is conceivable that the colors are an indication or a sex dimorphism and an investigation into the matter of a possible correlation of color and sex might prove rewarding.



Another remarkable thing affecting the color is undeniable hybridization of *franciscanus* and *purpuratus*. The hybrids when young have the primaries quite purple or bright violet and shades of these colors persist as the animal grows. The hybrids are distinguishable from *purpuratus* by the smaller number and much greater size of the primary spines, while their unusual color distinguishes them from *franciscanus*. Of course, many specimens are so nearly intermediate, their identification becomes a matter of opinion. A careful study of this hybridization would surely be rewarding.

*Distribution.*—There is no doubt that *franciscanus* is characteristic of the coastal region of the western United States and Canada, and Mortensen reports its occurrence on the Alaskan coast and even in northern Japan. How far south on the American coast its range extends is still somewhat uncertain. Mortensen says Cedros Island, Lower California, is the southern limit and two small specimens in the *Velero* collection from that island and two from Thurloe Bay, near the island, confirm that opinion. There is, however, in the present collection a very good adult specimen from "shore collecting at Petatlan Bay, Mexico," Lat.  $17^{\circ} 31' 45''$ , but this seems quite improbable and needs confirmation. In the vicinity of Newport and Balboa, California, *franciscanus* is common and grows to a large size, but the largest specimens in the *Velero* collection are from shore collecting between Cape Arago State Park and Yaquina Head Light on the Oregon coast.

*Type.*—M.C.Z. no. 1686 (Cotype).

*Type locality.*—San Francisco, California.

*Depth.*—Shore to 50 fms.

*Specimens examined.*—343 specimens from 24 stations.

### ***Strongylocentrotus purpuratus* (Stimpson)**

Plate 44, Fig. 22

*Echinus purpuratus* Stimpson, 1857, p. 86; 1857a, p. 526.

*Strongylocentrotus purpuratus* A. Agassiz, 1872a, p. 165.

Mortensen, 1943a, p. 236, pl. 26, figs. 1-8.

Like *franciscanus*, this species is characteristic of the western coast of North America. It is even more common, the present collection containing over 500 specimens. They show a diversity in spinulation which is more extraordinary than anything shown by any other American sea-urchin. The normal condition is the presence of a double series of primary spines in each ambulacrum and interambulacrum; these spines are about 10 mm long, rather stout and quite acute. Each ambulacral plate carries an additional primary spine, not so large at each end of the plate. Each inter-

ambulacral plate carries a similar but slightly larger spine at each end. Miliary spines are fairly numerous among these primary and secondary spines so the test is normally very completely but not densely covered. The abactinal system of plates is similarly well covered but the peristome is quite free from spines. Many, perhaps most adult specimens differ from this typical spinulation in one of two ways. On the one hand the primary spines are disproportionately bigger, 15 mm or more in length and more than a millimeter thick basally. In extreme cases the primaries are over 20 mm long and 2 mm thick at base. On the other hand, the primary spines increase markedly in number but decrease in thickness and length; they are 6 or 7 mm long and scarcely more than half a millimeter in thickness. This diminution of the primaries occurs for the most part above the ambitus and may continue to such an extent that there are no normal primaries on the upper half of the test, but the whole abactinal surface is covered by a fairly dense coat of small secondary and miliary spines. Whether this condition is due to some feature of the environment such as constant heavy surf or to a diseased condition resulting from parasites or some deficiency of the environment, we do not know, but the result is a sea-urchin whose identity would be difficult to determine without a good series of connecting links.

Aside from environmental conditions modifying structure and appearance, there is no doubt that hybridization with *franciscanus* is a frequent if not a constant factor in the life history of *purpuratus*. As the two species often occupy the same regions and even the same environmental areas, it is not strange that cross fertilization often occurs and as a result many individuals are found whose correct identification is too much for even an experienced taxonomist. Color is the most useful factor in determining the species for typical *purpuratus*; it is at first green and then becomes purple and when large enough to be called adult it is practically entirely purple as the name indicates. The larger species, *franciscanus*, is never purple nor does it have any trace of such purple as characterizes *purpuratus*. Young individuals are light brown, almost or quite a fawn brown, and usually this becomes increasingly dark, until very large adults are a very dark violet brown, sometimes almost if not quite black. But there is never any indication of the purple of *purpuratus*. Hybrids usually show some indication of purple on the primary spines. A second indication of hybridization is seen in the stoutness of the primary spines. While very large individuals of *purpuratus* may have unusually large primary spines they are never equal to the normal spines of *franciscanus*. Oftentimes specimens occur which have the general form and appearance of *purpuratus* but the

primaries are disproportionately stout yet have a purplish tint. Such individuals are probable hybrids. A critical study, in a marine laboratory, of cross fertilization between the two species would yield interesting, perhaps important results.

*Distribution.*—The range of *purpuratus* is given by Mortensen as from Cedros Island, Lower California to Vancouver Island, with a dubious southern limit at La Paz and an equally dubious northern limit at Sitka. He considers it strictly littoral with 20 meters apparently as the bathymetric limit. The *Velero* has secured specimens at 46 stations, of which the northernmost was at Boiler Bay, Oregon, the southernmost at Petatlan Bay, Mexico, Lat. 17° 32' N. As the only other stations south of the United States at which *purpuratus* was secured are at or near Cedros Island, the Petatlan Bay record needs confirmation. Neither the *Albatross* nor the Templeton-Crocker Expedition took *purpuratus* in the Gulf of California, or near La Paz. The specimens labeled Petatlan are undoubtedly *purpuratus* but, as in the case of *franciscanus*, the locality is hard to credit. As for the bathymetrical range of the species, there can be no doubt that it is greater than supposed for the *Velero* took it at several stations in water ranging from 15 to 88 fms. These were young individuals, however, and it is probable the normal habitat of the species is above 15 fms.

*Type.*—U.S.N.M. No. 2495.

*Type locality.*—San Francisco, California.

*Depth.*—Littoral to 88 fms.

*Specimens examined.*—498 specimens from 46 stations.

Family **Echinometridae**  
**Echinometra oblonga** (Blainville)

Plate 45, Fig. 24

*Echinus oblongus* Blainville, 1825, p. 95.

*Echinometra oblonga* Blainville, 1834, p. 225.

*Echinometra mathaei oblonga* Mortensen, 1943a, p. 393, pl. 48, figs. 1-20.

The status of this species or form of *Echinometra* is so perplexing that no two writers seem to have just the same opinion on the matter. Mortensen's treatment of the problem is entitled to the greatest respect, for his wide experience, extraordinary industry and unusual skill in wrestling with such a situation are beyond compare. The only reason for not accepting his conclusion outright is that *mathaei* does not occur in the Eastern Pacific whereas *oblonga* does, and there it intergrades with *VanBrunti* in a perplexing way. The *Velero* collection contains *Echinometras* which seem to be *oblonga* in its most typical form, high, elongated, well-rounded

## PLATE 55

- Fig. 46. *Encope laevis*, new species, oral view,  $\times\frac{2}{3}$ , p. 327  
Fig. 47. *Encope micropora* L. Agassiz, aboral view,  $\times\frac{2}{3}$ , p. 329

## PLATE 56

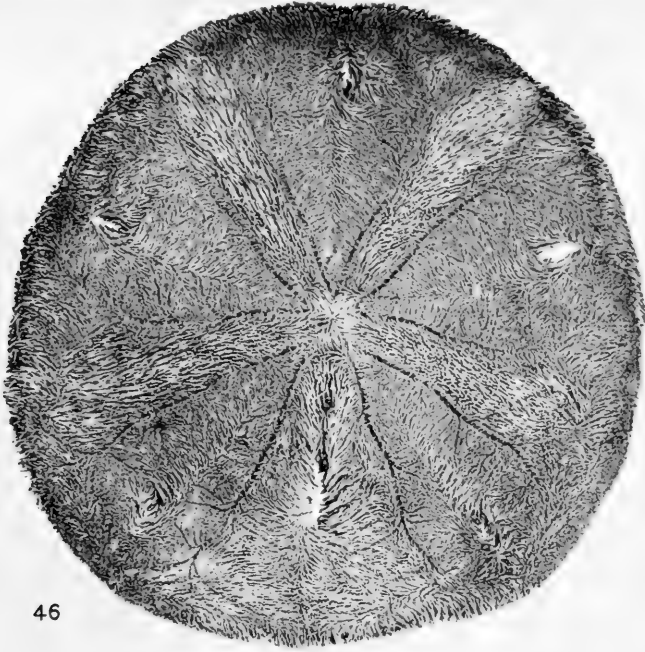
- Fig. 48. *Encope cocosi*, new species, aboral view,  $\times\frac{2}{3}$ , p. 330  
Fig. 49. *Encope cocosi*, new species, oral view,  $\times\frac{2}{3}$

## PLATE 57

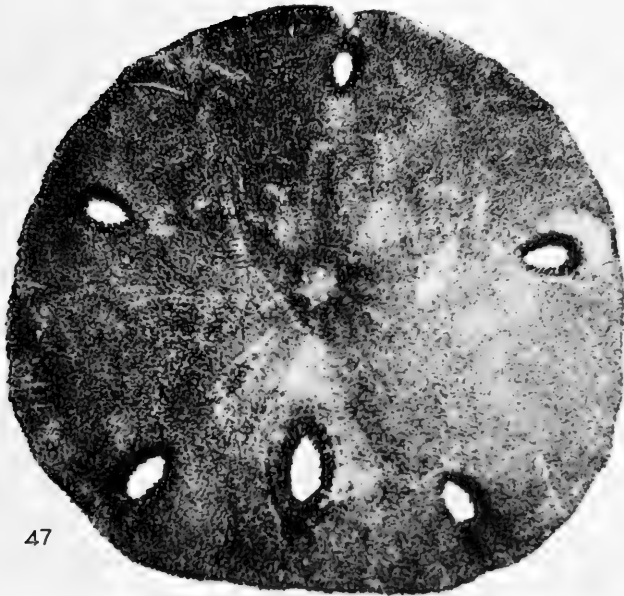
- Fig. 50. *Encope galapagensis* A. H. Clark, aboral view,  $\times\frac{2}{3}$ , p. 331  
Fig. 51. *Encope galapagensis* A. H. Clark, oral view,  $\times\frac{2}{3}$

## PLATE 58

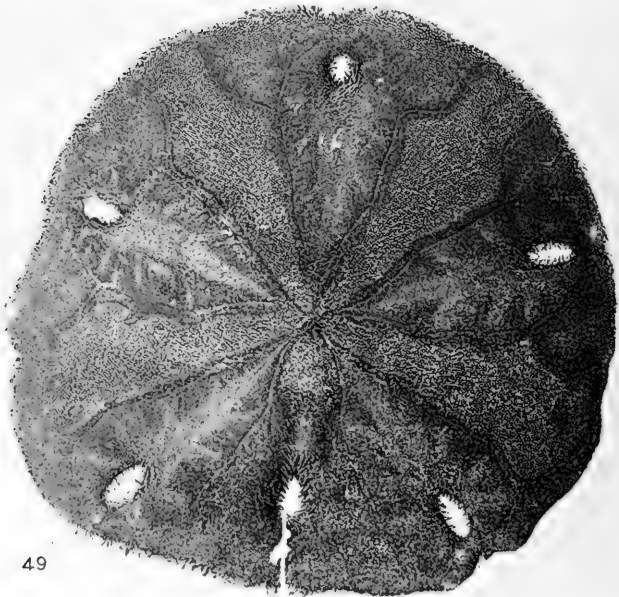
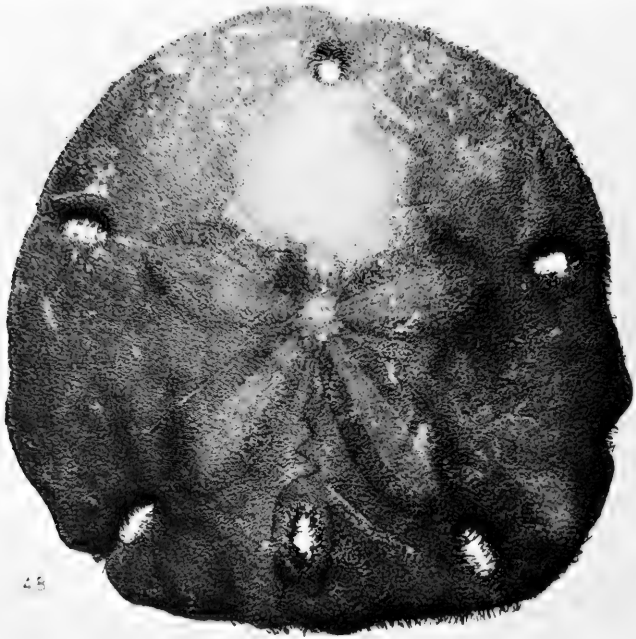
- Fig. 52. *Encope irregularis*, new species, aboral view,  $\times\frac{2}{3}$ , p. 332  
Fig. 53. *Encope irregularis*, new species, oral view,  $\times\frac{2}{3}$



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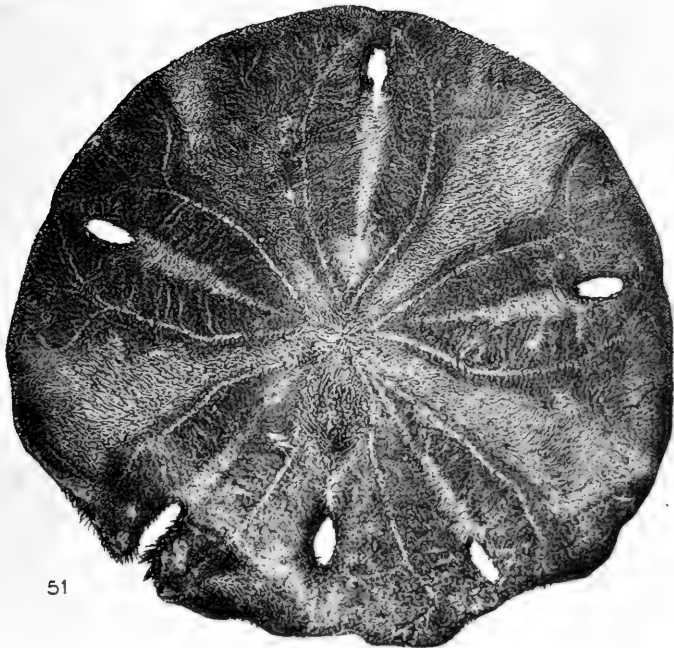


47

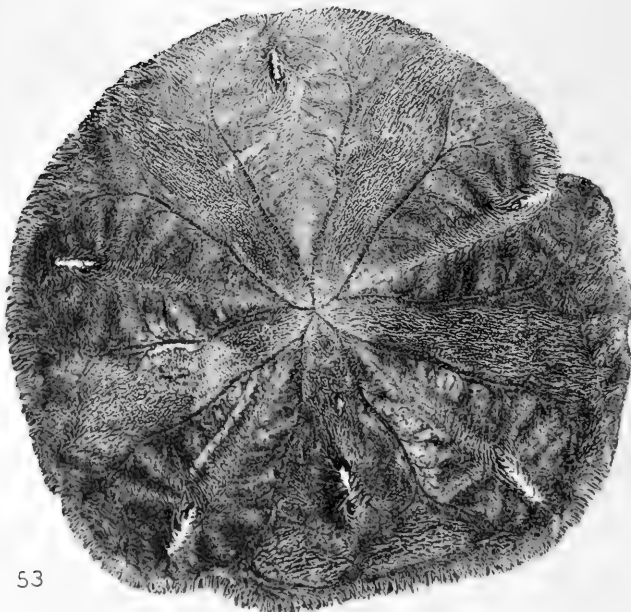




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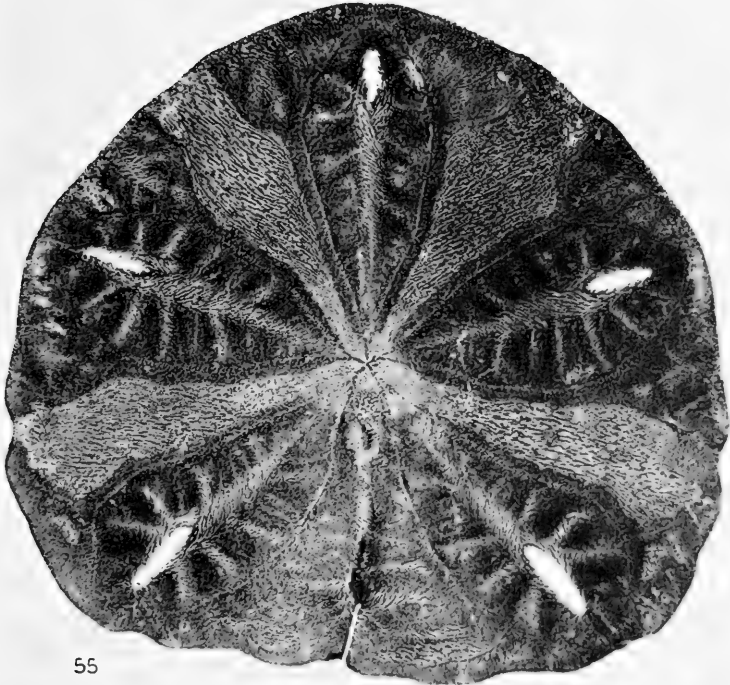
51



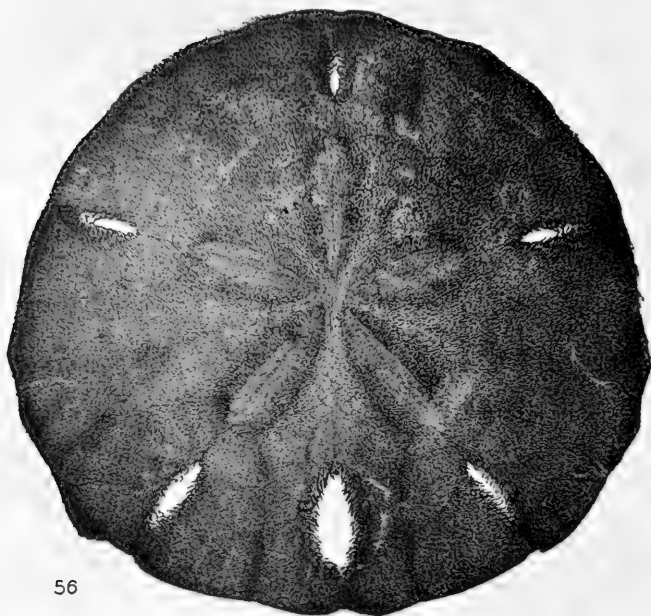




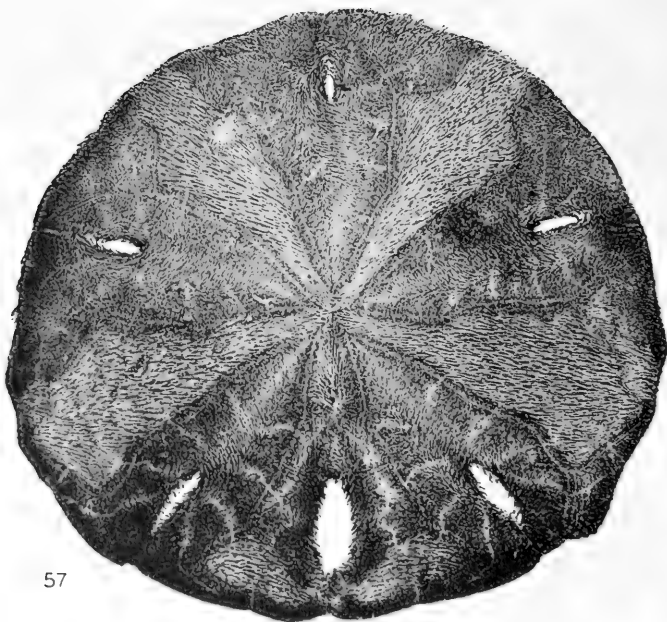
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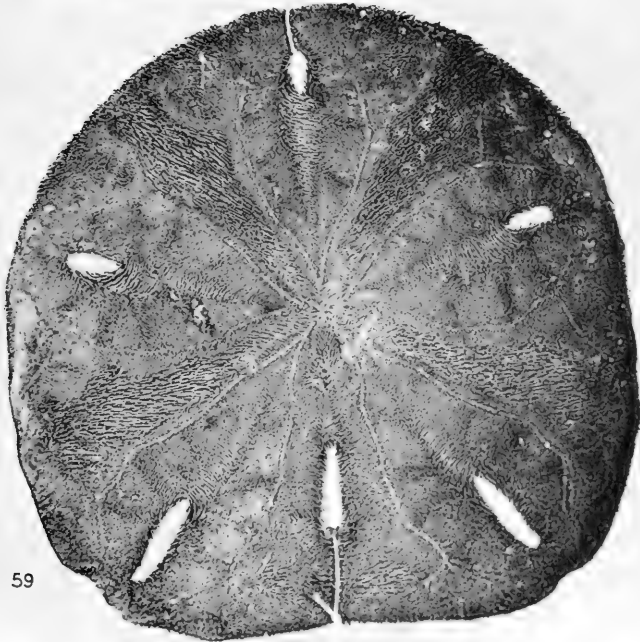
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56

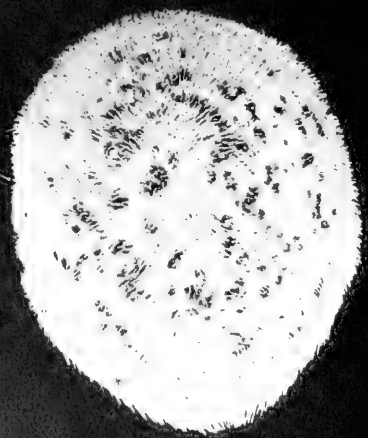


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61

## PLATE 59

- Fig. 54. *Encope ecuadorensis*, new species, aboral view,  $\times\frac{1}{2}$ , p. 333  
Fig. 55. *Encope ecuadorensis*, new species, oral view,  $\times\frac{2}{3}$

## PLATE 60

- Fig. 56. *Encope fragilis*, new species, aboral view,  $\times\frac{2}{3}$ , p. 335  
Fig. 57. *Encope fragilis*, new species, oral view,  $\times\frac{2}{3}$

## PLATE 61

- Fig. 58. *Encope insularis*, new species, aboral view,  $\times\frac{1}{2}$ , p. 336  
Fig. 59. *Encope insularis*, new species, oral view,  $\times\frac{1}{2}$

## PLATE 62

- Fig. 60. *Mellita longifissa* Michelin, aboral view,  $\times 1$ , p. 337  
Fig. 61. *Cassidulus pacificus* A. Agassiz, aboral view,  $\times 3$ , p. 338

test with 4 or 5 rather large ambulacral pores in each arc, and short, stout, pointed primary spines of an almost black color. These spines tend to point upward or definitely forward or backward and give the impression that the urchins live in crevices or fissures in or between rocks. They do not bore holes (as *Echinostrephus* does) but it is possible that they enlarge crevices into which they fit themselves to some extent. Nearly all specimens have the primary spines pointing more or less forward or backward, parallel to the longer axis of the test. The largest specimen is 45 mm long (not including spines), 39 mm wide and 29 mm high. If the spines are included the corresponding measurements are roughly 80 x 55 x 40 mm. The color of all the *Velero* specimens is uniformly very dark but not black as one is inclined to think at first sight. It is rather a very deep purple, as dark in the very young specimens as in the adults. Specimens of the following species (*VanBrunti*) are often nearly as dark but the purple tinge is more evident especially on the oral side. In the shape of the test, this species is clearly more elongated and higher than the Panamic, and the pore-pairs are definitely fewer, only 4 or 5, as against 6 to 8. Hence there is no serious difficulty in identifying *oblonga* as it exists in the Eastern Pacific. The trouble comes in the Western Pacific where the ubiquitous *mathaei* occurs so abundantly that it is difficult to draw any definite line between some of its very dark forms and the similarly dark *oblonga*. I think it must be agreed that *oblonga* is a variety gradually differentiating into a quite distinct species and in the Eastern Pacific it has attained that distinction.

*Distribution.*—The *Velero* has found *oblonga* common at Sulphur Bay, Clarion Island, and at Braithwaite Bay, Socorro Island. A fair-sized adult was taken along shore at Bindloe Island, in the northern Galapagos Islands. Along the western side of South Seymour Island, 7 very young but quite typical *oblonga* were collected and at Cartago Bay, Albemarle Island, an adult specimen was found. But not a single specimen has been secured at Cocos Island or along the Mexican or Costa Rican coast. The indications are that *oblonga* has come from the west and established itself firmly at Clarion Island. From there it has spread to its near neighbor Socorro, and from these two islands it is extending its range southward into the Galapagos Islands but is not yet common there and has apparently reached a southern limit at Albemarle Island.

*Type.*—Unknown.

*Type locality.*—Unknown.

*Depth.*—Shore and very shallow water.

*Specimens examined.*—85 specimens from 12 stations.

**Echinometra VanBrunti** A. Agassiz

Plate 46, Fig. 25

*Echinometra VanBrunti* A. Agassiz, 1863, p. 21.*Heliocidaris stenopora* H. L. Clark, 1912, p. 351, pl. 95, figs. 18-22; pl. 104, figs. 1-3; pl. 110, figs. 4, 5.*Echinometra VanBrunti* Mortensen, 1943a, p. 373, pl. 45, figs. 1-3.

This is apparently the commonest littoral sea-urchin of the tropical Eastern Pacific. The *Velero* collection contains 658 specimens taken at 92 stations. They range in size from young ones, nearly or quite circular, 5 to 10 mm in diameter, to large adults with a long axis exceeding 70 mm. Normal large adults have the lesser diameter nine-tenths of the longer, and the height is very generally about one-half the length. But there is considerable diversity and individuals having the normally lesser axis nearly or quite equalling the longitudinal axis are not very rare. There seems to be no doubt that *Heliocidaris stenopora* H. L. Clark is based on a large *Echinometra Van Brunti* as A. H. Clark, Ziesenhenné and Mortensen have recently pointed out. In the *Velero* collection there are some specimens in which the ambitus is nearly circular but they are commonly less than 40 mm in diameter and not one would be identified as *stenopora*, as the tuberculation of the test is not coarse enough and the primary spines are not sufficiently stout. Mortensen inclines to recognize a variety *rupicola* although it occurs in the same areas as typical *VanBrunti* but the hundreds of specimens in the *Velero* collection do not, in my opinion, warrant the recognition of such a form.

It was hoped and rather expected that among the *Echinometras* in the present collection, there would be from the Galapagos and Socorro Islands, some specimens of *E. insularis* but not one typical example has been found. Some specimens from Costa Rica have only 5 pore-pairs in the ambulacra at the ambitus but they have 6 pairs abactinally and the general appearance and spinulation is like that of *VanBrunti* from the same region. Unfortunately there is but a single young individual from Clarion Island, and only two lots from Socorro. This series includes one very large adult and 32 small ones and they are typical *VanBrunti*. There are 78 specimens from some 20 stations in the Galapagos but none of them represent *insularis*, which justifies the suspicion that that supposed species is not really valid.

The color of *VanBrunti* is remarkably uniform although the shade shows no little diversity. The basic color may be designated as violet especially when seen from below. There is a tendency on the one hand

towards gray and on the other towards black. As a rule specimens from any one locality are much alike in color though large specimens may be darker than small ones. There is never any white nor any hint of green, but suggestions of a red violet are sometimes evident, and very young specimens (under 15 mm h. d.) may have a very definite red orange or a dull yellow tint around the peristome.

*Distribution*.—According to Mortensen, this sea-urchin occurs as far north as “off Central California,” but the *Velero* has not found it north of the Mexican boundary. Indeed she has not taken it anywhere on the western side of Lower California, although she has found it at various points in the Gulf as far north as Guaymas and Angel de la Guardia Island. It is common on the Mexican and Costa Rican coasts and in Panamic waters. Further south it has been taken by the *Velero* at various points on the coasts of Colombia, Ecuador, and Peru as far south as the Lobos de Afuera Islands. At the Galapagos Islands, it is quite common, being taken at more than 20 stations though never in large numbers. Some typical specimens were secured at Cocos Island and one good series was collected at Braithwaite Bay on Socorro. A single young specimen was collected at Clarion Island, but the *Echinometras* of Clarion Island need further collecting and study.

*Type*.—M.C.Z. no. 1851 (Cotype).

*Type locality*.—Acapulco, Mexico.

*Depth*.—Shore to 29 fms.

*Specimens examined*.—658 specimens from 92 stations.

Order **EXOCYCLOIDA**  
Family **Clypeastridae**  
**Clypeaster europacificus** H. L. Clark  
Plate 46, Fig. 26

*Clypeaster europacificus* H. L. Clark, 1914, p. 27, pls. 129, 130, 131, 136, fig. 1.

The 102 specimens of this fine *Clypeaster* taken by the *Velero* form a very complete series from the babies 16 x 15 mm to the full grown adults just exceeding 200 mm in length. The largest specimen is 202 mm long by 200 mm wide and 30 mm high; the test margin is about 6 mm thick. In most specimens the width of the test is not so great proportionately, a normal adult is 184 by 174 mm with the height 27 mm. The young are nearly or quite circular and many individuals continue so throughout life. Some, however, elongate appreciably; the longest of the present series have the width nine-tenths of the length. As a rule the height is about 15



per cent of the length but occasionally it is appreciably more, in extreme cases it may be 30 per cent. The general texture of the test is not very stout and hence injuries to the margin are rather frequent resulting in more or less conspicuous deformities. One specimen about 113 mm in length, with the width somewhat less, has the central portion of the petaloid area abruptly raised and flattened, resulting in a curious hat-shaped form as seen from the side.

Color undergoes very considerable change with the growth. The youngest specimens are pale red violet, almost pink, above and cream color or nearly white below. With increasing size the color deepens. The upper surface becomes a deeper and more purple pink, violet, deep violet, brown violet, brown either yellowish or violet tinted, until in old specimens the very dark brown of the adult is reached. The ambulacral areas are often of a different shade so that the petals stand out more or less clearly. The cream-colored lower surface of the very young, becomes brownish yellow, yellow brown and ultimately a deep brown. In very old specimens there is a tendency for the ambulacral areas to darken and they may become more or less black at least along the midline. The dark shades of dried adults show considerable diversity, some specimens being quite gray. Young specimens, 25 mm or so in diameter may become deep violet above quite early, but occasionally remain light pink until sometime after that size is reached.

*Distribution.*—The original material on which the species was based came from the Gulf of California, Clarion Island, Hood Island in the Galapagos, and Panama. The *Velero* has extended that range very little, except to the south; the present collection contains a nice set of 12 small specimens, 25-70 mm long, from off La Plata Island, Ecuador, in 45-55 fms. In the Galapagos area only once was *europacificus* met with—a single specimen in Academy Bay, Indefatigable Island in 10-25 fms. It was not found at Clarion or Socorro Islands. From Panama, Costa Rica and Mexico a number of specimens were secured but the bulk of the material, more than 60 specimens, was taken in the Gulf of California, at various points up to Angel de la Guardia Island. The bathymetric range of this *Clypeaster* seems to be from 10 to 95 fms.

*Type.*—U.S.N.M. No. 34226.

*Type locality.*—Bay of Panama, 7° 57' N, 78° 55' W, 33 fms.

*Depth.*—10-95 fms.

*Specimens examined.*—102 specimens from 24 stations.

(Very likely this species is identical with Pfeffer's *Alexandria magnifica*. Th. Mortensen)

**Clypeaster rotundus** (A. Agassiz)

Plate 47, Fig. 28

*Stolonoclypus rotundus* A. Agassiz, 1863, p. 25.*Clypeaster rotundus* A. Agassiz, 1872a, p. 100.

H. L. Clark, 1914, p. 38, pls. 132, 133.

Although adult specimens of this *Clypeaster* are easily distinguished from the preceding, the young, before reaching a length of 25 mm are very difficult to determine. They are nearly or quite circular, or a little longer than wide, and very flat. The lower surface, at first nearly white becomes yellowish, and as a rule is soon yellowish-brown, as in *europacificus*. The subsequent color changes are similar in the two species but the body form is usually characteristic, for *europacificus* has the interradial margins more or less evidently concave or at least straight, resulting in a pentagonal form with the length only a little, if at all, greater than the breadth. In *rotundus* the interradial margins are more or less convex, and the outline may be nearly circular, but as a rule the length is somewhat greater than the width. The largest specimen in the present collection is 175 mm by 160; the height is 27 mm, but a second specimen with the same length and breadth is only 20 mm high. The most nearly circular adult at hand is 146 mm long by 137 mm wide, but a specimen 37 mm long is 36 mm wide.

*Distribution*.—There are 96 specimens in the *Velero* collection from 35 stations, well scattered along the coast from Santa Elena Bay, Ecuador to Georgia Island at the upper end of the Gulf of California. There are no records from the western coast of Lower California nor from anywhere above the Mexican boundary. There are 9 specimens from Clarion Island but none from Socorro. From Cocos Island there are two small specimens, dredged in relatively deep water, 30-50 fms. There are 20 specimens from 9 stations in the Galapagos Islands, but chiefly from Tagus Cove, Albatross Island. Some were taken in shallow water along shore but they were mostly dredged in 8-50 fms.

*Type*.—M.C.Z. no. 2188.

*Type locality*.—Acapulco, Mexico.

*Depth*.—Shore to 50 fms.

*Specimens examined*.—96 specimens from 35 stations.

**Clypeaster ochrus** H. L. Clark

Plate 47, Fig. 27

*Clypeaster ochrus* H. L. Clark, 1914, p. 30, pl. 141, figs. 1-3.

There can be no doubt of the close relationship between this species and *speciosus* but after a prolonged study of all the *Velero Clypeasters*, it seems best to maintain *ochrus* as at least an incipient species. Typical specimens in good condition are easily recognized, but immature or badly preserved individuals cause trouble. Moreover well-preserved specimens of the two species may be so much alike in color that it is very hard to determine to which species they belong but the greater height of the test with its somewhat greater concavity can usually be relied upon to distinguish *ochrus*; in *speciosus*, the height is about one-fifth of the length, in *ochrus* it is one-fourth. In the *Velero* collection, there are 47 *Clypeasters* which may be referred to *ochrus*. They range from 5 to 114 mm in length but the most typical is 104 x 96 mm with a height of 28 mm, the mouth is sunken 12 mm below the test margin. The characteristic color is a yellow brown with the petaloid areas and the lower surface dark brown in rather marked contrast, but most of the specimens from Cocos (Nuez) Island, Costa Rica, Panama and Ecuador are chocolate brown or purple brown of a more or less deep shade, rarely, however, as deep as in *speciosus*. One young specimen (48 x 44 mm) from James Island, Galapagos, in 10 fms is red purple, rather dull above but quite bright orally. The smallest specimen (5 mm), also from James Island, is a uniform light brown while the next largest (8 mm), from Ecuador, has the upper surface red violet.

*Distribution*.—The most typical specimens are from Ecuador, Colombia and the Secas Islands, Panama, but very good specimens are from Albemarle Island in the Galapagos. A large number of *Clypeasters* dredged at Nuez Island, off Cocos Island, in 31-50 fms are best referred to this species although the only adult from this locality is very dark colored. It has, however, the proportions and general appearance of *ochrus*. No specimens of *ochrus* were taken north of Costa Rica. Records from other authors extend the known distribution as far north as La Paz, Lower California.

*Type*.—M.C.Z. no. 4740.

*Type locality*.—Acapulco, Mexico.

*Depth*.—Shore to 50 fms.

*Specimens examined*.—47 specimens from 15 stations.

## PLATE 63

- Fig. 62. *Agassizia scrobiculata* Valenciennes, aboral view,  $\times\frac{2}{3}$ , p. 339  
Fig. 63. *Agassizia scrobiculata* Valenciennes, lateral view,  $\times\frac{4}{3}$

## PLATE 64

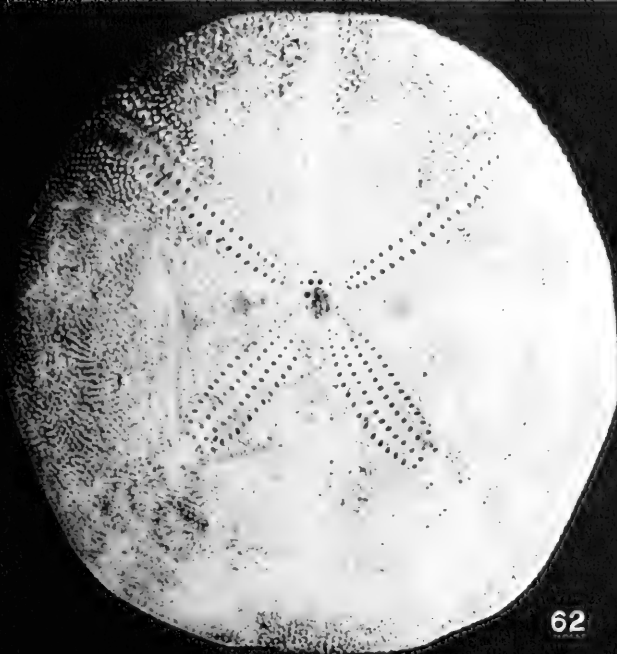
- Fig. 64. *Brisaster townsendi* (A. Agassiz), aboral view,  $\times\frac{2}{3}$ , p. 340  
Fig. 65. *Moira clotho* (Michelin), aboral view,  $\times\frac{8}{3}$ , p. 341

## PLATE 65

- Fig. 66. *Brisopsis pacifica* (A. Agassiz), aboral view,  $\times\frac{4}{3}$ , p. 341  
Fig. 67. *Brisopsis pacifica* (A. Agassiz), oral view,  $\times\frac{4}{3}$

## PLATE 66

- Fig. 68. *Plagiobrissus pacificus* H. L. Clark, aboral view,  $\times 1$ , p. 342  
Fig. 69. *Plagiobrissus pacificus* H. L. Clark, oral view,  $\times 1$   
Fig. 70. *Plagiobrissus pacificus* H. L. Clark, lateral view,  $\times 1$



62



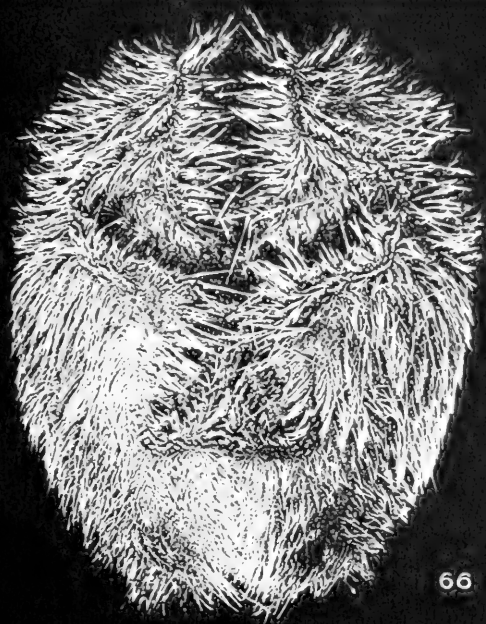
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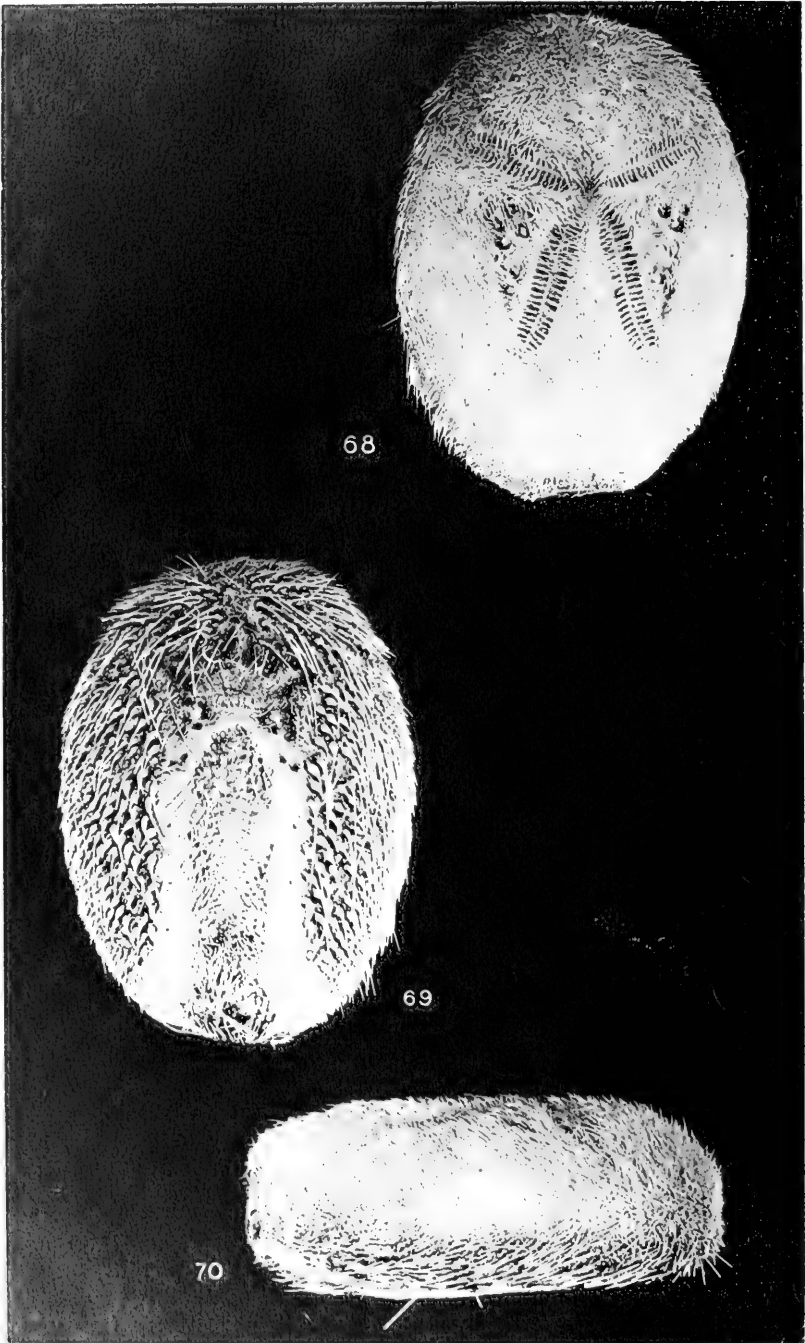
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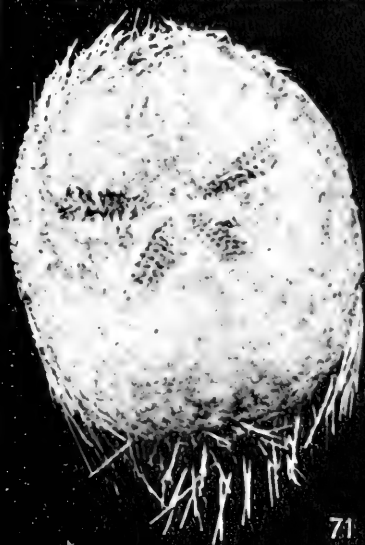


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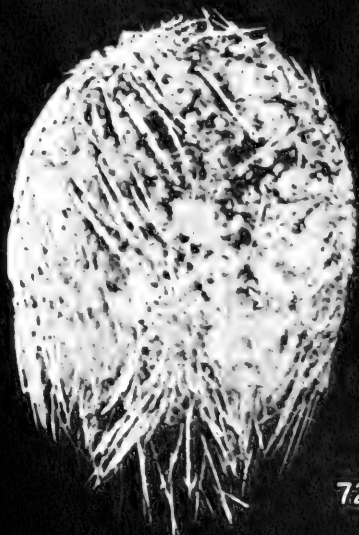
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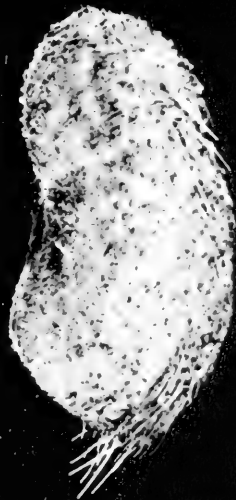




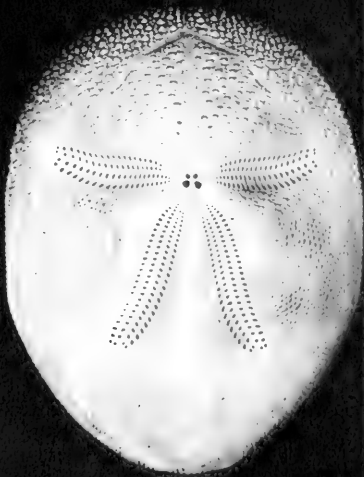
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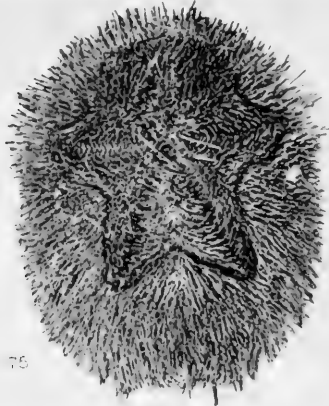
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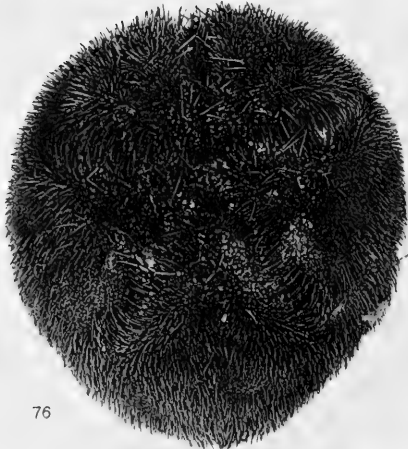
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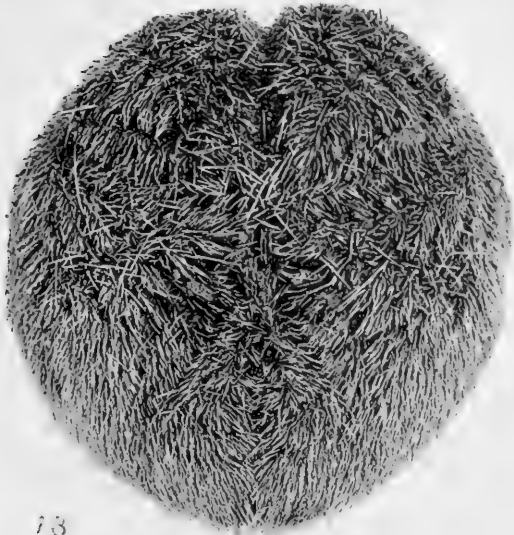
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## PLATE 67

- Fig. 71. *Ibiobryssus coelus* H. L. Clark, aboral view,  $\times\frac{8}{3}$ , p. 343  
Fig. 72. *Idiobryssus coelus* H. L. Clark, oral view,  $\times\frac{8}{3}$   
Fig. 73. *Idiobryssus coelus* H. L. Clark, lateral view,  $\times\frac{2}{3}$   
Fig. 74. *Brissus latecarinatus* (Leske), aboral view,  $\times\frac{2}{3}$ , p. 343

## PLATE 68

- Fig. 75. *Brissus latecarinatus* (Leske), aboral view with spines,  $\times 1$ , p. 343  
Fig. 76. *Meoma grandis* Gray, aboral view, rough,  $\times\frac{1}{2}$ , p. 344  
Fig. 77. *Meoma grandis* Gray, aboral view, smooth,  $\times\frac{1}{2}$

## PLATE 69

- Fig. 78. *Spatangus californicus* H. L. Clark, aboral view,  $\times\frac{1}{5}$ , p. 345  
Fig. 79. *Spatangus californicus* H. L. Clark, oral view,  $\times 1$

## PLATE 70

- Fig. 80. *Gonimaretia laevis* H. L. Clark, aboral view,  $\times 2$ , p. 347  
Fig. 81. *Gonimaretia laevis* H. L. Clark, oral view,  $\times 2$

**Clypeaster speciosus** Verrill

Plate 48, Fig. 29

*Clypeaster speciosus* Verrill, 1870a, p. 95.

H. L. Clark, 1914, p. 31, pl. 135, figs. 1, 2; pl. 136, fig. 5.

This is the common *Clypeaster* of the Gulf of California and the *Velero* collection contains 143 examples of it, ranging in size from young ones (6-20 mm long) whose specific identity may perhaps be debatable, to full grown adults 120-130 mm long. The width is usually about 90 per cent of the length, but shows considerable diversity ranging from 87 to 95 per cent. The color seems to be very constantly dark purple approaching black; but very young specimens are reddish violet, and orally lighter than on the upper side. The resemblance to the preceding species has been discussed above so that little need be said here, but it may be again emphasized that the line between the two species is often invisible.

*Distribution.*—This *Clypeaster* is pre-eminently characteristic of the Gulf of California and the *Velero* has not found it anywhere outside the Gulf save at Socorro Island, where a fine series of specimens was secured, and at Clarion Island, where two adults and a half a dozen young *Clypeasters* were taken which may well be referred to *speciosus* for the present. As far north in the Gulf as collecting was done this *Clypeaster* occurs, but south of the Gulf, it is apparently replaced by the preceding species.

*Type.*—Peabody Museum, Yale University. "None designated as type." (Stanley C. Ball)

*Type locality.*—La Paz, Gulf of California.

*Depth.*—Shore to 50 fms.

*Specimens examined.*—143 specimens from 20 stations.

**Clypeaster elongatus**<sup>6</sup>, new species

Plate 48, Fig. 30; Plate 49, Fig. 31; Plate 50, Fig. 33

Length 111 mm, breadth 89 mm, height 27 mm; the breadth is thus only .80 of the length, the height about .25. Mouth sunken 15 mm below the sides of the test. Test rather evenly elevated from margin to apex, perceptibly thinner posteriorly. Orally the test is flat near the margins but soon begins to slope to the mouth. Petaloid area about 70 mm long by 60 mm wide. Tuberculation of test quite close and fine with 200 or more tubercles to the square centimeter and 25 or so miliary tubercles to the square millimeter; the tuberculation is slightly more sparse orally than on

<sup>6</sup> *elongatus*=elongated in reference to the form of the test.

the upper side. Ridges between pore-pairs of unpaired petal (except adapically) with 7 or 8 tubercles rather close together; the miliary tubercles on these ridges scarcely more numerous. Madreporite rather small, about 3 mm across; ocular pores minute, but evident; genital pores distinct but not very large. Unpaired petal nearly 40 mm long, and about 17 mm wide, the interporiferous area some 9 mm, where widest, near middle; there are about 60 pore-pairs on each side and they nearly meet at tip so the petal is virtually closed. Anterior petals rather more than 30 mm long, and 17 mm wide, elliptical rather than oval, and only very slightly open at tip. Posterior petals, similar but longer (36 mm) and wider (19 mm), scarcely more open at tip. Periproct about 5 mm across, scarcely longer than wide, some 3 mm from the test margin, covered with numerous miliary-bearing plates.

Primary spines smooth and blunt, dorsally about 2 mm long but somewhat longer orally and near the mouth they may be 4 or 5 mm long. They are blunt and seem fragile; they may be slightly flattened or thickened at tip but are not noticeably widened. Miliary spines as long as the primaries and excessively slender; with the larger spines they form a close dense coat on the dorsal side; orally they are less numerous and hence the covering of the oral side is notably less dense than dorsally. Pedicellariae numerous and large; there is great diversity in the size but nearly all are tridentate and none are characteristic.

Color of the dry specimen is vinaceous to Hay's brown, aborally; orally the vinaceous tint is more or less replaced by clay color. The oral spines are clay color or lighter with the middle, and often most of the distal half definitely dark vinaceous brown on the upper or outer side.

The unique holotype of this *Clypeaster* was taken December 13, 1934, at Station 347-35 off North Seymour Island, in the Galapagos Islands, on a bottom of sand, rock and shell, in 3 fms. It was first referred to *rotundus*, later to *ochrus* or *speciosus*, but the long, narrow and high test, the unusual coloring and the shape of the petals, preclude reference to any of these known species. Among the scores of *Clypeasters* in the Hancock collection this individual stands out unique. It seems best to give it a name, even if additional specimens are never taken.

*Type*.—Holotype, AHF no. 47.

*Type locality*.—Station 347-35, off North Seymour Island, Galapagos Islands, 3 fms, December 13, 1934.

*Distribution*.—Type locality.

*Depth*.—3 fms.

*Specimens examined*.—The type specimen only.

Family **Scutellidae**  
**Dendraster excentricus** Eschscholtz  
Plate 49, Fig. 32

*Scutella excentrica* Eschscholtz, 1831, p. 19.

*Dendraster excentricus* L. Agassiz and Desor, 1847, p. 135.

*Echinarachnius excentricus* A. Agassiz, 1873, pl. 13a, figs. 1-4.

There are literally thousands of specimens of this common and characteristic west coast sand-dollar in the *Velero* collection but as rather more than eleven thousand are young individuals less than 10 mm in diameter they offer no help in the almost hopeless attempt to distinguish reliable specific and varietal lines in the mass of material at hand. Leaving obviously very youthful specimens out of account, there are approximately 750 specimens to which it should be possible to attach varietal if not specific names, for the alternative of calling them all *excentricus* is simply an evasion of the problem. After long and critical study of all the usable specimens which are past 30 mm in diameter, and of scores of smaller specimens as well, it seems necessary to recognize 3 species and one named variety in addition to the long known *excentricus*. It should be added at once that this does not leave *excentricus* a constantly well-defined species. Far from it! In the material here identified as *excentricus* sens. str. there are many specimens which differ obviously from a typical individual, though they come from the same region and even from the same station. In the absence of still more abundant material, the only practicable course is to list them as *excentricus*, pointing out the features in which they are puzzling.

Normal specimens may reach a very large size, the largest coming from the northern stations. Specimens from the Oregon coast are frequently 75 mm long, 80 mm wide and 12-14 mm high (or thick); the largest in the *Velero* collection is 87 mm long and 95 mm wide. Ordinary specimens from Monterey and southward are usually less than this, a typical specimen being 65 x 70 x 9 mm but there is a great deal of diversity in shape and stoutness. Among the Channel Islands and south to Corona del Mar, this sand-dollar is very common in shallow water, from low water mark down to at least 40 fms. South of the Mexican line there seems to be a tendency to a more elongate form and a variety *elongatus* was described in 1935 (H. L. Clark, p. 122). The present collection contains few specimens that can be referred to this variety and 8 of these are young bare tests (bleached), 7 from the vicinity of Cedros Island, Lower California and 1 from off San Nicolas Island, California. A fifth specimen is very different in appearance from these tests for although it is also



bare it is not at all bleached but is a fine shade of brown, with the dark brown lines of the posterior half of the test (one of the supposed characters of *elongatus*) very conspicuous. It is from Laguna Beach, California, and measures 62 x 63 x 9 mm. One other specimen, also bare and not bleached, measures 39 x 37 x 5 mm and is of the same color and texture as specimens of the same size of the species of *Dendraster* described below as *laevis*. The petaloid area shows clearly that it is not *laevis* and hence it would seem to be an odd *elongatus*.

Several other specimens show peculiarities that distinguish them as not normal. Two of these deserve a few words of description. The smaller, although not truly circular measures 43 x 43 mm. The anterior petal is long and narrow with a relatively uncrowded tuberculation, while the anterior paired petals are notably long and open at the tip. The color is a brown orange, particularly bright on the oral surface. It was taken north of Anacapa Island, California, in 15 fms. The other peculiar specimen measures 55 mm long by 61 mm in breadth. The anterior margin is nearly straight for about 15 mm while the posterior is straight for 20 mm or more. The apex of the test is about 30 mm from the anterior margin but the madreporite and the adjoining petal-bases are only 18 mm from the posterior margin. Associated with this, the lateral petals are unusually diverging, the tips of the posterior pair being 22 mm apart. The anterior pair are also markedly diverging and very long, their tips 35 mm apart. The color of the test where bare is dull purple. The dense coat of spines is more or less orange or yellow but the color of the test is dominant on the upper surface; hence the general effect of the upper side is dark, dull brown orange; the lower side is predominantly brown orange.

Coloration in *excentricus* is generally dull but shows a considerable diversity. The specimens from Oregon are essentially gray, the lighter with a tendency to cream color or dull white, especially orally, the darker ones to a dusky brown or even black. Most California specimens tend towards either a dull violet black or a bright maroon brown; the latter in some cases might be called dark red. Owing to the dense coat of spines on the lower surface, the oral side is usually lighter or more brightly colored than the upper. As *Dendrasters* often congregate in great numbers on suitable bottoms, they tend to crowd each other into a more or less vertically inclined position and thus lie tier upon tier on a rough bottom over which the tidal currents flow back and forth. As a result of this the anterior fourth (more or less) of the animal becomes bleached to some degree while the not buried part remains dark. This peculiar bicoloration may be quite striking.

*Distribution.*—The *Vclero* has taken *excentricus* at 42 stations, of which the northernmost was on the Oregon coast, 43° 41' N Lat. and the most southern near the tip of Lower California. No specimens have been taken at the Galapagos Islands or near any of the off shore islands. The great bulk of the material is from shallow water, out to about 20 fms, for the most part, but a few specimens have been taken in 40-50 fms and one specimen is labeled as from 113-127 fms, southeast of Marcial Point on the east coast of Lower California. There is perhaps some mistake about this label as no other specimens are known from the Gulf. Other authors extend the range to Alaska.

*Type.*—Unknown.

*Type locality.*—"An der Küste der Insel Unalashka, am Kamtschatischen Meere." (Grant and Hertlein, 1938, p. 84)

*Depth.*—Shore to 50 fms.

*Specimens examined.*—Approximately 12,316 specimens from 42 stations.

### ***Dendroaster laevis*<sup>7</sup>, new species**

Plate 50, Figs. 34-36

Length 52 mm, breadth 57 mm, height 6 mm; the breadth is thus markedly greater than the length; in young specimens, however, the length may be greater, a specimen 30 mm long is only 28 mm wide; the largest specimen is 68 mm long, 75 mm wide and 8 mm high. Lower surface perfectly flat, the mouth not depressed at all. Both mouth and periproct are remarkably small, the former 2 mm, the latter scarcely 1 mm across. The petaloid area is remarkably small, only about 26 mm long by 29 mm across; the apex is 30 mm from the anterior margin. Anterior petal is longest but the anterior paired petals are nearly as long, 15 to 15.5 mm; posterior petals about 11 mm. All the petals are about 6 mm wide. The pore-pairs are so small and the tuberculation of the whole test is so fine, there are no very evident distinctive features, but the pore-pairs make a single narrow band along each side of each petal; the intermediate area is quite uniformly covered with minute tubercles. The four genital pores are quite evident but the ocular pores are indistinct. Both above and below the outlines of the plates composing the test are clearly shown and the pattern they make is striking. This feature is not at all evident in either the larger specimens or in the bare tests but it is a very handsome feature of the holotype. Primary spines short and slender, knobbed at the tip,

<sup>7</sup> *laevis*=smooth, in reference to the remarkably close coat of delicate spines.

lying flat and close so that the surface of the test is relatively smooth, quite unlike the condition in the other species of the genus. Pedicellariae very small and not abundant or peculiar. At each mouth angle is a group of 8-10 slender, acute primary spines, lying almost horizontally over the mouth. Color old gold orally, more nearly deep colonial buff aborally. In the largest specimens the color is very dull, especially on the upper side; orally the yellow-brown shade is very evident.

This very distinct species was taken by the *Velero* at 9 stations between San Miguel Island, California, and the Coronados Islands, Mexico, in 4-30 fms. While most of the 118 specimens are young or very young, large adults were taken at 5 stations. The young are commonly quite yellow but the big adults are rather dull colored. A bare test when carefully cleaned revealed well the extraordinarily small petaloid area. The very small size of mouth and anus is another striking feature.

*Type*.—Holotype, AHF no. 48, 82 paratypes.

*Type locality*.—Station 976-39, north of Santa Barbara Island, California, 15-20 fms, May 28, 1939.

*Distribution*.—Channel Islands, California to Coronados Islands, Mexico.

*Depth*.—4-30 fms.

*Specimens examined*.—The type, paratypes and 35 specimens, from 9 stations.

### ***Dendraster mexicanus*<sup>8</sup>, new species**

Plate 51, Figs. 37-39

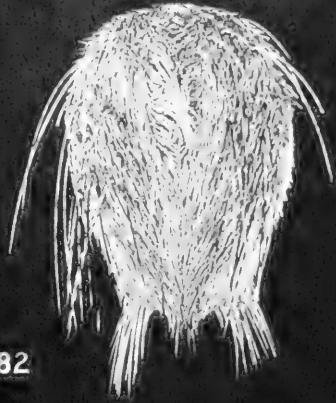
Length 60 mm, breadth 60 mm, height 9 mm. Lower surface nearly flat, the mouth a little sunken. Test rather evenly elevated from margin to apex which is about 28 mm from posterior margin. Madreporite just posterior to apex. Petaloid area 32 by 33 mm with the anterior petal 18 mm and each of the anterior laterals about the same. Tuberculation of test very close and fine near margin but distinctly coarser on the elevated part of test, particularly within the petals; on oral surface the tuberculation is coarser and more widely spaced. Posterior petals about 15 mm long and 8 mm wide; they are slightly curved and diverge markedly, the inner margins being 15 mm apart at tips; poriferous areas very wide (about 3 mm), the ridges between the pore-pairs are very narrow but carry a crowded series of 3-9 minute tubercles. Areas between the poriferous zones carry fairly numerous, but not crowded tubercles of diverse sizes;

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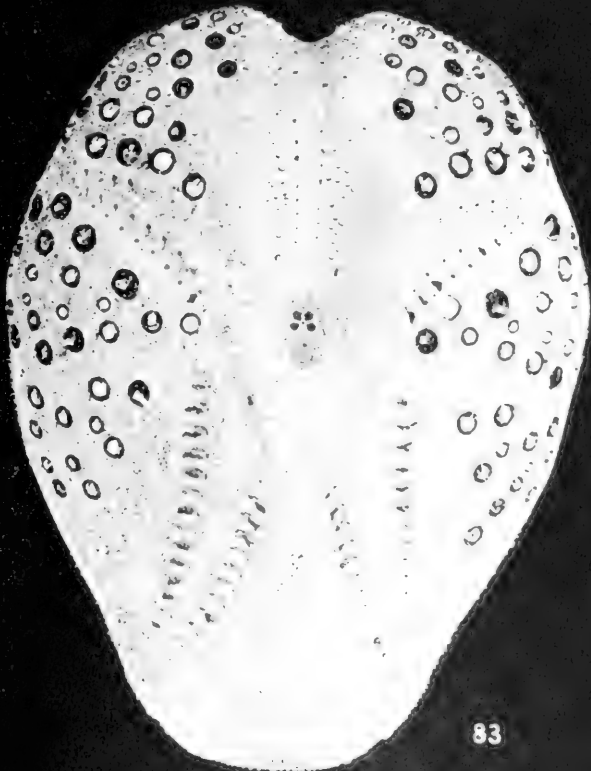
<sup>8</sup> *mexicanus*, in reference to the southern habitat of the species.

## PLATE 71

- Fig. 82. *Lovenia cordiformis* A. Agassiz, aboral view, rough,  $\times\frac{2}{3}$ , p. 347  
Fig. 83. *Lovenia cordiformis* A. Agassiz, aboral view, smooth,  $\times 2$



82



83



none are conspicuously large but many are larger than the tubercles of the interradial areas. Anterior lateral petals similar in general tuberculation but the great breadth of the poriferous zones is very striking; the petals are 9 mm wide and the interporiferous area is only 3 mm. There are 8-10 (or even more) tubercles in each series across the poriferous area. Anterior unpaired petal is similar to the other petals but is perhaps a trifle narrower. Abactinal surface densely covered with spines of which those covering the interporiferous part of each of the paired petals are 2 or 3 mm long. This series of long spines forks at the distal end of the petal and continues to the test margin. Between petals 1 and 2 (as well as between 4 and 5 and 1 and 5) there are 2 parallel series of long spines running to the disk margin, where all spines are 3 or even 4 mm long. This belt of long spines forms the outer margin of the disk. Orally, the primary spines are 3-5 mm long, cinnamon buff to light purple drab in color and contrast decidedly with the dark purple drab of the disk. Pedicellariae very numerous, chiefly minute ophicephalous<sup>9</sup> or triphyllous, crowded among the spines. Color of bare test dark purple drab; of the spine coat, light brownish drab.

There are 7 adult specimens of this *Dendraster*, of which 2 are more or less cinnamon brown while the other 5 are of varying shades of purple drab. The latter, including the holotype, are from San Rosario Bay, west coast of Lower California, in 15 fms. The other 2 and 13 very young individuals, 11-16 mm across, are from Lagoon Head Anchorage, west coast of Lower California, in 7 fms. The rough appearance of the posterior part of the dorsal surface, due to the long spines in radiating series (much as in *rugosus*) is a notable feature of this species but is not as important as the character and appearance of the petals on the cleaned test.

*Type*.—Holotype, AHF no. 49, 4 paratypes.

*Type locality*.—Station 610-37, Rosario Bay, Lower California, 15 fms, February 28, 1937.

*Distribution*.—West coast of Lower California from Rosario Bay to Lagoon Head Anchorage.

*Depth*.—7-15 fms.

*Specimens examined*.—The type, paratypes and 15 specimens from 2 stations.

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<sup>9</sup> It is regrettable that Clark gives no information about these ophicephalous pedicellariae otherwise found only in *Echinodiscus* and (young) *Astriclypeus* among Scutellids. It would have been particularly interesting to learn whether they are bivalved as the other pedicellariae, bivalved ophicephalous pedicellariae being otherwise a very great rarity. In a couple of specimens of this species, a young one and a fine adult specimen, sent me by Prof. McCullech, I do not find a single ophicephalous pedicellaria.

***Dendraster rugosus*<sup>10</sup>**, new species

Plate 52, Figs. 40-41

Length 49 mm, breadth 47 mm, height 9 mm; the breadth is thus very nearly equal to the length and it is probable that in fully grown individuals the equality is complete. Lower surface almost completely flat, the oral area being very slightly depressed (when the animal is upside down). Test rather evenly elevated from margin to apex, which is definitely posterior in position, less than 20 mm from posterior margin. Petaloid area 26 by 30 mm with the anterior petal the longest and narrowest. Tuberculation of test very close and fine abactinally but with numerous primary tubercles scattered irregularly about, mostly in the petals or near the test margin; tuberculation of oral surface rather sparse except near margin. Posterior petals about 11 mm long and 5.5 mm wide; they are quite straight and diverge markedly, the inner margins being 12 mm apart at tips; poriferous areas very narrow, about a millimeter wide, and the ridges between pore-pairs are so narrow they carry no primary tubercles. The areas between the poriferous zones carry longitudinal series of relatively large tubercles, about 4 basally but only 2 or 1 near the tips; these series are more or less irregular and incomplete but give a definite character to the petals. Anterior lateral petals essentially similar but larger, 14 by 6.5 mm; the poriferous zones are wider than in the posterior pair but are still quite narrow. The anterior unpaired petal is about 16 mm long but only 5 mm wide, for the poriferous zones are only a little curved and are as narrow as possible. Interporiferous areas in all 3 anterior petals show their primary tubercles rather conspicuously in 4 somewhat imperfect but still evident longitudinal series. Whole abactinal surface closely covered with spines; the primary spines, borne by the large tubercles of the petals and by similar tubercles scattered over the interambulacral areas, are about 2 mm long, nearly white and rather sharp, the other spines are scarcely half as long and are thickened at the tip and rather bluntly pointed. Genital pores 4, fairly large; the 5 ocular pores much less distinct. Mouth small, largely concealed by the long (4 or 5 mm) white spines crowding around it. Anterior primary spines of oral surface, 2 or 3 mm long, curve outwards to left and right on the anterior fifth of the test. Pedicellariae very small and hard to detect, not distinctive. Color of bare test pale ecru drab or pale vinaceous drab, spines whitish.

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<sup>10</sup> *rugosus*=rough, in reference to the appearance caused by the numerous projecting primary spines.



There are 4 specimens of this interesting *Dendraster* in the *Velero* collection. The holotype is the largest, with the others 37-39 mm long; the smallest 36 mm wide. They resemble the type in color and in every other respect. They were taken in Bay San Sebastian, Vizcaino, west coast of Lower California, in 17 fms on a sandy bottom. The delicate coloration, the long white primary spines and the very narrow poriferous zones are quite distinctive.

*Type*.—Holotype, AHF no. 50, 3 paratypes.

*Type locality*.—Bay San Sebastian Vizcaino, Lower California, 17 fms, August 28, 1932.

*Distribution*.—Bay San Sebastian Vizcaino, Lower California.

*Depth*.—17 fms.

Specimens examined.—The type and paratypes from 1 station.

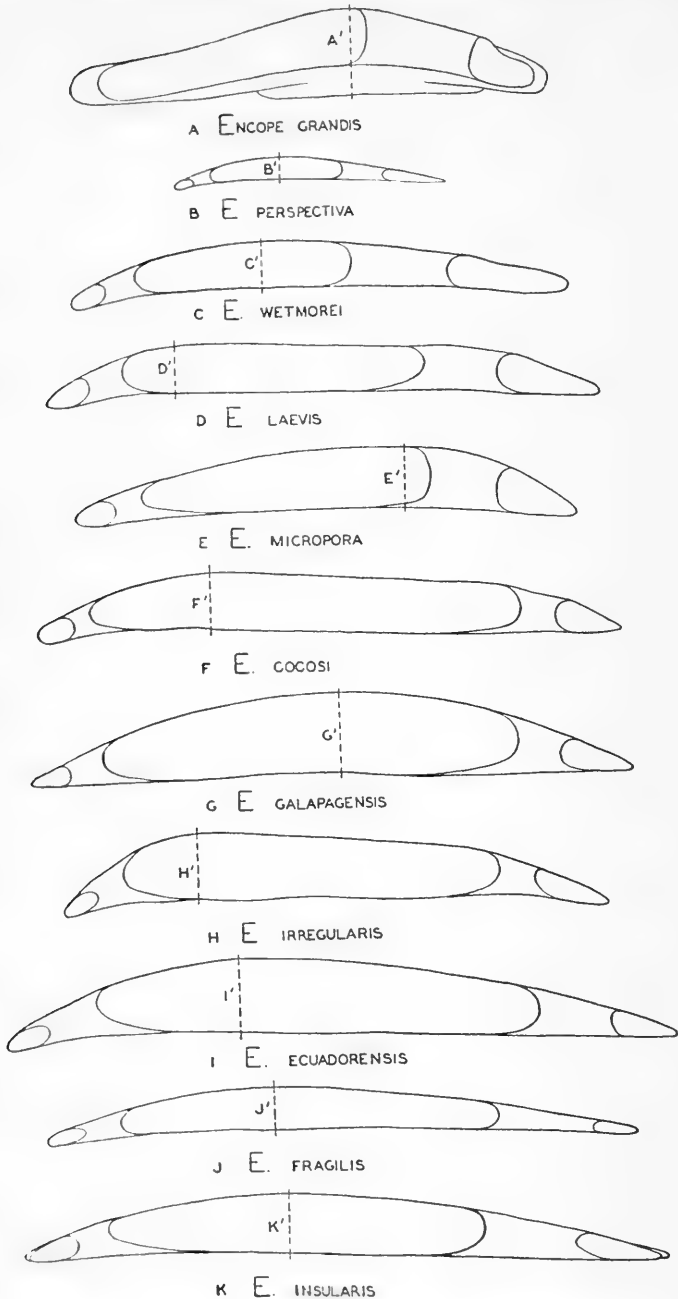
### Genus ENCOPE L. Agassiz

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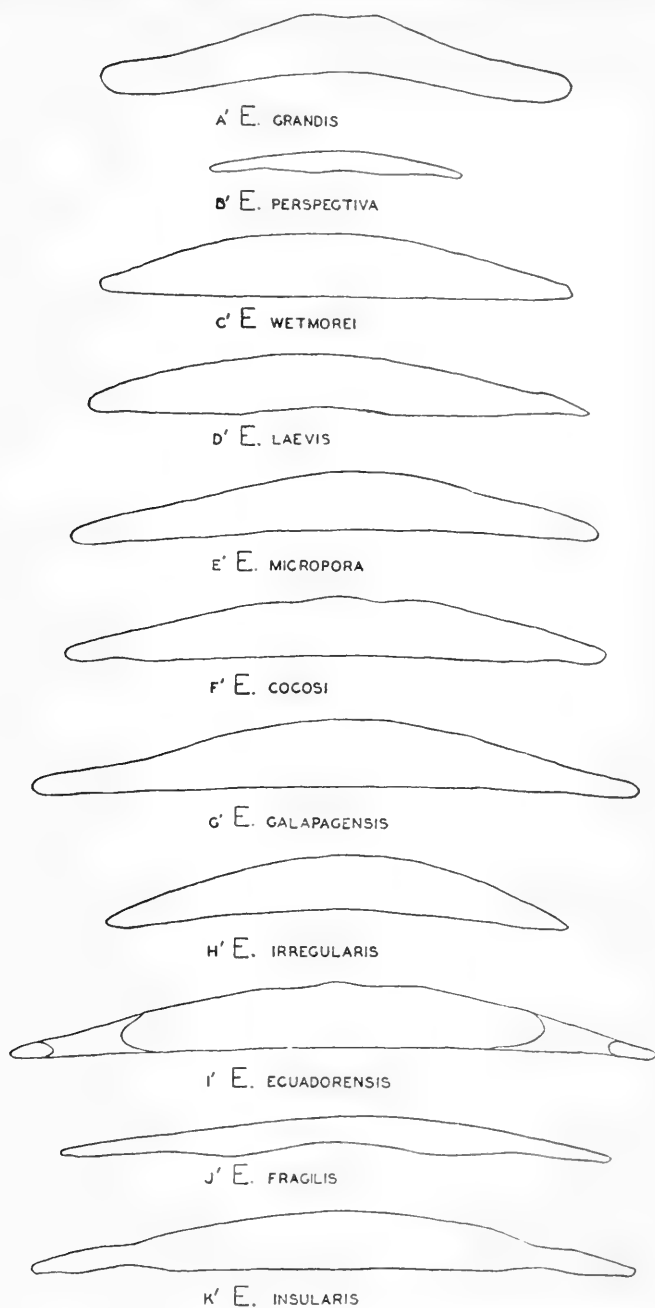
In establishing the genus *Encope* L. Agassiz (1840, Cat. syst. ectyp. Echinod. Mus. Neocom. p. 6; 17) mentions only the species *grandis*. This species accordingly is the genotype. To take a species not originally included in the genus as the genotype is against the rules and against common sense. In a letter to me of May 8th, 1947 (the last but one he wrote to me) Clark writes: "A young palaeontologist here (viz. Dr. Durham) who is working on a Monograph of fossil *Encopes* insists that *grandis* is the type. As you of course know, I consider that *emarginata* is the type. If you agree with him that *grandis* is the type, I'll have to make some changes in my MS; but if you agree with me that *emarginata* is the type then I shall be comfortably settled. At any rate *grandis* and *emarginata* are not congeneric, so one of them must have a new name."

It is clear that Clark thus leaves to me the decision of the question which species is the genotype of *Encope*—and there cannot be the slightest doubt but that *grandis* is the genotype. Further, I thoroughly disagree with Clark in seeing two different generic types in *grandis* and *emarginata*. The only noteworthy difference is that the edge of the test is thicker in *grandis* than in the other species; but whether the edge is some 5 mm or only 2-3 mm thick is certainly not a difference of generic value, and any difference of morphological value does not exist between *grandis* and the other species. Particularly it must be emphasized that the internal structure is exactly alike in both.

As said in the preface I think Clark is here making too many species; but without having access to the collections on which he is basing his



Text figure 1. Outline drawings at median longitudinal axis of the species of *Encope* illustrated on Plates 53-59.



Text figure 2. Outlines of transverse sections of same specimens at areas of greatest thickness or height.

various species I cannot go into a critical valuation of them, and I think it therefore the only fair thing to publish this part of his manuscript as he left it. Future investigations will have to decide about the value of all these species.

One more species, *Encope Stokesii* L. Agassiz will have to be added to the West American species of *Encope*. Clark gradually became convinced that this species is only the young of *micropora*, but this is decidedly a mistake. The internal structure of the test is markedly different from that typical of *Encope*, the buccal cavity being not closed as it is in *Encope* but remaining in open connection with intestinal cavity. The subgenus *Mellitella* established by Duncan (1889) for this species is therefore fully justified—perhaps it should rather form a genus of its own.

It is very improbable that this species, so fairly common in the warmer region of West American seas, should not be represented in the *Velero* collections. Specimens of this species have probably been identified by Clark as *Encope micropora*. A re-examination of his material will be needed for settling this matter.

*Encope (Mellitella) Stokesii* will be dealt with fully in the forthcoming Vol. IV.2 of my Monograph of the Echinoidea. Th. Mortensen

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The very large number (1,212) of *Encopes* taken by the *Velero* in her voyages to the tropical Pacific has necessitated a very detailed and time consuming comparative study of this well-defined and easily recognized genus. It was soon evident that more species of *Encope* are living on the western coast of tropical America than had been hitherto supposed and that the specific lines drawn needed realignment. In July, 1946, Austin Hobart Clark of the United States National Museum published a "Revision of the Pacific Species of the Genus *Encope*" with the description of a well-marked new species and the recognition of two new subspecies and a new variety. No statement as to the number of specimens available is made but Mr. Clark tells me that both the subspecies are based on "bare white tests devoid of spines." There are very few bare tests in the *Velero* collection and the identification of such tests is a difficult matter, with the possibility of error being very large, unless specimens with spines from the same locality accompany them. The hundreds of *Encopes* available from the Gulf of California show that the *Encopes* there are either the well-known form here listed as *Encope grandis* or *micropora*. It is fruitless to try and recognize either *borealis* or *californica* as subspecies or varieties, as they lack any constant association with any locality or any large group

of specimens. On the other hand what Mr. Clark calls *micropora galapagensis* is a very well-marked species, not found elsewhere and apparently the only *Encope* found at the Galapagos Islands. If the type *perspectiva jonesi* really came from these islands, it is strange nothing like it occurs in the *Velero* collection. Its being a bare test debars it from further consideration in this report.

The following key to the eleven species of *Encope* here recognized will require modification when more material from the Central and South American coast is available.

- A. Unpaired lunule in between the posterior petals for at least most of its length.
- B. Covering of test dorsally made up of rather slender spinelets the tips of which are swollen but not flat-topped, nor inverted; cones more or less considerably in contact . . . . . *perspectiva*
- BB. Covering of test dorsally made up of spinelets whose tips are more or less evidently inverted cones.  
Covering of test a fairly smooth pavement of cone-bases loosely in contact; color dark olive-gray . . . . . *wetmorei*  
Cone-bases larger and in close contact, making a very smooth pavement; petals very large, straight, wide at tip; color olive-brown or darker with marginal fringe of short brown or reddish-brown spinelets; lower surface brown . . . . . *laevis*
- AA. Unpaired lunule not forward between posterior petals but more or less in line with the posterior lunules or anterior to them.
- C. Lunules usually more or less circular or oval and relatively small; test usually less than 120 mm in length, commonly about 90-100 mm. Spines of test very slender with only slightly enlarged tips . . . . . *micropora*  
Test covered with the very numerous slender spines, each tipped with an oval ball, commonly white or light colored . . . . . *cocosi*
- CC. Lunules much longer than wide; test often wider than long.

- D. Lunules about twice as long as wide; test thick and heavy, the margins a couple of millimeters or more in thickness.
- E. Test large, up to 150 mm h. d.; unpaired lunule usually longer than posterior pair, its anterior end a little in advance of the other two; test high, flattened between tip of anterior petal and the posterior lunule, highest point may be determinable as in middle or at either end; normal color light brown above, with disk and lunule margins purple . . . . *galapagensis*
- EE. Test smaller; unpaired lunule about the same size and about in line with posterior lunules. Color dark gray or blackish. Test flattened on top, commonly irregular in outline, its greatest height about one-sixth or one-seventh of length; lunules relatively small and narrow, the posterior three nearly in line . . . . *irregularis*  
 Test more curved on top, oval or broadly oval; its height about one-tenth of length; lunules long and narrow, the anterior trio slightly smaller . . . . *ecuadorensis*
- DD. Lunules 3 to 4 times as long as wide; test thin and light with relatively thin edges. Unpaired lunule wider than other lunules; its anterior tip little or not at all in front of the posterior pair . . . . *fragilis*  
 Unpaired lunule long and narrow, its anterior end well in advance of the posterior pair . . . .  
 . . . . . *insularis*

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In this key Clark, according to his views did not include the species *grandis*. It is easily distinguished from the rest of the species by its margin being thicker, some 5 mm or even more. Th. Mortensen

**Encope grandis** L. Agassiz

Plate 53, Fig. 42

*Encope grandis* L. Agassiz, 1841, p. 57, pl. 6.

This easily recognized sea-urchin, or key-hole urchin, is very abundant in the Gulf of California and the *Velero* has brought home no fewer than 1,222 specimens, ranging in size from 40 x 40 mm to the big adults exceeding 100 mm in length with a breadth usually somewhat less but often somewhat greater. The largest specimen in the collection is 116 mm long by 111 mm wide and 16 mm thick, while another individual from the same station (689-37) is 111 mm long by 115 mm wide and 16 mm thick. The percentage of the total weight which the skeleton makes is very great but has not been worked out. Although the coarse and heavy build makes the specimens unmistakable, there is extraordinary diversity in the posterior unpaired lunule, which ranges from nearly circular to a long and narrow slit. The most striking case is a specimen 100 x 90 mm in which the lunule is circular and only 3 mm in diameter. This is such an extreme case it is probably pathological. At the other extreme is an individual with the lunule 20 mm long but only 6 mm wide. There is apparently no correlation between size or weight of the individual and the size of the lunule. Thus a specimen 100 x 105 mm has the lunule 17 x 10 mm but another specimen from the same lot, 92 x 92 mm has the lunule 33 x 16 mm. The color is dull purple, approaching black, or some shade of brown, ranging from fawn color in some young individuals to very deep blackish brown in adults. The marginal area is often darker than the center and the lower surface is lighter than the upper, often markedly so. But there is no distinctive feature in the coloration.

*Distribution.*—The *Velero* took *grandis* at only 10 fathoms, all in the Gulf of California, mostly along shore, but occasionally it was dredged in from 1 to 10 fms. The scarcity of young individuals or even small adults is striking but may be associated with the fact that all the material was collected between January 30 and March 23. Perhaps collections made in summer or early fall would show a larger number of young.

*Type.*—(Germany?)

*Type locality.*—" . . . provient probablement des Antilles."

*Depth.*—Shore to 10 fms.

*Specimens taken.*—1,222 specimens from 10 stations.

***Encope perspectiva* L. Agassiz**

Plate 53, Fig. 43

*Encope perspectiva* L. Agassiz, 1841, pp. 51, 146, pl. 10b, figs. 1-5.

A. H. Clark, 1946, pl. 3, upper fig.

It is a curious thing that this well characterized species is not adequately represented in the Hancock collection. In fact the only *Encopes* which can be referred to it with any confidence are 5 young ones and 2 fragments which were taken at Station 485-35 in Tenacatita Bay, Jalisco, Mexico, in 5 fms on a bottom of sand and shells. They range from 37 x 39 mm to 56 x 58 mm and are exceedingly thin and flat. The unpaired lunule is well forward between the hind pair of petals and is the largest of all. The spine-covering of the dorsal side of the test is made up of countless spinelets whose tips are ovate balls—a distinguishing feature of *perspectiva*. The color ranges from Lincoln green, through dusky olive green to dusky yellow green. The lower surface is brown, with more or less gray on the ambulacra. The *Velero* did not take an adult example of this well-marked species at any other place, but in March, 1939, she dredged, at Chacahua Bay, Mexico, some distance southeast of Tenacatita Bay, 14 specimens of very young *Encopes*, which have notably long, narrow unpaired lunules and are apparently young *wetmorei* or *perspectiva*, presumably the latter.

*Distribution*.—Known range from other authors, Ballenas Bay, Lower California to Costa Rica.

*Type*.—Unknown.

*Type locality*.—Unknown.

*Depth*.—5-15 fms.

*Specimens examined*.—21 specimens from 2 stations.

***Encope wetmorei* A. H. Clark**

Plate 54, Fig. 44

*Encope wetmorei* A. H. Clark, 1946, p. 2, pl. 1; pl. 2, fig. 1.

This interesting new species, so recently described, may be distinguished at once by the anterior position of the unpaired lunule, which lies well in between the posterior petals, and by the peculiar character of the spinules which cover the dorsal surface. These spinules have inverted conical tips, the bases of the cones forming a more or less smooth pavement covering the upper side of the test. This pavement is not so continuous or smooth as in the following species but is very faintly rough or "furry." The spines around the unpaired lunule are relatively long (3 mm or 4 mm), flat



and truncate. Around the other lunules they are smaller and more slender. The bare test is a distinct gray but the spine covering is a very dark shade of olive gray.

There are 4 specimens of *wetmorei* in the collection, each about 100 mm long with a width nearly or quite as great. One specimen is injured posteriorly so that the unpaired lunule has never been cut off at the rear. The other 3 specimens are symmetrical and uninjured. All of these specimens were taken in 5-10 fms on the south side of Petatlan Bay, Guerrero, Mexico, in March 1934. Besides these adults there are 32 very young *Encopes*, 6-15 mm in diameter, taken in 25 fms south of White Friars, near Petatlan Bay, which may be referred to *wetmorei* as they are apparently not *perspectiva*, and the position of the posterior lunule indicates they must be one of the two species.

*Distribution*.—Mazatlan, Mexico, to Pearl Islands, Panama.

*Type*.—U.S.N.M. No. E. 6768.

*Type locality*.—San José, Pearl Islands, Bay of Panama.

*Depth*.—5-25 fms.

*Specimens examined*.—36 specimens from 2 stations.

***Encope laevis*<sup>11</sup>, new species**

Plate 54, Fig. 45; Plate 55, Fig. 46

Length 117 mm, width 115 mm, height 12 mm. Test stout, relatively heavy and quite flat dorsally; highest point only about 25 mm from anterior margin, thence it slopes very gradually and slightly to the unpaired lunule, the margins of which are a little elevated; height of test there about 10 mm; posterior margin of test slightly convex but in other specimens it may be quite straight. Unpaired petal about 40 mm long, 21 mm wide some 10 mm from the tip, which is nearly but not quite closed; poriferous zones very wide (6 mm) with the narrow, crowded ridges each bearing some 25 minute tubercles, of about the same size as those which densely cover the median area. Anterior lunule small, about 6 mm long by 2 or 3 mm wide, 8 mm from the margin. Anterior paired petals about 40 mm from anterior margin only about 10 mm in front of the madreporite which is very large (10 mm) and densely granulated; the petals are about 35 mm long and 20 mm wide near the blunt tip; their lunules are only about 9 or 10 mm from test margin and only a little larger than the unpaired one. Posterior petals 42 mm long and 20 mm

<sup>11</sup> *laevis*=smooth, in reference to the remarkably smooth upper surface.

wide near the very blunt tip, their lunules are a little longer (about 8 mm) but scarcely wider than the anterior 3. Unpaired lunule nearly  $12 \times 3$  mm, and almost wholly within the area limited by the posterior petals. Its surrounding spines are relatively long (2-4 mm) flattened, particularly at the somewhat truncated tips, which, however, are not chisel-shaped. Entire upper surface of test densely covered with very low spines each of which is an inverted cone; the bases of these cones form a very smooth secondary surface for the upper side of the animal. Only around the lunules and at the very margin of the disk are there really spinelets and these are definitely blunt, though the tips of many are rounded at the corners. Lower surface as usual in the genus, the spines long and slender (4-5 mm) but lying more or less flat against the test, pointing towards the mouth on interambulacra 1 and 4 and towards the margin on interambulacra 2 and 3; on interambulacrum 5 they all tend to point towards the lunule, as they do on the five ambulacra.

No two of the 33 specimens are exactly alike in color, but in general they may be called olive brown lighter towards the center. Many specimens are darker than the holotype, appearing to be clove brown or even bone brown. None, however, approach the olive gray (almost deep green) of *wetmorei*. The marginal spines and the lower surface are definitely brown lacking the olive tint. The cleaned test where bare and dry (but not at all bleached) is a pale olive gray rather markedly in contrast with the normal olive brown of the spine-coat. While this species resembles both *perspectiva* and *wetmorei* in the position of the posterior lunule, it cannot well be referred to either one. It seems best to regard it as a related but distinct species. A specimen, for deposit in the National Museum, was sent to Mr. Austin Clark. He, however, fails to see any essential difference between it and *wetmorei*. Further careful study of the material at hand compels me to maintain *laevis* as a well-marked species.

*Distribution.*—All of the specimens of this species are from Station 962-39, 11 miles northwest of Corinto, Nicaragua, in 1-3 fms on a bottom of sand and dead leaves.

*Type.*—AHF no. 51, 32 paratypes.

*Type locality.*—Station 962-39, 11 miles NW of Corinto, Nicaragua, 1-3 fms May 4, 1939.

*Distribution.*—Nicaragua.

*Depth.*—1-3 fms.

*Specimens examined.*—The type and paratypes, from 1 station.

**Encope micropora** L. Agassiz

Plate 55, Fig. 47

*Encope micropora* L. Agassiz, 1841, pp. 50, 146, pl. 10a, figs. 4-8.*Encope californica* Verrill, 1871, p. 586.*Encope micropora* var. *borealis* A. H. Clark, 1946, p. 6, pl. 4.

The very large series of *Encopes* from the Gulf of California is convincing evidence that there is but one species of *Encope* in that Gulf [besides *E. grandis*.] The *Velero* collection included 712 specimens from 21 stations. They range in size from 6 to well over 100 mm in diameter. The finest specimens are from south of Mangles Anchorage, on the west side of the Gulf, in Lat. 26° 16' 55" N, in 3-5 fms and from Puerto Refugio, Angel de la Guardia Island, Lat. 29° 42' 37" N, along a rocky shore. The largest measures 127 mm long by 130 mm wide and 13 mm high. The only *microporas* in the collection from outside the Gulf of California are a handsome specimen, 105 x 104 mm and two very young ones (16 and 17 mm across), collected on the west coast of Lower California, at Lagoon Head Anchorage (28° 12' 25" N) Station 612-37, in 7 fms and a small bare test from San Juanica Bay, (Station 615-37). The attempt to distinguish varieties *borealis* and *californica* fails completely in the light of this abundant material, which is notably homogeneous in general appearance even though the color ranges from a deep brown, almost a purple brown, through chocolate brown, red brown or deep yellow brown to a sort of fawn brown. The position of the apex of the test ranges from well anterior to distinctly posterior but the character is not associated with any other distinctive feature and seems to have no taxonomic value.

*Distribution*.—According to other authors, *micropora* ranges from Lower California to Peru and the Galapagos Islands. (The Galapagos records are probably based on what is here treated as *E. galapagensis*.)

*Type*.—Paris Museum.

*Type locality*.—M. Stokes "mais il n'en est aucun dont l'origine me soit connue."

*Depth*.—Shore to 16 fms.

*Specimens examined*.—712 specimens from 21 stations.

***Encope cocosi*<sup>12</sup>, new species**

Plate 56, Figs. 48-49

Test large, stout, with small lunules. Length 120 mm and width the same; height, greatest about 35 mm from anterior margin, 12 mm; test slopes very gradually to the interambulacral lunule and then rather sharply to margin. Unpaired petal about 40 mm long by 16 mm wide, open by 3 or 4 mm, only 5 mm back of the lunule; poriferous areas about 4 mm wide, the intermediate area 8 mm. Tuberculation of test very fine and close, the petal-ridges with a single closely placed line of some 20 minute tubercles. Anterior lunule small, oval, about 6 x 4 mm, only 5 or 6 mm from test margin. Anterior paired lunules rather far back, a line joining them would be 50 mm from anterior margin of test; they are very small (6-8 mm long, 4-5 mm wide) and only 6-8 mm from test margin. Adjoining petals short and stout, about 33 x 18 mm, ending about 10 mm from lunule. Posterior petals markedly longer (40 mm) than anterior pair, about 18-20 mm wide. Interambulacral lunule small (9 x 4 mm), a little smaller than the posterior pair (10 x 5 mm) which virtually accompany it, as the 3 lie in a straight line parallel to the nearly straight posterior margin of test. Lower surface relatively uneven as the ambulacral furrows are evident and the vicinity of the lunules depressed. Spines of abactinal surface very numerous, short and slender, each one terminating in a conspicuously swollen light brown tip, resulting in a relatively smooth surface; only around the margin and the lunules are the spines elongated and somewhat pointed. Color clove brown becoming warm sepia on the margin; the lower surface is unusually evenly dark with little difference between the ambulacral and interambulacral areas.

Besides the holotype there is only one other *Encope* in the collection similar to this one in form and structural details and it is noticeably different in color as the swollen tips of the spines are very light cream color, resulting in a very definite drab upper surface; the lower is a deep bone brown. Both the brown and the drab specimens were taken in Wafer Bay, Cocos Island, Costa Rica, in 2-4 fms. Although apparently a derivative from the *micropora* stock, it is easily distinguished by the primary spines.

*Type*.—Holotype, AHF no. 52, 1 paratype.

*Type locality*.—Station 108-33, Wafer Bay, Cocos Island, Costa Rica, 2-4 fms.

*Distribution*.—Cocos Island.

*Depth*.—2-4 fms.

*Specimens examined*.—The type and paratype, from 1 station.

<sup>12</sup> *cocosi*, of Cocos Island, the only place where it has been taken.

***Encope galapagensis* A. H. Clark**

Plate 57, Figs. 50-51

*Encope micropora galapagensis* A. H. Clark, 1946, p. 7.

One of the most interesting results of the study of the large number of *Encopes* in the *Velero* collection was the discovery that the Galapagos form is easily recognizable as a distinct species. The character upon which the subspecies was based is not perfectly constant, for while the test is as a rule equally high both in front of and behind the middle, there is individual diversity which results in many specimens being slightly highest anterior to the middle. Very rarely a specimen is highest posteriorly. The most obvious character is the color, commonly an antique or brussels brown above with the margins of the lunules as well as of the test itself dusky purple. The lower side is a dark purple drab, sometimes quite purple, sometimes quite drab. The contrast between the upper and lower surfaces is usually marked. About 10 per cent of the specimens tend to be either grayish with a purple cast or even a rather evident purple. Such specimens show little evidence of the antique brown of normal specimens. The lunules are commonly elongated and relatively narrow, from 2 to 4 times as long as wide, but the anterior lunules are frequently small and more nearly circular. The unpaired lunule is longest and its anterior end is commonly between the tips of the posterior petals, but in some individuals a line between those tips would be entirely anterior to the unpaired lunule. Commonly the test is nearly circular but it is usually a little wider than long when full grown. The margin between the posterior petals is often nearly or quite straight but is commonly more or less convex.

The smallest specimen at hand is 10 mm in diameter with only the unpaired lunule evident. At 12-15 mm the posterior paired lunules appear as notches in ambulacra 1 and 5, but the notches indicative of the 3 anterior lunules are not evident until the young *Encope* is about 25 mm across. These young are very pale gray brown but at 3 mm the color is more brown and margin of the test is purple as in adults but not markedly so. The largest individuals exceed 130 mm in diameter, the length and breadth about equal or the width greater. At Tagus Cove, Albemarle Island, fine specimens were secured, 152 x 151 mm, and at Academy Bay, Indefatigable Island, specimens 150 x 155 mm were collected.

*Distribution.*—This fine *Encope* was taken only at the Galapagos Islands, from North and South Seymour Islands and Indefatigable, Albemarle, Charles, Hood, and Chatham Islands.

*Type.*—U.S.N.M. No. E. 6817.

*Type locality.*—Chatham Island, Galapagos.

*Depth.*—2-73 fms.

*Specimens examined.*—120 specimens from 22 stations.

***Encope irregularis***<sup>13</sup>, new species

Plate 58, Figs. 52-53

Test stout and more or less irregular in shape. Of all the specimens at hand, only one, a relatively young one, is symmetrical. The one selected for holotype is here used as basis of description but no other specimen is like it in all details. Length 112 mm, width 116 mm, height 13 mm. Apex of test only 25 mm back of anterior margin, from which point the test slopes gradually to posterior lunule and thence rapidly to margin. Unpaired petal and anterior pair of about equal length, 35 mm and width 18-20 mm; poriferous zones, 4 mm across with some 20 very small tubercles in each series; interporiferous area 10 mm wide with very fine tuberculation; tips of petal open, only 4 mm from anterior lunule, which is only about 5 mm from margin and is 9 x 4 mm in size. Anterior paired lunules about 40 mm from anterior end of test; each is about 8 mm long by 3 mm wide; the right hand one is closed by about 7 mm of test but the left hand one has never closed, though the lower margin has bent forward as though to do its part. Posterior petals somewhat longer than anterior but essentially similar. Interambulacral lunule small, only 8 mm long by 2.5 mm wide; its posterior end is 15 mm from rear end of test and its anterior end is well within (3 or 4 mm) the line joining the tips of the posterior petals. Posterior lunules short and narrow, 10 x 2 mm, only about 7 mm from test margin. Lower surface flat or barely concave, the pattern formed by the ambulacra unusually distinct and striking. Spines of abactinal surface relatively short and crowded, the tips swollen and flat for the most part but around the lunules long, flat and pointed or truncate. Color of abactinal surface very dark, approximately fuscous or fuscous black of Ridgway; the marginal fringe of short spines, the tips of the spines around the lunules and the whole lower surface are brown of some shade, usually dark and often with a purple cast. There is considerable diversity in the shades of color, so that no two individuals are exactly alike. In one large specimen there is a distinct hint of deep green, while in several dark violet is indicated. In general one may say the color is dark and dull.

Besides the holotype there are 21 specimens of this *Encope*, but 4 of these are so small (less than 25 mm) their identity is based wholly on the fact that they are from the coast of Costa Rica. The remaining 17 are remarkable for their asymmetry. The smallest, 85 mm in length, shows no

<sup>13</sup> *irregularis*=lacking regularity in form or character, in reference to the fact that nearly all the specimens are imperfectly formed at least in some detail.

striking defect but all of the rest are surprisingly different from each other. The least asymmetrical has a noticeable concave margin adjoining the right posterior lunule; the holotype has the left anterior lunule still unclosed; in another the lunules, especially the anterior one, are small; in several two or more lunules are unclosed; and finally a specimen 135 x 130 mm, is the most distorted of all, having no two interradial margins alike, only the anterior and the interambulacral lunules closed, and the whole left margin irregularly distorted.

*Distribution.*—The holotype and 13 paratypes are from Octavia Bay, Colombia, in 2 fms. Two small adults (about 115 mm long) are from Bahia Honda, Panama, one from shore, the other in 15-20 fms, and a similar but smaller specimen is from the Secas Islands, in 3 fms. The very irregular abnormal adult described above and 3 very young individuals are from Salinas Bay, Costa Rica, in 2 fms. The other very small specimen is from Cocos Bay, south of Port Culebra, Costa Rica, in 2 fms. Apparently this is a southern species, reaching a northern limit in Costa Rica.

*Type.*—Holotype AHF no. 53, 13 paratypes.

*Type locality.*—Station 434-35, Octavia Bay, Colombia, 2 fms, January 28, 1935.

*Distribution.*—Colombia to Costa Rica.

*Depth.*—2-20 fms.

*Specimens examined.*—The type, paratypes and 8 specimens from 6 stations.

### ***Encope ecuadorensis*<sup>14</sup>, new species**

Plate 59, Figs. 54-55

Test rather stout, 139 mm long, 146 mm wide and 15 mm high; greatest thickness just anterior to the paired petals, when it decreases slowly until near the posterior lunules and then more rapidly to margin. Unpaired petal 40 mm long and 15 mm wide, elongated elliptical; poriferous zones narrow, less than one-fourth of petal width, the pore-pairs rather crowded, the ridges between with a close series of 12-16 tubercles; closed tip of petal (which is damaged in the holotype) is about 10 mm from the lunule, which is 12 mm long by 4 mm wide, and some 9 mm from the margin. Anterior paired petals shorter and wider than the unpaired one, the form being somewhat oval rather than elliptical; they point to the anterior lunules which are 13 x 5 mm, and 10 mm from margin. Posterior

<sup>14</sup> *ecuadorensis*, in reference to the country where this is the local *Encope*.

petals a bit longer but not equal to the unpaired one, the lunules 18 x 5 mm and 10 mm from margin. Interambulacral lunule relatively small, about equal to one of the anterior pair; its posterior end about 10 mm from margin. Lower surface of test flat and not peculiar. Spines of abactinal surface very numerous, slender with abruptly bulbous tips, lying inclined towards horizontal, forming a fairly close coat; on the lower side the spines are relatively long but lie nearly horizontal; they may be blunt or pointed but are not notably enlarged at tip. Color of upper surface Saccardo's umber of Ridgway's Standard, but warm sepia and cinnamon brown on oral surface.

In addition to the holotype, there are but two other smaller adults and a bare test. This test is 130 mm long, 125 mm wide and 13 mm high; aside from its elongated form it is peculiar in having the anterior petal more elongated than in the type and relatively narrower. One of the other specimens, 120 mm long by 122 mm wide, is notable for its very dark color, Chaetura drab above, and cinnamon drab orally on the interambulacra, more drab on the ambulacral areas. The test itself is light olive gray. The other small adult is about 107 mm each way and the color is intermediate between the other two adults, a dull drab above, more cinnamon below. Although resembling *fragilis* in some ways, the character of the more solid test and the narrow poriferous zones of the anterior petal serve to distinguish this southern form.

*Distribution.*—This *Encope* is the tropical continental species, quite different from the Galapagos species and readily distinguished from the Panamic or Mexican forms. In addition to the 4 adults, there are 92 young *Encopes*, 5-30 mm in diameter which are too young for positive identification but are here considered as *ecuadorensis* on geographical grounds. The material was all taken at 5 stations on the Ecuadorean coast between Santa Elena Bay, Lat. 2° 10' 36" S, and San Francisco Bay, Lat. 0° 38' 40" N, in 2-12 fms.

*Type.*—Holotype, AHF no. 54, 2 paratypes.

*Type locality.*—Station 205-34, Santa Elena Bay, off La Libertad, Ecuador, 8-10 fms, February 8, 1934.

*Distribution.*—Ecuador.

*Depth.*—2-12 fms.

*Specimens examined.*—The type, paratypes and 93 specimens, from 6 stations.



***Encope fragilis*<sup>15</sup>**, new species

Plate 60, Figs. 56-57

Test rather fragile, 124 mm long, 130 mm wide and 10 mm high; greatest thickness just a little back of tip of unpaired petal which is 30 mm long and 14 mm wide; poriferous zones wide, the two equal in width to the median area; pore-pairs crowded, the narrow ridges between them covered by a single series of 20-24 minute tubercles; closed tip of petal 5 or 6 mm from anterior lunule which is 8 mm long and about 1.5 mm wide; its tip 8 mm from disk margin. Anterior paired petals about 26 mm long and 13 mm wide; they point directly to anterior lunules which are about 10 mm from their tip and measure 12 mm long by 2 (or less) wide. Posterior petals almost duplicates in size and form of the unpaired one. Posterior lunules about 15 mm long, 2.5-4 mm wide. Interambulacral lunule very large, 20 mm long by 8 mm wide, only about 8 mm from margin. Lower surface of test perfectly flat but not peculiar. Spines of abactinal surface very numerous, slender with abruptly bulbous tips lying almost horizontal, forming a delicate smooth coat; spines around lunules long and pointed, those of lower surface slender, pointed or blunt or even a bit widened at tip. Light brownish olive above, brightest on the petaloid area and on the lunule margins, darkest at disk margin; faintly outlining many plates are dark, Andover green lines, forming an indefinite but more or less evident pattern; lower surface a tawny olive.

In addition to the symmetrical and handsome holotype there are 5 other *Encopes* clearly belonging to this striking species. The smallest measures 80 x 80 mm with a thickness of 8 mm; the anterior and left posterior lunules are not completely closed in; a less symmetrical specimen is 90 x 88 mm and has both the right hand lunules open; a very symmetrical specimen, 90 x 92 mm has all the lunules fully closed; a very unsymmetrical and irregular adult is approximately 135 mm long and 125 mm wide; no lunule is closed in save the anterior which is imperfectly shut in. The largest individual is 154 mm long, 152 mm wide and 11 mm thick (35-40 mm back of the anterior margin); the dull greenish lines are present but much less evident than in the holotype. Of the smaller specimens only one gives any indication of them.

*Distribution*.—Most of the material referable to this very striking species was taken in or near Petatlan Bay, Mexico, at 5 stations. The holotype is from Station 764-38, near White Friars Rocks, Mexico, in 15-20 fms; the largest specimen and the very irregular adult mentioned above are from Station 963-39, nearby but in slightly deeper water (20-25

<sup>15</sup> *fragilis*—easily broken, in reference to its relatively delicate structure.

fms), and the 3 young individuals also mentioned are from Station 265-34 in Petatlan Bay, close by in 5-10 fms. In addition to these clearly identifiable specimens there are 146 small *Encopes*, 4-15 mm across, which are presumably young individuals of this fine species. Fifty-eight of these are from Station 764-38 (Type station). The others are from Station 264-34, south of White Friars, in 25 fms; Station 265-34, Petatlan Bay, 5-10 fms; Station 267-34, west of Morro de Petatlan, 25 fms and Station 965-39, Tenacatita Bay, 8-15 fms.

*Type*.—Holotype, AHF no. 55, 5 paratypes.

*Type locality*.—Station 764-38, North of White Friars, Mexico, 15-20 fms, January 8, 1939.

*Distribution*.—Petatlan Bay to Tenacatita Bay, Mexico.

*Depth*.—5-25 fms.

*Specimens examined*.—The type, paratypes and 146 juvenile specimens from 6 stations.

### ***Encope insularis*<sup>16</sup>, new species**

Plate 61, Figs. 58-59

Test large and flat, moderately thin at the margins, conspicuously flat and thin in young specimens (under 100 mm in diameter). Length 135 mm, width 133 mm, height 14 mm; greatest thickness on a line connecting the anterior lunules, whence test slopes evenly to the anterior margin and somewhat more gradually to the posterior margin. Unpaired petal about 30 mm long and 12 mm wide becoming somewhat pointed at tip but not closed; the poriferous zones are narrow (3 mm) with the ridges bearing about 10 tubercles; the interporiferous area is 6 mm wide, its tip about 11 mm from the anterior lunule which is 9 mm long and nearly 4 mm wide, located 8 or 9 mm from test margin. Anterior paired petals rather far back, a little shorter and wider than the unpaired one. Lunules of these petals very similar in size and form to that of the anterior area. Posterior petals longer than the others, about 35 mm in length and 15 mm wide, their lunules long and narrow, 20 mm by 5 mm only 8 mm from margin. In all specimens except the holotype and the next largest, these lunules remain open distally. Interambulacral lunule long and narrow, about 20 by 4 mm, nearly 20 mm from margin, its anterior end 8 mm in front of the paired lunules. Posterior margin of test nearly straight in the type but less definitely so in other specimens. Lower surface of test flat and not peculiar. Spines of abactinal surface very numerous, slender with more

<sup>16</sup> *insularis*, of an island, in reference to its occurrence at Socorro and Clarion Islands.

or less markedly bulbous tips, lying inclined towards horizontal and forming a fairly even coat; in other specimens the bulbous tips are less uniformly evident, and the coat is not so smooth. Color mummy brown, the lower surface a brighter shade.

Besides the holotype, there are 4 other adults (100 to 120 mm in greatest diameter) which undoubtedly represent this rather fragile species. The largest closely resembles the type but is a somewhat brighter brown. The other 3 are nearly black, the smallest in particular is very dark above and light purplish gray on the oral side. A specimen 75 mm in diameter is a deep brown while a test 53 mm across is more nearly black. There are 2 bleached fragments and 4 very young individuals which are labeled as from Clarion or Socorro Islands.

*Distribution.*—The holotype, which is the largest specimen, was taken in Braithwaite Bay, Socorro Island, in 14-18 fms, in January, 1934, and another adult and 8 young individuals were collected at the same time and place. Five months later, 2 small adults, 2 very young specimens and a water worn fragment of an adult were taken at or near the same spot. Five years later one fine adult and 2 very young individuals were taken at Sulphur Bay, Clarion Island, in 25-45 fms. Apparently the species is confined to the vicinity of those two islands.

*Type.*—Holotype, AHF no. 56, 4 paratypes.

*Type locality.*—Station 129-34, Braithwaite Bay, Socorro Island, Mexico, 14-18 fms, January 3, 1934.

*Distribution.*—Socorro and Clarion Islands, Mexico.

*Depth.*—14-45 fms.

*Specimens examined.*—The type, paratypes and 13 specimens, from 5 stations.

### ***Mellita longifissa* Michelin**

Plate 62, Fig. 60

*Mellita longifissa* Michelin, 1858, p. 360, pl. 8, fig. 1.

This striking and easily recognized sand-dollar seems to be either very rare or very hard to collect for in all of the many years collecting by the *Velero*, it has been met with but once, when 2 apparently dead tests were taken at San Juanico Bay, well up on the western coast of Lower California. They were evidently picked up on the beach as the label reads simply "shore." One is completely bare of spines and is a trifle water worn. The other, which is slightly the larger, has rather more than half the upper surface still fairly well covered with the short, curved, capitate, white spines. As the epidermis of the test is apparently black or blackish, the resulting effect is a "pepper-and-salt" gray. Apparently this was at least

approximately the color in life. This specimen is 70 mm long, 75 mm wide and 9 mm high at the test apex, which is about 30 mm from anterior margin. The unpaired lunule is 22 mm long and 1.5 mm wide. The rarity of this well-marked species, more apparent perhaps than real, is probably due to an unusually subterranean habit which defies ordinary trawling and dredging.

*Distribution*.—Gulf of California to Panama.

*Type*.—Paris Museum?

*Type locality*.—"Habite.-Localite inconnue.-Collection Michelin."

*Depth*.—Shore to 30 fms.

*Specimens examined*.—2 specimens from 1 station.

Family **Cassidulidae**  
**Cassidulus pacificus** (A. Agassiz)  
 Plate 62, Fig. 61

*Pygorhynchus pacificus* A. Agassiz, 1863, p. 27.

*Cassidulus pacificus* Grant and Hertlein, 1938, p. 108, pl. 13, fig. 6; pl. 29, figs. 4, 5; pl. 30, fig. 6.

Mortensen, 1948, Monograph of the Echinoidea, IVi, p. 210, pl. 2, figs. 1, 2, 11-13, 19; pl. 11, figs. 2, 11-13.<sup>17</sup>

This interesting Cassiduloid is represented by 19 specimens and fragments of another. The fragments are the ventral surface of a large individual about 50 mm long by 40 mm wide, and half a dozen pieces of the upper part of the test. The chief interest in these pieces is the color, for they have preserved the color of the living animal to a remarkable degree. The ground color is cream color becoming quite yellow along the sides and on the margins of the lower surface. This surface is quite white and unspotted but the upper surface is covered with irregular blotches of Andover green. Around the periproct, more particularly below it, is an evident patch of vinaceous drab. With these fragments, a specimen 20 x 17 x 10 mm was taken which is undamaged; it is nearly white with evidence of cream color and with irregular rather numerous small blotches of purple. The other 18 specimens show considerable diversity; 5 specimens are quite brown, the largest one conspicuously blotched at the anterior end, dorsally with a darker shade; several half grown individuals are nearly white, with faint indications of small dusky blotches; some small specimens are light gray without spots. These small individuals are about 8 mm long.

<sup>17</sup> This work unknown to Clark, being published only half a year after his death.  
 —Th. M.

*Distribution.*—The *Velero* found no Cassiduloids along the mainland coast. All of the 20 specimens were taken at islands, 9 at Socorro, 9 at Clarion, and one, with the adult fragments was dredged in 48-73 fms near Barrington Island in the Galapagos Islands. The Socorro specimens were found in 4-10 fms near Cape Rule and in deeper water (10-30 fms) in Braithwaite Bay. The Clarion material was taken off the north side of the island in 30-56 fms or off Sulphur Bay in 25-26 fms. Other records show the distribution to include the Gulf of California to Panama.

*Type.*—M.C.Z. no. 2719 (Cotype).

*Type locality.*—Acapulco, Mexico.

*Depth.*—4-73 fms.

*Specimens examined.*—20 specimens from 7 stations.

Family **Hemiasteridae**  
**Agassizia scrobiculata** Valenciennes

Plate 63, Figs. 62-63

*Agassizia scrobiculata* Valenciennes, 1846, pl. 1, figs. 2-2f.

Although this Spatangoid is reported from various stations between Mazatlan, Mexico and Capon, Peru, the *Velero* met with it very rarely. A bare test, 16 x 13 x 10 mm was found on shore at Willards Island, Gulf of California, far north of Mazatlan, and a large bare test (21 x 19 x 16 mm) was picked up on shore at Cartago Bay, Albemarle Island, Galapagos Islands. One of the prizes of the *Velero's* visit to the Galapagos in 1938 is a remarkably fine test of this Spatangoid presented to Captain Hancock by Mr. Osorio of Ritter's Landing, Charles Island. It was picked up along shore but is neither bleached nor damaged in any way, although the spine-coat is entirely lacking. It measures 55 mm in length, 50 mm in breadth, and 40 mm in height. The color is a dull light brown, the 4 genital and 5 ocular pores are easily seen and the fascicles are notably distinct. This is by far the largest specimen yet recorded. Besides these bare tests, the *Velero* dredged one living specimen, a very unusual capture. It is 16 x 14 x 12 mm with the surprisingly long white spines, 2 to 3 mm. The test is white but the dried muscles at the bases of the spines are yellow brown, so the whole effect is very pale brown. This interesting capture was made in the Gulf of California, between Angel de la Guardia and Mejia Islands, in 6-11 fms.

*Distribution.*—Gulf of California to Peru; Galapagos Islands.

*Type.*—Paris Museum?

*Type locality.*—Unknown.

*Depth.*—Shore to 11 fms.

*Specimens examined.*—4 specimens from 4 stations.

**Brisaster townsendi** (A. Agassiz)

Plate 64, Fig. 64

*Schizaster townsendi* A. Agassiz, 1898, p. 82.*Schizaster (Brisaster) townsendi* Mortensen, 1907, pt. 2, p. 123.*Brisaster townsendi* H. L. Clark, 1917, p. 179, pl. 155, figs. 4, 6, 8.

A common Spatangoid of the Eastern Pacific between southern Alaska and the Galapagos Islands, this species was taken by the *Velero* at 14 stations. The largest of the 120 specimens is badly damaged but measures 60 mm in width and must have been about 70 mm long and some 30 mm high. The smallest is 7 x 5.5 mm. All are some shade of brown, ranging from a very light shade, with fascicles conspicuously darker (Station 1163-40, 215-225 fms) to a very dark brown, the fascioles more or less conspicuous (Station 1497-42, 60-74 fms).

The specimens from Station 1133-40, off Redondo Beach, California, in 49-172 fms are remarkable for having the lateroanal fasciole developed as a conspicuous band more or less closely surrounding the anus, not in any sense lateral. At several stations both *Brisaster* and *Brissopsis* occur and it seems probable that some of the puzzling specimens are hybrids. In his full description of this *Brisaster*, Agassiz (1904) refers to the shape of the young when 10 mm in diameter. Some of the *Velero* specimens are smaller than that and have a very striking pentagonal form. These young pentagonal individuals have the sides of the pentagon measuring 5 or 6 mm. The peripetalous fasciole follows the margin of the pentagon on the upper side. Ventrally each interambulacrum is a convex bulge, the posterior (subanal) one somewhat the largest. The mouth is but little anterior to the center, and there is no definite sternum.

*Distribution.*—The *Velero* took *Brisaster* at stations ranging from Oregon (Station 1497-42, Lat. 44° 49' 10" N) to southern California (Station 1223-41, Lat. 33°, 27' 10" N), at depths of 20-250 fms, but the bulk of the specimens are from the vicinity of the Channel Islands in depths of more than a hundred fathoms. The greatest depth was in San Pedro Channel at 225-250 fms. Off Redondo Beach specimens were taken at 49-172 fms and off Santa Cruz Island in 64-134 fms. The absence of *Brisaster* from stations further south is no doubt due to the little dredging the *Velero* did at greater depths than 150 fms, for the *Albatross* material on which the species is based was collected at depths of 146-995 fms at stations from the Gulf of California to Panama. Other records extend the range north to southeastern Alaska.

*Type.*—M.C.Z. no. 2961 (Cotype).

*Type locality.*—Gulf of Panama to Guaymas, Mexico.

*Depth.*—20-995 fms.

*Specimens examined.*—120 specimens from 14 stations.

**Moira clotho**<sup>18</sup> (Michelin)

Plate 64, Fig. 65

*Moera clotho* Michelin, 1885, p. 247.*Moira clotho* A. Agassiz, 1872a, p. 147.

H. L. Clark, 1917, p. 196, pl. 156, figs. 5-7.

This odd, highly specialized Spatangoid is easily recognized by the deeply sunken, narrow, paired petals and even more deeply sunken anterior petal which presumably serves as a brood pouch for the young. The genus includes several species and ranges from the southeastern coast of the United States and the western coast of tropical America to Japan and Australia, to Suez, and Zanzibar, but apparently does not occur in European seas or on the west coast of Africa. The *Velero* met with it at 4 widely separated stations. There are 35 specimens altogether but more than half are very small, 5-10 mm long, and none are very large. These small ones are chiefly from Ecuador in 1 or 2 fms. The finest specimens are from the upper end of the Gulf of California, near Consag Rock, on a bottom of brown mud in 21 fms. The largest are about 26 mm long, by 22 mm wide by 18 mm high. They are almost pure white in color with the lateroanal fasciole yellow.

*Distribution.*—Gulf of California to Ecuador.*Type.*—Paris Museum?*Type locality.*—Mazatlan, Mexico.*Depth.*—1-21 fms.*Specimens examined.*—35 specimens from 4 stations.Family **Spatangidae****Brissopsis pacifica** (A. Agassiz)

Plate 65, Figs. 66-67

*Toxobrissus pacificus* A. Agassiz, 1898, p. 83.*Brissopsis pacifica* Mortensen, 1907, p. 168.

H. L. Clark, 1917, p. 203, pl. 155, fig. 1.

This is apparently the commonest Spatangoid in the Eastern Pacific. The *Velero* took 674 specimens at 65 stations. They range in size from very young (6 x 5 mm) to big adults (57 x 47 x 31 mm), but the very great majority are less than 35 mm long. As both *Brissopsis pacifica* and *Brisaster townsendi* were taken at 6 stations, it is not surprising that hybrids occur apparently with considerable frequency. While the two species are alike in dull coloration, *pacifica* tends to lighter shades and the fascioles are more conspicuous. There is some evidence that muddy or even foul

<sup>18</sup> In Grant and Hertlein, 1938, the specific name is consistently misspelled "*clothro*." H.L.C.

bottoms affect the coloration and appearance of the specimens but the data are not adequate to warrant positive statements. The evidence of hybridization with *Brisaster* has been presented under the discussion of *Brisaster townsendi*.

*Distribution*.—The fact that *Brissopsis* was taken at 65 stations is evidence of its general distribution, but an analysis of the data shows that nearly all the material is from moderately deep water off the coast of California, particularly in the vicinity of the Channel Islands. Specimens were secured near Clarion Island, but the most notable extension of the range is the taking of 2 small but indubitable specimens at Station 786-38, northeast of Indefatigable Island in the Galapagos Islands, in 392 fms.

*Type*.—M.C.Z. no. 3063 (Cotype).

*Type locality*.—Albatross Station 3355, off Point Mala, Panama, 182 fms.

*Depth*.—5-39 fms.

*Specimens examined*.—674 specimens from 65 stations.

### ***Plagiobrissus pacificus* H. L. Clark**

Plate 66, Figs. 68-70

*Plagiobrissus pacificus* H. L. Clark, 1940, p. 351, pl. 2, figs. 3, 4.

The occurrence of this rather striking Spatangoid in the Gulf of California is of great interest as it was known hitherto only from the type and paratype taken on Hannibal Bank, Panama, in 35 fms. In the *Velero* collection there are 67 specimens of this interesting Spatangoid, of which 9 are large enough to be called adults, but the test is thin and fragile and 4 are more or less crushed. The smallest is 10 x 7.5 x 4.5 mm and is quite undamaged. The largest is 56 x 41 x 20 mm, thus much larger than the holotype. Several specimens have a gray tint to the test instead of brown and there is a great deal of diversity as to the degree of brownness. While the general tuberculation and the arrangement of fascioles agree well with *Metalia*, the shape of the test is quite different from the short thickset form of most of the known species of that genus, and the large tubercles in interambulacra 1 and 5 show conclusively that it is not that genus.

*Distribution*.—All the material of *Plagiobrissus* was taken in the Gulf of California at depths of 5 to 75 fms except 3 specimens, as follows: a single fine bare test from Station 948-39, which is in Panama Bay in 30-35 fms; a very good half-grown specimen from Station 773-38, which is off Nuez Island, Cocos Island, in 31-50 fms; and a damaged young individual, 14 mm long, whose identification is somewhat dubious, from Station 212-



34, off La Plata Island, Ecuador. Apparently this Spatangoid occurs throughout the Panamic region, but further material is necessary to establish the limits of its distribution.

*Type*.—M.C.Z. no. 7625.

*Type locality*.—Hannibal Bank, Panama, 35 fms.

*Depth*.—5-75 fms.

*Specimens examined*.—67 specimens from 19 stations.

### **Idiobryssus coelus** H. L. Clark

Plate 67, Figs. 71-73

*Idiobryssus coelus* H. L. Clark, 1939, pp. 173-176, pl. 17.

The holotype of this odd little Spatangoid is the only specimen at hand. It was taken, together with a smaller paratype, in 40-70 fms, in Darwin Bay, Tower Island, Galapagos Islands, January 16, 1938. It is 12 mm long by 10 mm wide and 4 or 5 mm high. The color in life was white, but the dry specimen is more or less pale brown. The paratype is in the Museum of Comparative Zoology, Cambridge.

*Distribution*.—Tower Island, Galapagos Islands.

*Holotype*.—AHF no. 2.

*Type locality*.—Darwin Bay, Tower Island, Galapagos Islands.

*Depth*.—40-70 fms.

*Specimens examined*.—The type.

### **Brissus latecarinatus** (Leske)

Plate 67, Fig. 74; Plate 68, Fig. 75

*Spatangus brissus* var. *latecarinatus* Leske, 1778, pp. xx, 185.

*Brissus carinatus* Gray, 1825, p. 431.

*Brissus latecarinatus* H. L. Clark, 1917, p. 219.

This widespread Indo-Pacific Spatangoid has long been known from the Panamic region but the *Velero* has not secured many specimens nor are any of those at hand even half grown. Moreover of the 21 specimens, 16 are bare tests, nearly all bleached, and the largest is only 56 x 44 x 30 mm. This is almost one-third of the size of the largest recorded specimen, now in the collection of the California Academy of Sciences, which Grant and Hertlein (1938, p. 130) describe as 166 mm long, 128 mm wide and 106 mm high. Of the *Velero* specimens having the spines on and evidently alive when taken, the largest is 39 x 32 x 32 mm (Station 1079-40). The other *Velero* specimens, alive when taken, were found at Secas Islands, Panama (Station 446-35) and at Pond Island, Gulf of California (Station 1079-40). The bleached tests at hand, were found along the east shore of Angel de la Guardia Island, March 6, 1936; at

Willards Island, in January, 1940, and at Puerto Refugio, Angel de la Guardia Island, also in January, 1940. All the specimens at hand were taken along shore.

*Distribution*.—Gulf of California to Panama; Indo-Pacific from Hawaii, Australia to the Red Sea and Japan.

*Type*.—Unknown.

*Type locality*.—Unknown.

*Depth*.—Shore.

*Specimens examined*.—21 specimens from 6 stations.

### *Meoma grandis* Gray

Plate 68, Figs. 76-77

*Meoma grandis* Gray, 1851, p. 132.

A. Agassiz, 1873, p. 603, pl. 34, figs. 1, 2.

This big dull-colored Spatangoid appears to be common in the tropical Eastern Pacific, north of the equator, and the *Velero* collection contains some 90 specimens from 25 stations. All, however, are adults as the smallest is 80 x 72 x 39 mm. The largest is nearly twice that but is at present broken into two large bare pieces. It was in life at least 150 mm long, by 137 mm wide and 75 mm high. No other specimen is nearly so large, the biggest being 120 x 110 x 50 mm. Only 2 specimens, besides the large fragments, are bare. The color of the naked tests is a light brown gray or a deep brown with a violet cast. All of the other specimens are brown, usually very dark but the fragments from Cocos Island are definitely yellow brown. Several specimens are nearly black. On the whole, this *Meoma* must be regarded as the dullest colored, most unattractive echinoid of the west coast.

*Distribution*.—*Meoma* ranges from Port Utria, Colombiafi some 6 degrees north of the equator, in 15-30 fms, to the upper end of the Gulf of California (Angeles Channel, 28° 57' N). At the outlying islands, the *Velero* took good specimens in Braithwaite Bay, Socorro Island, and fragments of at least two large ones in Chatham Bay, Cocos Island. At the Galapagos Islands, the only specimen met with was the very large one, whose bare fragments were dredged in 58-60 fms, east of the south end of Albemarle Island. The bathymetric range of *Meoma* is not great, from along shore in a fathom or so to something less than 60 fms.

*Type*.—British Museum (No number).

*Type locality*.—Gray's original locality, "Australia," generally considered erroneous.

*Depth*.—Shore to 60 fms.

*Specimens examined*.—90 specimens from 25 stations.

***Spatangus californicus* H. L. Clark**

Plate 69, Figs. 78-79

*Spatangus californicus* H. L. Clark, 1917, p. 235, pl. 156, figs. 1-3; pl. 157, fig. 10.

This interestingly isolated *Spatangus* is represented in the *Velero* collection by 240 specimens from 47 stations, ranging in size from 21 x 18 x 12 mm to 86 x 79 x 43 mm. The general form is ovoid, more or less flattened both above and below, but some individuals are more ellipsoidal though flattened on the oral side. Occasionally the breadth equals the length and in such individuals the height may be less than half the breadth. The color shows a considerable diversity and is difficult to describe. Theoretically the test is a rich deep purple and the spines more or less nearly white, but often the test is deep red brown or, on the other hand, a clear gray without hint of red or purple. Occasionally the test is light with dark blotches and such specimens have a very different appearance and are much more nearly handsome than the dull purple one. The spines may be cream color or yellow or orange brown but are usually quite in contrast with the test.

The development of the very young into mature individuals affords some very interesting and puzzling stages which are confusing because of the resemblance to *Palaeotropus*. The striking feature of these stages is the simple nature of the ambulacral pores which are single and not paired. In some very young individuals only the pores at the apical end of the ambulacra are clearly present and each is single. There is thus no well-marked petal, only a double series of pores at the upper end of each ambulacrum as in *Palaeotropus*. With increasing age and size the older pores elongate horizontally and become two pores united by a short groove essentially like the pore-pairs on each side of the petal in *Spatangus* and its allies. This alteration in the appearance of the petals does not take place at the same stage of development in all young, but usually occurs very soon after the assumption of the spatangoid form so that most individuals 8-10 mm long have normal petals of 2 columns of double pores. Rarely, individuals as much as 15-20 mm long, have only single pores in each side of the ambulacrum, and the absence of petals in such specimens is very puzzling and may cause them to be referred to *Palaeotropus*. (See Fig. 76.)

*Distribution.*—The *Velero* did not take *Spatangus* until February, 1936, when specimens were secured in 100-120 fms, south of Coronados Island in the Gulf of California. A little later specimens were dredged in 165 fms off San Francisquito Bay and in 100 fms a bit nearer the mouth

of the Gulf. It was over 2 years before further specimens were secured and these were taken off Santa Catalina Island in 50 fms. The following year *Spatangus* was found in deep water, 130-330 fms, off Santa Rosa Island. In the fall of 1939, 5 stations between Catalina Island and San Benito Island, Lower California, yielded numerous specimens. In the months between February 1940 and October 1941, especially in the summer of 1941, *Spatangus* was secured at many stations at depths of 35-



Text figure 3. *Spatangus californicus* x4.

225 fms. But nearly all the material was taken near or south of the Channel Islands and near San Benito and Cedros Islands. A few specimens were secured near the end of Lower California but none were taken further south nor near any of the outlying islands.

*Type*.—U.S.N.M. No. 789.

*Type locality*.—Albatross Station 2973, "off Southern California, 68 fms."

*Depth*.—35-225 fms.

*Specimens examined*.—240 specimens from 47 stations.

**Gonimaretia laevis** H. L. Clark

Plate 70, Figs. 80-81

*Gonimaretia laevis* H. L. Clark, 1917, p. 244, pl. 161, figs. 5-7.

This interesting Spatangoid, originally described from 3 small specimens (24-34 mm long) is well represented in the *Velero* collection by 57 specimens and the large adults are exceptionally handsome for a Spatangoid. The largest at hand is 42 x 36 x 18 mm, about a third larger than the holotype; the smallest, not quite 10 mm long, well shows the characteristic features of both genus and species. The color of the largest specimens is a light fawn brown but many of the smaller ones are quite a dark brown. The primary spines are not conspicuous but are very slender and quite appressed. The coat of secondary spines, in the best specimens, is very dense and has a silky appearance and feeling. The large pedicels near the mouth are a deep brown (almost black in dry specimens). Although lacking the diversity of color and the numerous long primaries of *Lovenia*, this Spatangoid rivals that notable genus in the general attractiveness of its appearance.

*Distribution.*—Although taken at 21 stations, this very striking “sea-mouse” (if it may be called by the popular name long ago given to *Lovenia*) was found chiefly among the Channel Islands, California, and up in the Gulf at least to Angel de la Guardia Island. A single specimen was taken at the San Benito Islands, Mexico. One lot is labeled 814-38, a station near Hood Island, Galapagos Islands, but in the absence of other specimens from south of the Gulf, this label must be regarded with suspicion. There is no doubt of the specimens being young *Gonimaretia* for they closely resemble others of the same size from the Gulf of California. While occasionally taken in 3-5 fms, most specimens were dredged in water of moderate depths, 20-165 fms.

*Type.*—U.S.N.M. No. 805.

*Type locality.*—*Albatross* Station 2911, south of San Clemente Island, California.

*Depth.*—3-165 fms.

*Specimens examined.*—57 specimens from 21 stations.

**Lovenia cordiformis** A. Agassiz

Plate 71, Figs. 82-83

*Lovenia cordiformis* A. Agassiz, 1872, p. 57.

H. L. Clark, 1917, p. 254, pl. 161, figs. 8-12.

Grant and Hertlein, 1938, p. 136, pl. 13, figs. 1, 2.

There can be little question that this relatively common Spatangoid is one of the handsomest species of the warm Eastern Pacific. It is well represented in the *Velero* collection by 100 specimens from 44 stations, but

owing to the relatively delicate test most of these, unless very small, were more or less damaged when taken. The very long primary spines are exceedingly slender and fragile and are commonly broken off to a considerable extent, and the test itself is more often broken than not. The largest specimen in the collection is from the Galapagos Islands and measures 75 x 51 x 20 mm. The anterior left corner and most of the large primaries are gone. Another very large specimen is 55 mm across but it is badly damaged at the posterior end so its living length cannot be determined. Many of the specimens are less than 10 mm in length, some less than 5 mm, and these small ones are easily confused with other young Spatangoids but if the condition of the specimen permits the internal fasciole to be seen, there can be no confusion of *Lovenia* with other genera.

The color of these striking Spatangoids is diverse, ranging from a light gray brown with the long primary spines pure white to a deep yellowish brown or a gray brown with the primaries not essentially different. The gray brown shades into lavender and purple, with the long spines conspicuously banded. The handsomest specimens are definitely light purple, fading into light brown or dirty white orally. The long spines on the sides and orally are unicolor, lavender or very pale brown, but dorsally they are prettily banded with light brown, pale orange or dirty white, and lavender or purple. The long spines of ambulacrum 3 are nearly white with widely separated very narrow bands of dark purple. Bare tests are a light dingy lavender or yellow brown, if not bleached, and the sunken primary tubercles, large oddly shaped "petals" and conspicuous inner fasciole make them unusually interesting curios.

*Distribution.*—*Lovenia* is a striking feature of shore and shallow water collecting at Newport and Corona del Mar. Further north it ranges to San Pedro and the Channel Islands, where it has been taken in 17-75 fms. The northern limit of its range is apparently just above 34°. It is fairly common in the Gulf of California, as far north as 29° 33', in water 2-75 fms deep. Rather common on the west coast of Mexico, it extends its range to the Secas and Jicarita Islands, Panama, in 12-30 fms. The *Velero* took it twice at Braithwaite Bay, Socorro Island, twice at Cocos Island and twice in the Galapagos Islands, at Chatham and Albemarle Islands in 4 and 30 fms. It seems a little strange that more specimens were not secured at the Galapagos Islands, for so conspicuous a shallow water sea-urchin is not easily overlooked.

*Type.*—M.C.Z. no. 3188 (Cotype).

*Type locality.*—"San Diego, Guaymas."

*Depth.*—Shore to 75 fms.

*Specimens examined.*—100 specimens from 44 stations.

## LITERATURE CITED

## AGASSIZ, A.

1863. List of Echinoderms sent to different institutions in exchange for other specimens, with annotations. Bull. Mus. Comp. Zool., vol. 1, no. 2, pp. 17-28.
1872. Preliminary notice of a few species of Echini. Bull. Mus. Comp. Zool., vol. 3, no. 4, pp. 55-58.
- 1872-74. Revision of the Echini. Mem. Mus. Comp. Zool., vol. 3, no. 1, pp. v-xii, 1-242, pls. A-G; no. 3, pp. 379-623, 28 pls.
1898. Preliminary report on the Echini. Dredging operations of the Albatross. Bull. Mus. Comp. Zool., vol. 32, no. 5, pp. 71-86, pls. 1-13.
1904. The Panamic Deep Sea Echini. Mem. Mus. Comp. Zool., vol. 31, pp. i-x, 1-243, 112 plates.

## AGASSIZ, A. AND H. L. CLARK

1908. Hawaiian and other Pacific Echini. Mem. Mus. Comp. Zool., vol. 34, no. 2, pp. 47-132, pls. 43-59.

## AGASSIZ, L.

1841. Monographies d'échinodermes vivans et fossiles. Echinites. Famille des Clypeastroides. II<sup>e</sup> monographie: Scutelles.

## AGASSIZ, L. AND E. DESOR

- 1846-47. Catalogue raisonne des families, des genres et des especes de la classe des Echinodermes. Annales des Sciences naturelles (Zool.), ser. 3, vol. 6, pp. 305-374, pls. 15, 16; vol. 7, pp. 129-168.

## BLAINVILLE, H. M. D. DE

1825. Oursin. Dictionnaire des Sciences Naturelles, vol. 37, pp. 59-98.
- 1834-36. Manual d'Actinologie ou de Zoophytologie. 688 pp., 100 pls.

## CLARK, AUSTIN H.

1946. Echinoderms from the Pearl Islands, Bay of Panama, with a revision of the Pacific Species of the Genus *Encope*. Smiths. Misc. Coll., vol. 106, no. 5, pp. 1-11, pls. 1-4.

## CLARK, H. L.

1907. The Cidaridae. Bull. Mus. Comp. Zool., vol. 51, no. 7, pp. 165-230, pls. 1-11.
1910. The Echinoderms of Peru. Bull. Mus. Comp. Zool., vol. 52, no. 17, pp. 321-358, pls. 1-14.
1912. Hawaiian and Other Pacific Echini. Mem. Mus. Comp. Zool., vol. 34, pt. 4, pp. 205-383, pls. 90-121.
1913. Echinoderms from Lower California with Descriptions of New Species. Bull. Am. Mus. Nat. Hist., vol. 32, art. 8, pp. 185-236, pls. 44-46.
1914. Hawaiian and Other Pacific Echini. Mem. Mus. Comp. Zool., vol. 46, pt. 1, pp. 1-78, pls. 122-143.
1917. Hawaiian and Other Pacific Echini. Mem. Mus. Comp. Zool., vol. 46, pt. 2, pp. 81-283, pls. 144-161.
1935. Some New Echinoderms from California. Ann Mag. Nat. Hist., ser. 10, vol. 15, pp. 120-129.

1939. A Remarkable New Genus of Sea-Urchin (Spatangidae). *Allan Hancock Pacific Expeditions*, vol. 2, no. 11, pp. 173-176, pl. 17.
1940. Notes on Echinoderms from the West Coast of Central America; Eastern Pacific Expeditions of the New York Zoological Society. *Zoologica*, New York Zool. Soc., vol. 25, pt. 3, pp. 331-352, pls. 1, 2.
- DESOR, EDOUARD  
1858. Synopsis des Echinides fossiles. Pp. i-lxvii, 1-2, 1-4, 1-490, XLIV pls.
- DÜDERLEIN, L.  
1887. Die japanischen Seeigel. I: Familien Cidaridae und Saleniidae. Pp. 1-59, pls. 1-11.
- ESCHSCHOLTZ, J. F. VON  
1831. Zoologischer Atlas . . . Vol. 4.
- GRANT, U. S. AND L. G. HERTLEIN  
1938. The West American Cenozoic Echinoidea. Publications of the Univ. of Calif. at Los Angeles, in Mathematical and Physical Sciences, vol. 2, pp. 1-225, pls. 1-30, figs. 1-17.
- GRAY, J. E.  
1825. An attempt to divide the Echinids, or Sea-eggs, into natural families. *Annals of Philosophy*, vol. 26, pp. 423-431.  
1851. Descriptions of some new Genera and Species of Spatangidae . . . *Ann. Mag. Nat. Hist.*, ser. 2, vol. 7, pp. 130-144.
- JACKSON, R. T.  
1899. Localized stages in development in plants and animals. *Mem. Boston Soc. Nat. Hist.*, vol. 5, pp. 89-153.  
1912. Phylogeny of the Echinini. *Mem. Boston Soc. Nat. Hist.*, vol. 7, 490 pp., 76 pls.
- LAMARCK, J. B. P.  
1816. *Histoire Naturelle des Animaux sans Vertèbres*, vol. 3, 586 pp.
- LESKE, N. G.  
1778. *Additamenta ad Jacobi Theodori Kleinii Naturalem dispositionem echinodermatum et lucubratiunculam de aculeis echinorum marinorum*. Leipzig: pp. i-xx, 1-218, pls. 37-54.
- MICHELIN, JEAN LOUIS HARDOUIN  
1855. *Revue et Magasin de Zoologie pure et Appliquée*, ser. 2, vol. 7, pp. 246-248.  
1858. *Revue et Magasin de Zoologie pure et Appliquée*, ser. 2, vol. 10, pp. 360-361.
- MOLINA, JUAN IGNACIO  
1782. *Saggio sulla storia naturale del Chili*. 327 pp.
- MORTENSEN, TH.  
1903-07. Echinoidea. The Danish "Ingolf" Expedition report, vol. 4, pt. 1, 193 pp., 21 pls. 1 map; pt. 2, 200 pp., 19 pls.  
1928. New Cidaridae. *Vidensk. Medd. naturh. Foren.*, vol. 85, pp. 65-74.



- 1928a. A Monograph of the Echinoidea, vol. I: Cidaroidea, 551 pp., 88 pls., 173 figs.  
1935. A Monograph of the Echinoidea, vol. II, 647 pp., 89 pls., 377 figs.  
1940. A Monograph of the Echinoidea, vol. III, pt. 1, 370 pp., 77 pls., 197 figs.  
1942. New Echinoidea. Vidensk. Medd., Naturh. Foren., vol. 106.  
1943. A Monograph of the Echinoidea, vol. III, pt. 2, 553 pp., 56 pls., 321 figs.  
1943a. A Monograph of the Echinoidea, vol. III, pt. 3, 446 pp., 66 pls., 215 figs.

**STIMPSON, WILLIAM**

1857. Crustacea and Echinodermata of the Pacific Shores of North America. Boston Jour. Nat. Hist., vol. 6, pp. 522-531, pl. 23.

**VALENCIENNES, A.**

1846. Voyage de "Venus": Zoophytes, pls. 1-15.

**VERRILL, A. E.**

- 1867-71. Notes on the Radiata in the Museum of Yale College. Trans. Conn. Acad. Arts and Sci., vol. 1, pt. 2, pp. 247-613.  
1870a. Descriptions of Echinoderms and Corals from the Gulf of California. Am. Jour. Sci., ser. 2, vol. 49, pp. 93-100.

**ZIESENHENNE, FRED C.**

1937. Echinoderms from the West Coast of Lower California, the Gulf of California and Clarion Island. The Templeton Crocker Expedition X. Zoologica, pt. 3, no. 15, pp. 209-239.  
1941. Some Notes on the Distribution Records of Little Known Southern California Echinoderms. Bull. So. Calif. Acad. Sci., vol. 40, pt. 3, pp. 117-120.

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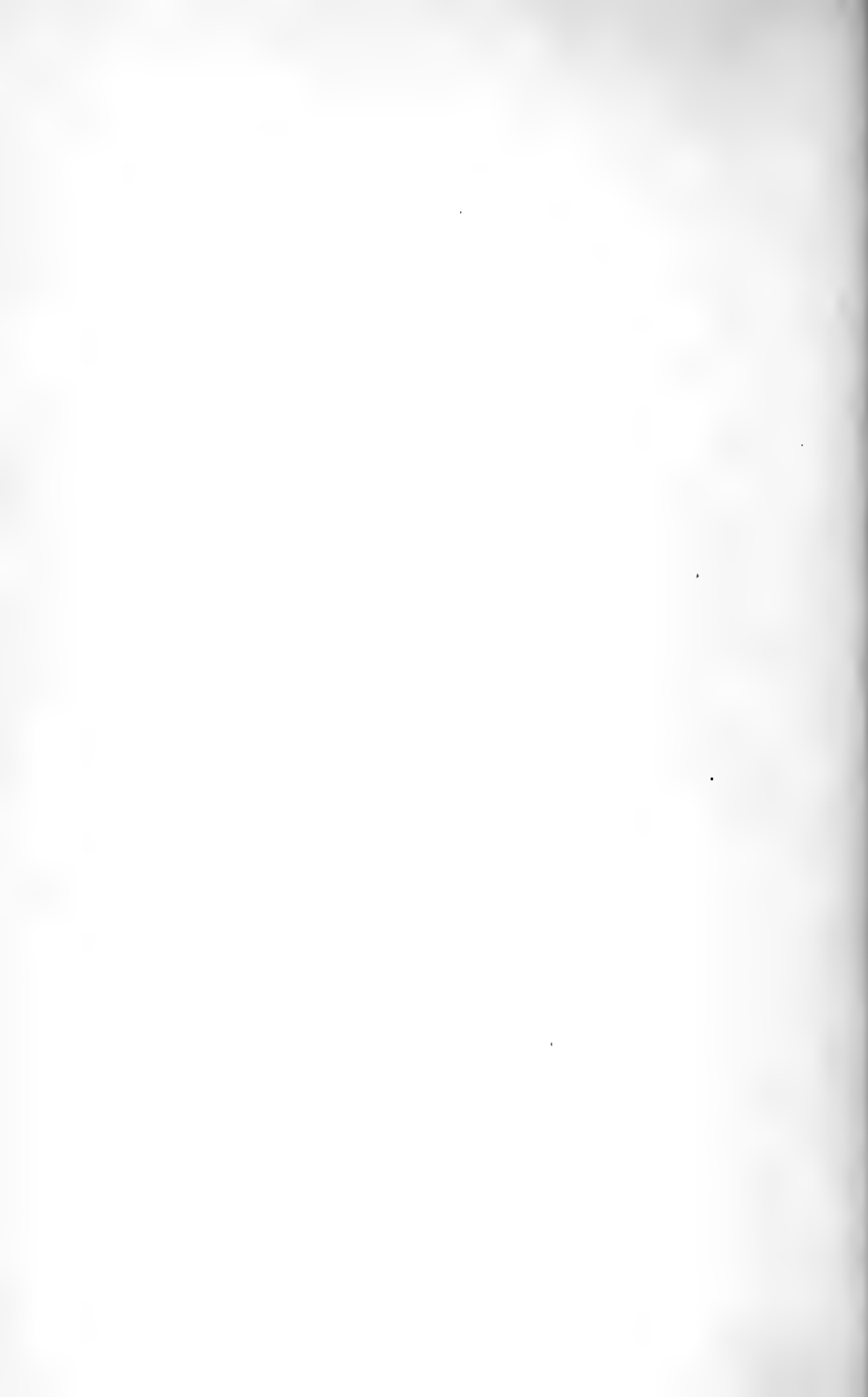
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