
NEW STARFISHES FROM DEEP WATER OFF
CALIFORNIA AND ALASKA.

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In this paper are described 1 genus, 2 subgenera, and 24 species of starfishes believed to be new. They are as follows:

Eremicaster, new subgenus.	Hippasteria californica.
Porcellanaster (Eremicaster) tenebrarius.	Cryptopeltaster, new genus.
Bathybiaster pectinatus.	Cryptopeltaster lepidonotus.
Dipsacaster eximius.	Lophaster furcilliger.
Persephonaster penicillatus.	Peribolaster biserialis.
Benthopecten acanthanotus.	Pteraster jordani.
Dytaster gilberti.	Hymenaster quadrispinosus.
Minaster swifti.	Zoroaster ophiurus.
Odontaster crassus.	Myxoderma, new subgenus.
Pseudarchaster alascensis.	Zoroaster (Myxoderma) sacculatus.
Pseudarchaster pusillus.	Zoroaster (Myxoderma) evermanni.
Tosia leptocerama.	Brisinga exilis.
Mediaster tenellus.	Freyella fecunda.
Hippasteria heathi.	

One subfamily, the Pseudarchasterinae, is raised to family rank.

The specimens on which these descriptions are based were dredged by the steamer *Albatross* in Alaskan waters during the summer of 1903, and off the coast of southern and central California in the spring of 1904. In the final reports on these dredging operations numerous figures of all the new forms will be published. The collections are the property of the U. S. Bureau of Fisheries and are temporarily deposited in the zoological museum of Stanford University for study. A full series, including the types, will eventually be deposited in the U. S. National Museum.

Family PORCELLANASTERIDÆ Sladen, 1889.

Genus PORCELLANASTER Wyville Thomson.

Porcellanaster Wyville Thomson, *Voyage of Challenger*, Atlantic, I, 378, 1877 (*P. ceruleus* Thomson).

EREMICASTER, new subgenus.

Differs from typical *Porcellanaster* in having 3 cribriform organs to each interradius; segmental pits and papillae present; adambulacral plates with 1 or 2 spines. Type, *Porcellanaster (Eremicaster) tenebrarius*, new species.

Porcellanaster (Eremicaster) tenebrarius, new species.

Rays 5. R=37 mm.; r=12 mm. R=3 r. Breadth of ray at interradiation line, 14 to 15 mm.; at outer edge of lateral cribriform organ, 9 mm.; height of epiproctal cone, 3 to 5 mm., in different specimens.

Rays elongate, stout, fairly slender, abruptly tapering at base, but very gradually on outer three-fourths; interbrachial arcs wide and well rounded; disk only slightly or not at all inflated; ambulacral furrows very wide; actinostome large; rays more or less reflexed, but not greatly curved.

Abactinal area slightly sunken below level of inner edge of superomarginal plates; fairly narrow on rays (4 mm. wide at outer edge of lateral cribriform organs, 2 mm. at middle of ray); integument thin but resistant, covered with simple, slender spinelets which are well spaced, sheathed in membrane, and slightly longer toward edge of disk than in the center; spinelets absent from rays beyond outer cribriform organ; scattered among the spinelets are numerous papulae, especially in the inter-radial areas; externally these papulae appear subglobular, and are much larger than the spinelets; epi-proctal cone varying in thickness, and from 3 to 5 mm. high.

Marginal plates arching inward, so that contour of body is defined by the inferomarginals when viewed from above, these forming a sloping lateral face to the rays and disk. Superomarginals, 18 or 19 in number from the median interradiial line to extremity of ray, nearly quadrate and larger than the lower series, each plate bearing 1 robust, tapering, sharp spinule (or occasionally 2) nearly as long as height of plate, these forming a series at upper edge of plates and decreasing in size toward extremity of ray; terminal plate prominent, notched at inner abactinal edge adjacent to integument, and bearing 5 tubercular spinules, 1 at extreme tip, 1 at either side of end of furrow, actino-lateral in position, and 1 on either side, abactino-lateral in position, placed farther inward; inferomarginal plates longer than high, corresponding to superomarginals in number, and not extending upon actinal surface at all, but forming an angle with it.

Cribriform organs, 3 in each interbrachial arc, placed rather close together, the median largest, having about 20 to 24 lamellae, each organ with a slight depression down the center.

Adambulacral plates narrow and rather long, conspicuously excavated on furrow margin, adoral end most prominent and surmounted by 2 sharp tapering spinelets, one, slightly curved, usually directed into the furrow, the other often a trifle smaller, either reflected back over the plate or turned aborad; midway between extremities of plates a small, thin, scale-like papilla, with the straight base upon which it is articulated running parallel to the furrow, and having the rounded free edge directed outward. The pit covered by the papilla is in a very rudimentary condition on the proximal plates, and beyond the basal fourth of the ray is absent, the papillae themselves becoming changed into small lanceolate spinelets, accompanying the 2 other spinelets, so that on the outer half of the ray each plate appears to have 3 spinelets.

Mouth plates prominent, the united pair forming a broad keel; median suture prominent, the companion plates touching at inner and outer ends; inner extremity of the combined pair rounded, with a single, robust, short, conical spinelet at the union of the two, at this inner angle; placed higher up, a curved, compressed, smaller spinelet at either side, on each plate, and between the latter and the margin adjacent to first adambulacral plate 2 semicircular papillae, the adoral occasionally the smaller, though not conspicuously so.

Actinal interradiial areas small and triangular, and covered with a thin skin through which the plates are not discernable until the specimen is partially dried.

Madreporic body large, adjacent to a median cribriform organ.

Color in life: General tint whitish, bluish cast on disk due to viscera showing through integument.

Localities: Type from station 4397, about 200 miles off San Diego, Cal., 2,196-2,228 fms., gray mud.

This species is nearest *Porcellanaster crassus*, which was taken by the Challenger Expedition in 2,335 fathoms in the South Pacific, midway between Sydney and Valparaiso. From this form *tenebrarius* differs in having longer and slenderer rays, more numerous marginal plates, longer spinelets on the abactinal membrane, frequently 2 superomarginal spines, 2 adambulacral spinelets, less well-developed pits and papillae, and broader mouth plates, which have an additional lateral spinelet.

Two of the specimens regularly have 2 superomarginal spinules, and on a few plates there are 3, forming a linear series.

Family ASTROPECTINIDÆ Gray, 1840.

Genus BATHYBIASTER Danielssen & Koren.

Bathybiaster Danielssen & Koren, Nyt Magaz. for Naturvidensk, XXVII, 4, 1883, 285; Den Norske Nordhavs-Expedition, 1876-78, Zoologi, XI, Asteroidea, 1884, 94.

Bathybiaster pectinatus, new species.

Rays 5. $R = 73$ mm.; $r = 15.5$ mm. $R = 4.7 r$. Breadth of ray at base, between first and second superomarginals, 16 mm.; midway along ray, 13.5 mm.

Rays moderately elongate, tapering continuously from base to a sharply pointed extremity; inter-brachial angles rounded; lateral walls nearly vertical, high; abactinal surface slightly inflated on disk, otherwise plane; actinal surface convex on rays; a low epiproctal elevation.

Paxillæ of abactinal area small, not crowded except at center of disk; arranged in transverse rows at sides of paxillar area of rays; no definite arrangement along median radial line; size decreasing toward ends of rays, and at center of disk, largest paxilla on disk midway to margin, each consisting of 3 or 4 centrally situated, small, cylindrical, round-tipped, membrane-invested spinelets, surrounded by a peripheral series of 10 or 12 slightly slenderer ones, the whole forming a very compact, flat-topped, subcircular, or irregularly elliptical group; small papillæ readily seen in the spaces between the paxillæ, especially on the rays.

Superomarginal plates, 46 in number from median interradial line to extremity of ray, encroaching but slightly upon abactinal area, short, high, and regular, and covered with small subcircular squamules along the median transverse or vertical line, these becoming slenderer and more papilliform toward edges of plate, especially in the fasciolar grooves; at about 1 mm. from upper end of plate an erect, slightly flattened, sharp spinelet attaining a length of 1 to 1.25 mm., and decreasing in length toward tip of ray, the series forming a regular longitudinal series at border of abactinal surface; spinelets much reduced in size on first 2 or 3 plates. Inferomarginal plates corresponding exactly to superomarginals in number and length, and like them covered with squamiform spinelets, which increase in size toward lower end of plate, but are slender and spinuliform in the fascioles; about 1 mm. from upper end of each plate a flattened slender tapering spine, attaining a length of 3.5 mm., the series of which extends the length of the ray, except that it is absent from the first 2 or 3 plates. These spines stand out at right angles to the side of the ray, and are longer than those of the superomarginal series, decreasing, like them, toward the extremity. At a similar distance from the lower end of the plates is another longitudinal series of spinelets, a trifle smaller than the superomarginal series, 1 spinelet to a plate and more or less appressed to the ray, this series extending about $\frac{2}{3}$ the length of ray (to 18th inferomarginal).

Adambulacral plates with a prominent angular margin to furrow. Armature of the character common to species of *Psilaster*, rather than that usual to *Bathybiaster*: (1) Furrow series consisting of 8 delicate subequal spinelets, a trifle curved, round-tipped or subtruncate, 2 at either end of the series flattened with sides to furrow, the 4 central ones with edges to furrow; lateral-most spinelets often shorter than the others; (2) actinal surface with 2 longitudinal series of flattened, truncate, or round-tipped spinelets, about 5 to each series, outer spinelets slightly wider than inner and all subequal to furrow series; both furrow and actinal spinelets incased each in a membranous sheath, thin on furrow series but pulpy and thick on actinal spinelets, especially the outer, which appear in consequence heavily clavate. It is difficult to make out the arrangement of spinelets unless the specimen is dried.

Mouth plates long and narrow; armature consisting of a marginal series of 15 short, regular, slightly flattened spinelets, appressed against a superficial series of 14 heavier, cylindrical, round-tipped or subclavate spinelets, which increase in thickness toward outer end of plate; inner end of combined pair of plates truncate, 2 spinelets at angle slightly larger and heavier than the others, slightly bent at base, and appressed to innermost of superficial spinelets; all incased in membrane, and the armature as a whole distinctly like *Psilaster*.

Actinal intermediate areas small, the plates extending about to 22d inferomarginal or about $\frac{2}{3}$ length of ray; plates beset with compact groups of very fleshy, spatulate round-tipped papillæ, which become pressed into various shapes by mutual contact; calcareous spinelet within papilla delicate,

oblong, and usually truncate; number of papillæ to each plate varying, and arrangement so compact that if the prevalent slime is thoroughly cleaned off the outlines of the groups in the interradial areas are clearly distinguishable; at outer end of mouth plates a few isolated papillæ which resemble in shape a flattened grain of corn attached by the small end. These groups of spinelets are considered as pedicellariæ by Danielssen and Koren in *B. pallidus*. In the present species the compact grouping suggests pedicellariæ, but I seriously doubt whether they serve any such purpose.

Madreporic body small, broadly oval, situated a little to the outer side of a point midway between center and margin of disk. Striations coarse, radiating from center of larger (adcentral) end.

Locality: Station 4387, off San Diego, Cal. (longitude of Point Conception), 1,059 fms., mud.

While the present species is undoubtedly a *Bathylbiaster* in general facies, in the character and armature of the marginal plates and actinal intermediate plates, yet in the armature of the adambulacral and mouth plates it strongly resembles *Psilaster*. The peculiar adambulacral spinelets of *B. loripes* Sladen (from off the west coast of South America near the entrance to the Straits of Magellan) are not even suggested in this species.

Genus *DIPSACASTER* Alcock.

Dipsacaster Alcock, Asiatic Soc. Bengal, LXII, 1893, 172 (no diagnosis); Ann. N. H. (6) XI, 1893, 87 (*D. pentagonalis* Alcock).

Dipsacaster eximius, new species.

Rays 5. $R=108$ mm.; $r=44$ mm. $R=2.45r$. Breadth of ray at base, 51 mm.; at middle of R, 40 mm.

General form flattened, rays broad, leaf-like in shape, tapering gradually, but with an outwardly curved contour, extremity bluntly pointed; interbranchial angles wide, abruptly rounded; abactinal surface but slightly inflated, a slight depression on interradial lines; actinal surface subplane, tube feet large, with pointed tips.

Abactinal paxillæ very regularly arranged on rays in chevrons pointing toward center of disk, the regularity continuing nearly to the center, but along median radial line a slight irregularity; each paxilla consisting of a high pedicel surmounted by a globular or elongate crown of very numerous, slender spinelets sheathed in delicate membrane, the whole forming a dense glomerular tuft, the central spinelets bluntly tipped, but those on the side mucronate, less crowded, and usually extending in a bristling arrangement down sides of pedicel for some distance. In a dried specimen the centrally situated spinelets are much sharper, due to a shrinkage in the membranous envelope.

Marginal plates regular and massive; inferomarginals extending laterally beyond superomarginals a distance nearly equal to the width of the latter, thus defining the contour of the body; exposed surfaces of plates separated by remarkably deep fasciolar channels. Superomarginal plates, 32 in number from median interradial line to extremity of ray, slightly wider than long, forming an arched bevel to margin of paxillar area, and confined entirely to abactinal surface, even in the interbranchial arc, where they are shortest and widest; exposed surface, which is slightly tumid, covered with small polygonal granuliform spinelets along transverse median line, these rapidly becoming slenderer at margins of elevated ridge, and finally capillary in the fasciolar grooves. Nearly all the plates bear a tubercular, strongly clavate, knobbed spinelet rather nearer the aboral edge than the center, with occasionally 1 or 2 smaller companions. These do not extend far above the general level of the other spinelets, except in one large specimen. Inferomarginal plates corresponding exactly in number and position to superomarginals; specialized ridge of each plate very high, and tumid; plates forming a broad border to actinal surface, and much wider than long; on lateral end of each plate, that portion forming edge of ray, a transverse series of 4 to 6 stout, tapering, sharp spinules, the uppermost (or that next) longest, these spinules forming an armature on margin of ray; general covering of plate consisting, on actinal surface, of ovate to oblong-lanceolate squamiform spinelets, which become capillary and very sharp in the fasciolar channels; outer end of plate bristling with slenderer, sharper, lancet-like spinelets, those on sides of the broad fasciolar grooves with excessively fine, mucronate tips.

Adambulacral plates massive, with a curved furrow margin; armature consisting of (1) a furrow series of 6 strongly compressed, round-tipped spines, usually standing at right angles to surface of plate, and with their edges to the furrow, the 2 centrally situated longest (3.75 mm.) and bluntest and

the rest graduated, the laterals being $\frac{2}{3}$ to $\frac{3}{4}$ as long and more lanceolate in shape. (2) On the actinal surface about 3 irregular longitudinal series of much smaller and slenderer spinelets, which decrease rapidly in size as they recede from the furrow, the series adjacent to the furrow spines consisting of about 3 or 4 spinelets, tapering, pointed, and $\frac{1}{2}$ to $\frac{2}{3}$ the length of the longer of the former; the outer 2 series are very irregular, the outermost being smaller than adjacent actinal intermediate spinelets, and between the former and the latter is a narrow zone free from spinelets.

Mouth plates large and prominent actinally, the combined pair broadest at about the middle; armature consisting of (1) a furrow or marginal series of 8 spines, similar in character to median spines of adambulacral furrow series, which begin at about middle of plate and form a fairly straight series to inner angle, increasing in size as they proceed inward, the inner 2 quite broad, flat, and knife-like, and, in common with the others, the edge away from furrow often thinner than that toward it; (2) actinal surface covered with slender, spaced, spinelets, which increase in size toward the suture and inner angle.

Actinal intermediate areas large, the plates arranged in chevrons. The breadth of ray in this species is largely due to the intermediate plates, of which 4 longitudinal series extend over $\frac{1}{2}$ the length of ray, 3 series slightly over $\frac{1}{2}$, 2 series over $\frac{3}{4}$, and a single series nearly to tip. Plates strongly carinated, the keel running transversely, each surmounted by a prominent paxilliform tuft of spinelets, of which the peripheral are slender and papilliform, the central much stouter, often clavate, with flattened, flaring pointed tips which appear to be bent outward toward marginal plates; spinelets of the series adjacent to adambulacrals heavier, often subprismatic and square-tipped. In the dry state all the spinelets are much slenderer, and the peripheral ones capillary. Between these actinal paxillae are fairly deep fasciolar channels.

Madreporic body large (9 mm. in diameter), irregular in outline, situated nearer to center than midway to margin, and hidden by 18 or 19 large paxillae.

Locality: Type from station 4334, Los Coronados Islands, southwest of San Diego, Cal., 525 fms., green mud.

This species is particularly characterized by its broad rays and disk, and the extensive actinal intermediate areas. It further differs from *D. pentagonalis* and *D. sladeni* of the Indian region in details of armature. The capture of this genus off California is rather surprising.

According to Mr. M. H. Spaulding, the color in life is orange yellow, lighter yellow beneath.

Genus PERSEPHONASTER Wood-Mason and Alcock.

Persephonaster Wood-Mason & Alcock, Ann. N. H. (6) VIII, 1891, 430 (*P. croceus* Wood-Mason & Alcock).

Persephonaster penicillatus, new species.

Rays 5. R = 176 mm.; r = 35 mm. R = 5r. Breadth of ray at base (between second and third superomarginals) 36 mm.

General form flattened; rays long, and tapering from a narrow base, in smaller specimens just a trifle swollen above the base; disk rather small, capable of slight inflation; interbrachial angles rounded; abactinal integument thin, a trifle convex at base of rays, rather sunken in middle of disk; marginal plates conspicuous, armed with stout spines, not encroaching upon abactinal area; no pedicellariae present; superambulacral plates present.

Abactinal area covered with rather small regular paxillae disposed in very regular transverse, slightly curved rows on the rays, but not regularly on center of disk; these series rather widely spaced and between them a double row of conspicuous papulae, which are numerous also on the disk; each paxilla consisting of an elongate, elliptical base set longitudinally with reference to long axis of ray, surmounted by a stout, cylindrical, convex-tipped pedicel which bears a crown of 8 or 10 very slender, tapering, needle-like spinelets, considerably longer than the pedicel, and usually standing upright in a cylindrical coordinate group, highly characteristic; paxillae largest on proximal radial areas, and, owing to the fact that the spinelets stand close together, appearing widely spaced, the papulae in alcoholic specimens being very conspicuous, though not large.

Superomarginal plates, 39 in number, from median interrachial line to extremity of ray, confined almost entirely to side wall; plates strongly tumid, subquadrate, except in interbrachial arc, where they are much higher than long; abactinal margin slightly arched; no fasciolar furrows between either

series; near center of each plate a robust tapering spine (or occasionally 2) much longer than the plate (7 or 8 mm.) and directly obliquely upward and outward, these spines longest at about middle third of ray and decreasing in length very gradually toward its extremity, most of them very curiously bifid for half or two-thirds their length, as if composed of 2 fused spines, and possessing, consequently, 2 closely appressed points; abactinal margin of plate bearing 1 or 2 upright, much shorter spinules (2 to 3.5 mm.), robust, tapering and pointed, 1 often shorter than the other; general surface of the plate bristling with small, spaced, capillary thornlets, very much smaller than the paxillar spinelets.

Inferomarginal plates corresponding in number to superomarginals, to which they are opposite, forming a steep, slightly arched level to actinal area; they are also tumid, especially along the transverse axis the tumidity passing into the upper plate without any conspicuous break at the suture between the two. A few of the proximal plates with a transverse series of 3 stout, tapering, pointed spines, frequently a trifle flattened and bifid like those of upper series; the rest of the plates, including the first 2, bearing 2 such spines, the upper the longer (8 to 9 mm.); toward distal part of ray the lower occasionally much reduced in size, and on some of the plates the upper split to the base, being in reality 2 spines with a common articulating boss; these spines are all commonly appressed to the ray, as in *Psilaster*. General surface of plates bristling with delicate spaced spinelets, which increase in size toward lower end of plate.

Adambulacral plates set obliquely; as a rule broader than long, with a curved furrow margin; armature consisting of (1) a furrow series of 5 or, less commonly, 6 (in smaller specimens, 3 or 4), compressed, rather delicate, slightly curved, blunt spinelets (4 mm.) often capped with a knobby membranous tip, arranged palmately, and usually graduated in length from the adoral to the aboral end of the series, these spinelets usually radiating stiffly apart; (2) on actinal surface an enlarged, flattened, blunt spinule, frequently with a shallow groove running from tip halfway to base, this surrounded by a variable number of smaller, flattened, blunt, membrane-invested spinelets frequently arranged in 2 longitudinal rows, 3 or 4 in each, the spinule standing on the inner series or between the 2, in which case the spinelets appear to form a wide circle around it; outer spinelets usually much flattened at tip and furrowed lengthwise as if incipiently bifid; in smaller specimens there are but 2 or 3 actinal spinelets and 1 spinule.

Mouth plates elongate, narrow, prominent actinally; interradial length 13 mm.; width of combined plates 5 mm.; at inner angle of the 2 combined plates 2 stout, enlarged, somewhat curved blunt spines, and the whole surface of the plate covered with thick, blunt, short, very robust spinelets which are largest near the inner angle and decrease in size and thickness toward the margin adjacent to first adambulacral; furrow series very angular and consisting of a group of spinelets, about 5 in number, situated at a higher level than the tooth, and continued to the first adambulacral along the excavated, short, free margin in 4 more short pointed spinelets. In a smaller specimen there is a regular and prominent series along the margin of the median suture, with a few slenderer spinelets along the sides, lower down, the actinal surface being very prominent. The first adambulacral forms a short and very wide companion plate.

Actinal interradial areas small; intermediate plates small, extending in a single series to within a short distance of tip; in interradial areas plates arranged in short irregular series extending from adambulacral to marginal plates; irregularly roundish, armed with a group of appressed, rather delicate, often flattened, obtuse, grooved, occasionally bifid spinelets, similar near the adambulacral plates to their outer actinal spinelets and forming thence all the transition between these and the lower spinelets of the inferomarginals; these spinelets all sheathed in membrane, which is frequently swollen at the tip. They frequently stand upright; spinulation by no means dense.

Madreporic body large (7 mm. in diameter), circular to irregularly oval, free, situated nearer margin than midway to center; striations rather fine; ridges narrow, branched, centrifugal.

Color in life, madder brown.

Locality: Station 4380, off Los Coronados Islands, southwest of San Diego, Cal., 530 to 638 fms., gray sand and rocks.

Family BENTHOPECTINIDÆ Verrill, 1899.

Genus BENTHOPECTEN Verrill.

Benthopecten Verrill, Amer. Jour. Sci., XXVIII, 1884, 218 (*B. spinosus* Verrill).
Pararchaster Sladen, in Narr. Challenger Exp., 1, 610, 1885.

***Benthopecten acanthonotus*, new species.**

Rays 5. R=? (tip of all of rays broken); r=9.5 mm. Breadth of ray at base, 10 mm. Length of interradial spine, 12 mm.

Rays narrow, depressed, very gradually tapering, probably very long; disk small, the abactinal surface inflated; along rays the abactinal surface nearly plane; lateral walls low, the rays having consequently a thin, flat appearance; actinal surface convex.

Abactinal surface beset with delicate, rather widely spaced, capillary spinelets, 1 to 2.5 mm. long, with a rugose surface, these decreasing in number and becoming slenderer and shorter as they proceed along the rays, here and there a few longer; on disk about 10 longer spinules (5 mm.), widely spaced; on abactinal surface many pedicellariæ, consisting of 2 opposed semicircular series of short curved spinelets, or more often the spinelets, about 12 in number, forming a circle with points meeting in the center, such apparatus from 0.75 to 1.5 mm. in diameter; spinelets rather numerous on disk and basal portion of rays, decreasing in numbers as they proceed outward; papulæ numerous on disk and extending along rays to sixth superomarginal, being confined to sides of area beyond fourth superomarginal.

Marginal plates confined to side wall of ray, considerably longer than high; upper series apparently set somewhat obliquely as regards the long and dorso-ventral axes. Each superomarginal bearing in the center a long, slender, tapering spine, that of the 3d or 4th plate being longest (8 mm.); 2 or 3 tiny capillary spinelets on adoral half of plate, and 1 or 2 in vicinity of spine. Each inferomarginal also bearing a long slender spine, on a slight boss, directed horizontally outward, the fourth being longest, each about equal to or a shade larger than the corresponding superomarginal spine; a second spinule, $\frac{1}{2}$ to $\frac{2}{3}$ the length of the larger, just below it; a few scattered capillary spinelets on the general surface; between lower odd interradial, and first inferomarginal of either ray, and between first and second inferomarginals, a characteristic pedicellarian apparatus, consisting of 2 combs, each of about 9 or 10 curved spinelets, meeting over the suture, the apparatus occupying the whole height of the plate (3 mm.); it sometimes occurs between the second and third plates in addition, or skips the suture between the first and second. On one side of one ray an apparatus occurs also between the 6th and 7th, and 9th and 10th plates, there being also 4 or 5 spines from an adjacent adambulacral entering into the make-up. Dorsal odd interradial plate with a prominent spine, 12 mm. long; the lower with a spinule, about the size of the adjacent inferomarginal spinules.

Adambulacral plates comparatively large, with a slight semicircular prominence into the furrow; armature consisting of (1) a furrow comb of 4 or 5 slightly curved, slender, subcylindrical, blunt spinelets, 3 of which are about equal, the aboral shorter, and when there are 5 the adoral also, these spinelets placed close together, and a wide interval between successive series, the spinelets usually standing vertically; (2) on the actinal surface 2 slender, slightly tapering, blunt spinules in a transverse series, the inner $\frac{2}{3}$ the length of the outer, which about equals 2 plates in length (3 mm. near base of ray); these spinules are articulated to slight knobs or bosses.

Mouth plates large, convex actinally, and the united pair with a broad furrow margin; in contour the combined pair broadly hatched-shaped; armature consisting of (1) a furrow series of 4 spines, which increase rapidly in size toward inner angle, where the innermost of 2 companion plates forms 2 prominent teeth, much heavier than the others; (2) on actinal surface 5 spines and spinelets, forming a linear series to outer end of plate, decreasing in size as they proceed outward, the inner spines being stout, cylindrical, and slightly tapering, the outermost slender and much shorter, the intermediate 3 graduated between the extremes.

Actinal interradial areas very small, second adambulacral plate in contact with the first inferomarginal; 2, or at most 3, intermediate plates. A comb of 3 to 7 curved spinelets meets a similar but smaller comb on the inferior interradial marginal plate, forming one of the peculiar pedicellarian apparatuses. On one interradius this is represented by an upright spinule and a rudimentary comb which is turned toward the interradial line.

Madreporic body convex, prominent, circular, with coarse, irregular centrifugal striations; situated about $\frac{1}{2}$ its own diameter from the edge of the interradial plate.

Locality: Station 4387, off San Diego, Cal. (longitude of Point Conception), 1,059 fms., mud.

This species is provided with pedicellariæ on the proximal 2 or 3 inferomarginal plates, and abundantly on the abactinal surface. In Sladen's synopsis of *Pararchaster* (Challenger Asteroidea, 5) the present form would be arranged under B, section a, where also *P. huddlestoni* and *P. violaceus* of Alcock apparently belong, *acanthonotus*, in respect to the inferomarginal pedicellariæ, being nearer the latter form. From this it at once differs in having a profusion of abactinal pedicellariæ, slenderer and smoother marginal spines, a less prominent inferior interradial marginal plate, and a different adambulacral and dental armature. The present species is nearest *pedicifer*, among those described by Sladen, but really does not bear comparison with that form.

Family PLUTONASTERIDÆ (Sladen) Verrill, 1899.

Genus DYTASTER Sladen.

Dytaster Sladen, Narr. Challenger Exp., 1, 608, 1885.

Dytaster gilberti, new species.

Rays 5. $R = 114$ mm.; $r = 22$ mm. $R = 5.2$ r. Breadth of ray at base, 22 mm.; at tenth superomarginal, $\frac{1}{4}$ length of ray, 17.5 mm.

Rays elongate, robust, tapering at first very slightly, then more rapidly, to a pointed extremity; abactinal integument inflated on disk, plane on rays; actinal surface convex; lateral wall of ray vertical on proximal half, gradually arching inward and upward on outer half, so that the marginal plates form a steep bevel; interbrachial arcs rounded.

Abactinal paxillar area covered with small paxillæ without definite order, and rather crowded on disk but distinctly spaced on ray; each consisting of a short pedicel surmounted by short, cylindrical, papilliform, obtusely-tipped, equal-sized spinelets, or the peripheral slightly slenderer; 15 to 20 in number at base of rays, even more on disk, and about 12 to 15 at outer part of ray. These stand vertically, the peripheral series flaring a trifle on disk and basal portion of rays, but all radiate on paxillæ of the outer part of ray. Over most of the ray papule may be distinguished between paxillæ.

Superomarginal plates, 50 in number from median interradial line to extremity of ray, nearly quadrate except in interbrachial arc, where they are higher than long; plates confined to side wall, except that the upper end forms a very narrow border to the paxillar area; each plate slightly tumid and bearing a rigid, erect, robust, tapering spine at the abactinal end, about as long as height of plate; general surface of plates covered with very small papilliform spinelets which are slenderer at the edges than in the center; inferomarginals corresponding, plate for plate, with superomarginals, tumid, forming a rounded border to actinal area, and covered, like the dorsal series, with a fine nap-like spinulation, which is coarser and more widely spaced on the actinal surface; in center of each plate a tapering, rigid spine, which stands out at right angles to lateral wall of ray, and is a trifle longer than corresponding dorsal marginal spine; these 2 series very regular and extending the length of the ray the lower on the line between the actinal and lateral faces; on the first 2 superomarginals an additional spine between regular spine and actinal margin of plate.

Adambulacral plates longer than wide, with a slightly curved furrow margin; armature consisting of (1) a furrow series of 10 (8 or 9 sometimes) fragile, slightly tapering, round-tipped, faintly compressed spinelets, which are slightly bent at the base and graduated toward either end of the series; (2) on the actinal surface just behind the furrow series, a longitudinal row of about 9 much shorter, thick, clavate spinelets, and on the outer edge of the plate a series of delicate, slender, tapering, papilliform spinelets which follow the contour of the plate and are smaller than the other series; furrow spinelets about as long as extreme width of plate.

Mouth plates large, prominent actinally, and the united pair broadest at middle, but only slightly, or not at all, narrower at outer end; lateral margins toward furrow slightly excavated, and the end toward actinostome truncate. (Unfortunately the armature in the specimen examined has been largely destroyed.) Marginal series much like that of adambulacral plates, and consisting of about 14 spines, compressed and curiously expanded above the slender base, from this expansion tapering

to the extremity; these spines seem to increase in size toward the inner angle, where there are 6 teeth, larger and heavier. General surface of plates covered with small papilliform spinelets similar to those of actinal intermediate plates, these increasing in size and thickness at inner angle.

Actinal interradial areas small, the intermediate plates, which are slightly convex, extending to the sixth or seventh inferomarginal, those adjacent to the adambulacral plates being largest; plates armed with spaced, radiating, small, papilliform spinelets. In a smaller specimen than the type several plates of each area bear a peculiar pedicellarian apparatus consisting of 3 or 4 shorter, thickened, clavate spinelets closely appressed. In the type there are but 1 or 2 to each area.

Madreporic body large, 8 mm. in diameter, situated a little more than half its own diameter distant from margin, and hidden by 40 large ornate paxillæ, which stand flush with the general surface; these paxillæ are larger than any on the general abactinal surface and their spinelets are heavier and more clavate, those situated on the periphery being slenderer, however, and apparently mucronate.

Locality: Station 4397, off San Diego, Cal., 2,196-2,228 fms., gray mud.

This is apparently a very distinct species related to *Dytaster exilis* Sladen, from which it differs in having shorter and broader rays, the sides of which are curiously arched inward on the distal portion; less crowded paxillæ which have a greater number of spinelets; more numerous marginal plates, the ventral series of which do not encroach upon the actinal area to any great extent, and a rather less numerous series of furrow spinelets, which further differ in form.

This species is named for Dr. Charles Henry Gilbert, professor of zoology in Stanford University.

Subfamily MIMASTERINÆ Sladen, 1889.

Genus MIMASTER Sladen.

Mimaster Sladen, Proc. Roy. Soc. Edin. XI, 1882, 702; Trans. Roy. Soc. Edin., XXX (ii) 1882, 579. (*M. tizardi* Sladen.)

Mimaster swifti, new species.

Rays 5. $R=114$ mm.; $r=43$ mm. $R=2.65r$. Breadth of ray at base, between first and second superomarginals, 50 mm.

General form large and robust, much flattened; rays broad at base, tapering evenly to a bluntly pointed extremity which is upturned; interbrachial arcs wide, rounded, but subangular, rather more rounded than in *M. cognatus*; abactinal surface slightly inflated, sunken in interradial areas; actinal surface slightly convex on rays, evidently capable of inflation, especially in actinal interradial areas; marginal plates conspicuous; no pedicellariæ.

Abactinal area more depressed than in either *tizardi* or *cognatus*, and covered with robust, roundish, or subhexagonal, uniform, rather closely placed paxillæ, which are arranged in transverse oblique rows at the sides on the proximal portion of rays, but are without order on distal half and on central portion of disk; paxillæ also forming longitudinal rows on basal portion of rays and largest on radial areas; each consisting of a low stout pedicel expanded at both ends, the summit surmounted by a nearly flap-topped group of about 25 short, robust, round subclavate, granuliform spinelets, those in the center occasionally flat-topped, but usually like the rest, round-tipped; in addition to these about 2 irregular peripheral series of very much smaller lanceolate subpetaloid spinelets placed lower down on the pedicel and appressed closely to bases of outer robust spinelets, so that they are not usually superficially visible; papulæ very numerous, arranged irregularly about the pedicels.

Marginal plates fairly conspicuous, but partaking of the nature of very large paxillæ; a well-defined, narrow, naked groove between superomarginals and abactinal paxillæ; both series with especial raised ridges, crowned with coarse granuliform spinelets, which increase in size toward center of ridge, where they are quite heavy and similar to very much enlarged spinelets of the paxillæ, though more tubercular and pointed; on inferomarginals the spinelets are still thicker and heavier and increase in size toward actinal end of plate; superomarginals, 40-43 in number from median interradial line to extremity of ray, much wider than long and most prominent at middle of ray, where the furrows between them are wider than elsewhere; they encroach upon the abactinal area, forming a well-defined border; inferomarginals corresponding to the dorsal series, and between the 2 series a fairly prominent groove; between inferomarginal spinelets and actinal intermediate plates another groove, for the most part obscured.

Adambulacral plates wide and short and rather closely placed, so that the peculiarly characteristic armature forms a dense mass of spines along margins of furrows; on each plate about 10 stout, subcylindrical, untapered, occasionally slightly compressed, truncate or round-tipped spines, which decrease in size as they recede from the furrow, and are arranged either in 5 longitudinal series of 2 or irregularly on outer half of plate; furrow series commonly oblique, and composed of 3 instead of 2 spines, or 1 may stand on center of margin and 2 just behind it; on outer end of plate 5 or 6 robust, smaller spinelets similar to those of actinal intermediate plates, forming a group about the outer spines, into which they grade in size.

Mouth plates comparatively large, rather prominent actinally, this appearance being accentuated by a depression in the interradial area at their outer end; general surface covered with numerous robust, irregular spinelets, which increase in size and become more compressed toward the free margin of the plate; marginal series beginning at outer (aboral) end, high in the furrow, as rather inconspicuous flattened lanceolate spinelets, which rapidly increase in size toward inner angle, the innermost being much enlarged, that next to it nearly as much, spatulate or hatchet-shaped and directed toward actinostome, which is almost entirely closed by the mouth plates. The latter, as a whole, have a very dense, bristling appearance, like the adambulacral plates.

Actinal interradial areas large and paved with superficially oblong plates, arranged in series running from adambulacrals to marginals, there being 10 in the series opposite the first adambulacral; these plates extending far along ray, but not attaining the tip, the number of plates in the transverse rows rapidly then gradually diminishing; each plate bearing on its convex eminence a group of coarse spinelets, which increase rapidly in size toward the center; peripheral spinelets very unequal, rather slender, but the central ones clavate, bluntly pointed, and similar to the centrally situated spinelets of the inferomarginals.

Madreporic body inconspicuous, situated midway between margin and center of disk, partially hidden by paxillæ; striations fine, but ridges coarse, centrifugal, undulating.

Locality: Station 4253, Stephens Passage, Alaska, in 188 to 131 fms.; rock and broken shells; bottom temperature 40.9°.

This is a distinct and rather peculiar species, differing widely from either *tizardi* or *cognatus* in both the general form, which is flattened, and the spinulation, which is notably coarser and more granuliform on the abactinal surface. The marginal plates are more conspicuous and the furrows between them more marked, while the armature of the adambulacral, mouth, and actinal intermediate plates appears coarser, particularly that of the first 2. The armature of the mouth plates with the spatulate teeth and peculiar furrow series is very characteristic.

This species is named for Lieut. Franklin Swift, U. S. Navy, commanding the *Albatross*.

Family ODONTASTERIDÆ Verrill, 1899.

Genus ODONTASTER Verrill.

Odontaster Verrill, Amer. Journ. Science, XX, 1880, 402 (*O. hispidus* Verrill).

Odontaster crassus, new species.

Stellato-pentagonal, with distinct rays. $R=21$ mm.; $r=13$ mm. $R=1.5$ r. Breadth of ray at base, 15 mm.

Disk large, rays short and blunt, uniformly tapering from the broad base; abactinal surface slightly inflated on radial areas; actinal area subplane; interbrachial angles very wide, shallow, and obtuse; marginal plates massive, conspicuous.

Abactinal paxillæ large and fairly elevated, arranged very regularly in a medium radial and about 6 parallel rows on either side (at base of radial area); each pedicel surmounted by a radiating group of 15 to 20 slender, tapering spinelets, which are longer than the pedicel or tabulum; papular pores fairly conspicuous, 6 about each plate, absent from interradial area where the spinelets of paxillæ or plates are shorter; basal plates of primary apical system much larger than any of the others; tabulum low.

Marginal plates broad and conspicuous; superomarginals forming a raised border to abactinal area; 17 in number to side of body, or 8 to the ray; interradial plate larger than the others, subtri-

angular. Supermarginals transversely oblong, wider than high, tumid, covered with granuliform spinelets which are thimble-shaped on margin of ray, but slender around edges of plate. Inferomarginals corresponding to supermarginals in number and position, but a trifle less tumid; granuliform spinulation a little coarser, and heaviest at the outer edge of the plate. Deep grooves, subfasciolar in form, separate the plates of both series. The lower odd interradial plate is not so large as the upper; both, however, reach the marginal sutural groove.

Adambulacral plates short and rather wide in proportion; armature consisting of 2 (less commonly 3) terete, tapering, bluntly pointed spinelets on the furrow margin, one slightly smaller than the other; on actinal surface 6 or 7 similar spinelets which diminish in size as they recede from the furrow, and usually disposed in 3 more or less regular longitudinal series, 2 spinelets to each, the outermost about the size of adjacent actinal intermediate spinelets; other adambulacral spinelets conspicuously longer.

Mouth plates with a movable recurved, conspicuous, lanceolate spine which has an obtuse inner and a sharp hyaline outer tip; 1 to each pair of plates; this spine rather broad actinally, not much compressed, and as long as the interradial dimension of the plates; a line of about 5 furrow, and another of 5 or 6 actinal spinelets, the latter crowded by the hyaline spine and extending along either side of it, diminishing in length outward; both furrow and superficial spinelets terete, pointed, very similar to adambulacral spinelets.

Actinal interradial areas large; plates squarish, in 6 regular chevrons and an odd plate adjacent to marginal interradial; plates bearing a group of 5 to 12 radiating, stout, short, pointed spinelets, shortest on margins of plate, occasionally forming a fairly ornate rosette.

Madreporic plate midway between center and inner edge of interradial plate; shape very broadly oval; striations coarse, irregular.

Locality: Station 4313, vicinity of San Diego, Cal., 92 fms., gray sand, broken shells.

This species is even more robust than *P. robustus* Verrill. The marginal plates are fewer and the odd interradial larger. The armature of the marginals is apparently more granuliform, the actinal intermediate plates more numerous, and the adambulacral armature is more robust. There are 2 instead of 4 or 5 furrow spinelets.

Family PSEUDARCHASTERIDÆ, new.

=Pseudarchasterinæ Sladen, Challenger Asteroidea, 109, 1889, as amended by Verrill, Trans. Conn. Acad., X, 1890, 187.

Genus PSEUDARCHASTER Sladen.

Pseudarchaster Sladen, Narr. Challenger Exp., 1, 617, 1885.

Astrogonium Perrier (non Müller and Troschel), Exped. Scientif. Travailleur et du Talisman, Echinod., 1894, 338.

The name *Astrogonium*, employed by Perrier and a few other writers for Sladen's genus *Pseudarchaster*, was originally proposed by Müller and Troschel (System der Asteriden, 1842, 52) and included 4 genera, *Hippasteria* Gray, *Goniaster* (Agassiz), *Pentagonaster* Gray, and *Tosia* Gray. The genus was thus a composite group without any type, and may be considered as a synonym of any of the foregoing genera, all of which are now recognized. The transferring of the name to a well-known group, none of the species of which was known to Müller and Troschel, is contrary to the simplest and most commonly accepted usage in matters nomenclatural. *Astrogonium* is forever a synonym.

Pseudarchaster alascensis, new species.

Rays 5. R=99 mm.; r=34 mm. R=2.91 r. Breadth of ray at base 40 mm.; at middle, 15 mm.

Rays rather well-developed, abruptly and arcuately tapering at base, then very gradually to the blunt extremity; interbranchial arcs wide and rounded; abactinal area subplane, only a trifle inflated on center of disk; actinal area slightly inflated.

Abactinal paxillæ crowded, fairly regular, largest in proximal radial regions, very crowded and small at ends of rays, where only the median radial series attains the ocular plate, but the 2 adradial series very nearly reach it; 1½ to 2 paxillæ correspond to each marginal plate; armature of paxillæ consisting of 1 or 2 central, polygonal or subprismatic, robust, elongate granules, heavier at tip than base and either flat or convex-tipped, surrounded by about 5 or 6 similar granuliform spinelets, alternating

with very much slenderer, prismatic, pointed spinelets; or the 5 to 7 or 8 robust spinelets may form a central group, often in an ornate rosette, surrounded at a slightly lower level by the slender spinelets, the latter standing between the heavy spinelets, however. Spinelets intermediate between the 2 sizes occur on the periphery of some of the paxillæ.

Superomarginal plates, 50 in number from median interradiial line to extremity of ray, much wider than long, widest in interbrachial arc and forming an even bevel, which is more arched on outer part of ray; these plates covered with a very regular hexagonal granulation, which is coarser at the outer (lateral) end of the plate, and distinctly though not distantly spaced, a peripheral series of smaller closer granules being clearly distinguishable; granulation of these plates coarser than that of the paxillæ. Inferomarginals corresponding exactly to superomarginals and forming a similar border to their area, covered with a coarse hexagonal granulation, which increases rapidly in coarseness toward outer edge of plate, where many of the granules flare at the tips and are somewhat squamiform. In the interbrachial arc the plates bear a median transverse series of 4 or 5 flattened, sharp lanceolate, appressed spinelets, which becomes reduced to one beyond the middle of the ray.

Adambulacral plates with an angular furrow margin bearing a palmate series of 5 tapering, more or less compressed spinelets, the median (or adoral admedian) the longest and most compressed; tips rounded; the lateral spinelets often with flat side uppermost; furrow series continued along adoral and aboral margin of plate in 3 or 4 spaced, much smaller, papilliform spinelets; on the actinal surface 2, or occasionally 3, enlarged, robust, pointed spinules, standing in a transverse, oblique, or longitudinal series, between them and the furrow series a semicircular row of 3 or 4 shorter, blunt, papilliform spinelets, very irregular, and on outer part of plate several smaller, clavate, spinelets; exclusive of the furrow series about 22 spinules and spinelets to each plate, the outermost very irregular in distribution, and on distal part of the ray showing a tendency to group themselves about the 2 or 3 larger spinules.

Mouth plates remarkable for their bristling armature; rather narrow, especially at the outer ends, and appearing quite distinct from one another; 1 enlarged tooth at inner angle of the combined plates, and the 3 adjacent spinelets decreasingly graduated on either plate, the next 4 longer and subequal, the outer slightly shorter than the 4; on actinal surface a dense mass of blunt cylindrical spinelets, which are rather long and slender on the inner end of the plate, but short, papilliform, and clavate on the outer part, the one kind passing insensibly into the other; the smaller spinelets form 2 regular rows on the outer part of the plate, but in one interradius there are 4.

Actinal interradiial areas large, the intermediate plates extending as far as the tenth inferomarginal; plates armed with spaced papilliform spinelets, those in the center robust and clavate, with slightly flaring tips bent outward, the peripheral smaller, round-tipped, occasionally subprismatic, very unequal and irregular, and radiating over narrow fasciolar grooves between the plates; these grooves lead from the inferomarginal fascioles to those between the adambulacral plates, following an irregular course. A number of scattered plates have one of the central spinelets considerably enlarged and pointed.

Madreporic body small, situated $\frac{1}{3}$ the distance from center to inner margin of superomarginal plates; striations very irregular.

Locality: Station 4236, near Yes Bay, Behm Canal, Alaska, in 147 to 205 fms., rocks, coarse sand; bottom temperature, 42.8°.

This species is characterized by well-developed post-adambulacral fascioles. It is probably most nearly related to *Pseudarchaster pretiosus* (Doederlein) from Japan (Tokyo and Sagami bays 20-30 meters) and may prove identical when a comparison of specimens is made. The original description (Zool. Anz. 1902, 326) is rather too short and incomplete to determine details of ornamentation.

Pseudarchaster pusillus, new species.

Rays 5. $R=32$ mm.; $r=14.5$ mm. $R=2.2$ r. Breadth of ray at base, 17.5 mm. A prevalent variation has still shorter rays: $R=28$ mm.; $r=15$ mm.; and another $R=29$ mm.; $r=17$ mm. R = respectively 1.86 r and 1.7 r. In the last specimen, breadth of ray at base = 18.5 mm.

This species differs from the foregoing in having shorter and broader rays, larger disk, smaller paxillæ, which, instead of being crowded, are distinctly spaced, giving an open appearance to the abactinal area; conspicuous papulæ; much narrower and less numerous superomarginal plates, which

consequently do not encroach so much upon the abactinal area, especially on rays, leaving a broad paxillar area; more prominent spinules on inferomarginals. The most striking differences, however, are in the proportions of the rays and disk, and in the character of the paxillæ, which are very evident when this species is compared with equal-sized specimens of the foregoing.

Paxillar area either plane or slightly convex; paxillæ arranged in regular chevrons, well spaced, and consisting of an ornate crown of 4 or 5 robust, clavate, or low pestle-shaped granules, alternating with or surrounded by a regular series of slender papilliform spinelets; lateral paxillæ much smaller; at about middle of ray 7-9 longitudinal series of paxillæ and the area 2 to 2.5 times as broad as a superomarginal plate. In general form the species varies from stellate to stellato-pentagonoid with deeply arcuate sides.

Superomarginals, 25 in number from median interradiial line to extremity of ray, forming a steeply arched bevel to border; 1 or 2 of the granules near outer border of plate much enlarged, subtubercular, the others distinctly spaced, hexagonal, decreasing in size toward inner edge. Inferomarginals with a widely spaced subpapilliform granulation, and a median transverse row of 4 prominent sharp spinules which are reduced to 2 on outer half of ray.

Adambulacral plates with a palmate furrow series of 4 or 5 terete, papilliform spinelets, blunt, and graduated to either end of the series; on actinal surface a semicircle of unequal "barley-corn" spinelets on border of plate, surrounding a similar but enlarged central spinule, often curved. The outer plates of the series have the spinelets frequently arranged in 2 rows, and there are 2 spinules enlarged.

Actinal intermediate plates extending halfway to tip of ray, and fasciolar, as are the marginal plates; they bear a small group of widely spaced ovoid granules, which become slender when dry. An enlarged spinule is also frequently present.

Mouth plates similar to those of *alascensis*; a median odd spine at inner angle, and the furrow series angular, rising slightly toward the peristome; angle slightly nearer the inner or suture than the outer or aboral end of the margin, and the 8 spinelets graduated toward it, decreasing rapidly in length, so that the median spinelets of the series are quite small and inconspicuous; on actinal surface a superficial series of 8 spinelets graduated in length from outer to inner angle, and bordering the suture, and a similar series of 3 or 5 merging into it from the aboral margin. Some specimens have an intermediate series.

Madreporic body fairly conspicuous, situated midway between center and inner edge of superomarginals. It is relatively larger and more conspicuous than in *alascensis*.

Color in life: Abactinal surface dull coral red, rather deep, varying to maroon in small specimens, in which case the abactinal paxillar area is much darker than marginal plates, which are bright coral red; actinal surface of inferomarginal plates pinkish buff; actinal intermediate areas grayish, often tinged with pink; tube feet olive buff to raw sienna. A second phase is of the same general tint but much paler.

Locality: Station 4423, between Santa Barbara and San Nicholas Islands, 216 to 339 fms., shells, black pebbles, green sand.

This species might naturally be considered the young of the foregoing, but I have young of *alascensis* and they are widely different, having longer and narrower rays, very wide superomarginal plates, larger and crowded paxillæ which are essentially like those of the adult, less numerous and less prominent inferomarginal spinules, and no actinal interradiial spinules. In fact the last are scarce in fully matured individuals of *alascensis*. Minor differences occur on the madreporic body and adambulacral armature. The facies of the two forms is entirely different, owing to the character of paxillar area and the proportions. Though perfectly distinct, I believe the species are rather closely related.

Family GONIASTERIDÆ Forbes, 1840 (restr.).

Subfamily GONIASTERINÆ Verrill, 1899.

Genus *TOSIA* Gray.

Tosia Gray, Ann. N.-H., VI, 1840, 281 (*T. australis* Gray).

Tosia leptocerama, new species.

Pentagonal. $R=63$ mm.; $r=44$ mm. $R=1.43$ r. In smaller examples (e. g., $R=38$ mm.; $r=22$ mm.) the contour is often stellato-pentagonoid, R equaling 1.73 r; but usually the form is pentagonal.

Disk remarkably thin for the genus, the marginal plates being small, elongate, and inconspicuous; sides of body only 3.5 mm. high; edges of disk curved inward gently toward the interradius; superomarginals not in contact at tips of "rays;" radial areas of abactinal surface and center of disk somewhat inflated; actinal area subplane, or sunken, making the inferomarginals appear as a narrow ridge, the body being not more than 1.5 mm. thick in the median interradial area.

Marginal plates elongate and, owing to the thinness of the disk, rather small; except for the first 2 or 3 plates, the members of the 2 series alternate. Superomarginals, 14 in number from each interradial line to extremity of series, or 28 to each side of disk, about as high as broad, and much longer than high, except at the end of the series, where they are shorter; these plates forming a narrow border to the abactinal area and covered with a rather uniform, dense, polygonal granulation, a peripheral series being readily distinguishable; the outer plates with a small naked area on abactinal face, bearing 1 to 3 small, 2-jawed pedicellariæ, larger than the granules; these pedicellariæ present also on the inner plates, but there only a narrow area about each is left free by the granules; lower margin of each superomarginal angular. Inferomarginals 16 to the ray or 32 to a side, and much wider than high, encroaching farther upon actinal area than do the dorsal series upon the abactinal; in the middle of the actinal surface a small naked area, increasing in size toward outer end of series, which bears 1 to 3 small, 2-jawed pedicellariæ, but slightly larger than the granules. There is considerable variation as to the extent of the naked areas, which are much reduced on some specimens. Granulation of inferomarginals similar to that of superomarginals.

Abactinal surface covered with spaced, low, tabulate plates, arranged with great regularity in a radial series, which is largest, and numerous other parallel series, decreasing rapidly in size toward the margin, where the plates are small and more crowded; in center of disk plates are arranged without order, and are more or less irregular in a narrow interradial area, which is free from papulæ. Bases of plates of radial areas, when viewed from the inner side, in a prepared specimen are substellate, regularly with six truncate or blunt processes, a shallow sulcus running from the center of the plate to each interradial angle. The plates are entirely free from one another, those of the radial and either adradial series being lengthened transversely, the others rounder. In the vicinity of the marginal plates they become more crowded and lengthened longitudinally. In the center of disk the plates are roundish, and in the narrow interradial area quadrate, roundish, lozenge-shaped, or, near margin, oblong. In the proximal portion of the radial areas, small secondary plates or paxillæ, with narrow ossicle-like bases, are interspersed rather irregularly, but form a fairly regular series between the radial and either adradial row of plates. The low tabulum surmounting each plate is slightly convex, and bears a central group of robust, flat-topped, quadrate or polygonal granules (about 10 on radial plates) surrounded by a peripheral series of smaller, square-tipped, flattened regular granules. Nearly all the plates bear 1 or 2 delicate pedicellariæ with wide-spatulate jaws, higher than the granules. At the edge of the disk where the plates are very irregular only the marginal series of granules may be present, on account of the compression of the plate. The papulæ are conspicuous on account of the open character of the tabulate armature, and are numerous. The abactinal membrane is rather flexible, the plates not being in contact.

Adambulacral plates nearly quadrate, with a straight furrow margin; armature consisting of a furrow series of 8 or 7 untapered, flattened, square-tipped spinelets about half as long as the length of the plate, subequal or slightly shorter at either end, united at the base by a membrane, very regular and standing parallel; on the actinal surface 2 irregular longitudinal series of smaller granules, the inner well spaced from the furrow series, as in *Mediaster*, and consisting of 3 or 4 compressed, square-

tipped, sharp-edged granules, larger than those of the outer series, which are very irregular in distribution, 8 or 9 in number, and similar to, but a trifle larger than the actinal intermediate granules; there are sometimes 2 irregular rows of these smaller outer granules; at adoral end of inner actinal series a pedicellaria with 2 broadly spatulate jaws, slightly larger than the granules of the series, which the pedicellaria greatly resembles when the jaws are closed; at tip of "ray" 4 or 5 spinelets in the furrow series, and on the actinal surface a blunt, prominent tubercle, surrounded by several granules, this tubercle grading into the granules of the inner actinal series. The pedicellaria persists to within 2 or 3 plates of the tip.

Mouth plates triangular, with a longer furrow margin than the edge adjacent to first adambulacral; furrow series consisting of 12 or 13 spinelets similar in character to those of adambulacrals, but increasing in size toward inner angle, where there is an oblancoolate, blunt, flattened or compressed tooth, the other spinelets square in section or slightly compressed; on actinal surface a linear series of low, squarish granules adjacent to the median suture, several others along the aboral edge, and 2 or 3 intermediate between the superficial and marginal series.

Actinal interradial areas very extensive; intermediate plates quadrate, roundish, or irregular, those adjacent to the adambulacrals much larger than any of the others, and usually oblong in shape, the short end toward furrow; plates arranged in rows parallel to furrow, considerable irregularity existing; plates covered with uniform, hemispherical, beadlike granules slightly spaced; pedicellariæ similar to those of adambulacral plates scattered here and there, especially near the furrow, but their numbers subject to great variation.

Madreporic body irregular in outline, larger than any plates, situated $\frac{1}{3}$ distance from center to margin; slightly convex and the striations, of medium coarseness, radiating from the center, irregularly.

Color in life: Vermilion, yellowish on actinal surface.

Locality: Type from station 4378, off Point Loma, near San Diego, Cal., 376 to 594 fms., green mud and sand.

This is a variable species as regards the minor details of ornamentation and contour of body. The younger specimens are not so noticeably thin and flat, and the marginal plates are more normal. The secondary abactinal plates are wanting in young specimens, and in examples $\frac{2}{3}$ the size of type vary considerably in numbers. The pedicellariæ appear to be numerous on the abactinal surface of all the specimens.

This is in some respects a very abnormal *Tosia*, especially in the character of the abactinal plates, and in the presence of secondary smaller ossicles intercalated between the larger primary plates. The small marginal plates give it a very peculiar appearance, and, combined with the thinness of the body, form characters which will readily separate this species from any other now referred to the genus.

I found a very flat *Myzostoma* (*M. fisheri* Wheeler) in an interradial portion of the cœlomic cavity of one specimen.

Subfamily MEDIASTERINÆ Verrill, 1899.

Genus MEDIASTER Stimpson.

Mediaster Stimpson, Jour. Boston Soc. Nat. Hist., I, 1857, 490, pl. 23, figs. 7-11 (*Mediaster aequalis* Stimpson).

***Mediaster tenellus*, new species:**

Rays 5. $R=58$ mm.; $r=19$ mm. $R=3r$. Breadth of ray, between first and second superomarginals, 20 mm.; at middle of ray, 7 or 8 mm.

General form flattened; disk large; rays fairly long and slender, tapering abruptly at base, then more gradually; interbranchial arcs very wide, and rounded; abactinal surface inflated on radial areas, sunken on interradial areas, the rays especially being convex; actinal surface considerably inflated on disk; marginal plates small, confined nearly to sides of body.

Abactinal area covered with ornate, regularly spaced paxillæ, largest in a regular median radial series, decreasing thence toward tip of rays and margin of disk; paxillæ of median radial series elongated transversely, the others roundish, the former bearing on the periphery of the pedicel or tabulum 15-17 prismatic, blunt spinelets, as long as or slightly longer than the lesser dimension of the tabulum and decidedly longer than is usual in this genus; in the center 6 or 7 irregular, prismatic,

pointed granules, much shorter than the peripheral spinelets; ornamentation of the other paxillæ differing only in having less spinelets and granules. At the tip of the ray the plates lose their tabulate character. Many of the paxillæ bear on the edge or nearer the center, a small upright pedicellaria, whose 2 jaws are slightly higher than wide and very much larger than the central granules. Papulæ are numerous, single, especially conspicuous on radial areas because the paxillæ are spaced. They are absent from the very tip of the rays and a small interradial triangular area adjacent to the median marginal plates.

Marginal plates rather smaller than in any other species of the genus, and throughout most of the ray the superomarginals are confined to the side wall; 30 in number from median interradial line to extremity of ray, thin, slightly longer than high throughout most of ray, and forming a slightly arched, steep bevel to side of body; first plate conspicuously higher, or wider, than long, and longer on inner than lower edge. General surface covered with evenly spaced thimble-shaped granules which increase in size toward the center of each plate, the peripheral being rather small and pinched. A few plates bear pedicellariæ similar to those of the paxillæ. Inferomarginals beyond the second plate alternating with superomarginals and wider than high, forming a narrow border to the actinal area, thin, slightly longer than broad, and the upper edge angular, like the lower edge of the superomarginals; granulation rather coarser than that of superomarginals, square or prismatic, and very few pedicellariæ on the series.

Adambulacral plates rather regularly quadrate and remarkable for the long furrow spinelets, of which there are 5 in each series, strongly compressed, regular, round-tipped, the adoral slightly shorter than the other 4, these spinelets reaching nearly across the furrow and tapering slightly as regards their thickness, the tip being often beveled; on the actinal surface a longitudinal series of 3 spinelets, the central longest and about $\frac{3}{4}$ the length of the furrow spinelets, the series standing midway between furrow margin and outer margin, upon which are 3 or 4 less regular granules similar to those of the actinal intermediate plates; first plate and a few others with a peculiar pedicellaria on actinal surface consisting of 2 or 3 slender upright strap-shaped jaws, occasionally faintly spatulate, nearly as high as the inner actinal series.

Mouth plates slightly convex actinally and the furrow armature consisting of 8 spinelets, similar in character to those of the adambulacral plates; the 2 inner larger than the others, and those between inner and outer members of the series slightly shorter, or, in other words, graduated in size from the middle toward either end of the series; on actinal surface a number of elongate granules, and one of the peculiar pedicellariæ, the latter situated near the median suture at about middle of plate.

Actinal interradial areas large, the plates extending to ninth inferomarginal or about half the length of ray, arranged quite regularly in series parallel to the furrow, slightly convex and armed with 6-8 spaced, elongate, prismatic granules, usually forming an ornate rosette.

Madreporic body convex, oval, situated nearer center than midway to margin; striations coarse, undulating, interrupted, centrifugal.

Locality: Station 4427, off Santa Cruz Island, Cal., 376 to 510 fms., black mud, broken stones.

This species is remarkable for the small marginal plates, the high, slender, pedicellariæ of the actinal surface, and for the unusually long furrow spinelets. The peripheral spinelets of the abactinal paxillæ are also more elongate than is usual in the genus. *Mediaster tenellus* is therefore far removed from *equalis*, the type of the genus, and probably deserves to be set apart in a different subgenus, for which the name *Isaster* of Verrill might prove available. The present form approaches the genus *Nymphaster* in the actinal pedicellariæ, but does not have the marginal plates of that genus, and the abactinal plating and pedicellariæ are not those of *Nymphaster*. *Tenellus*, however, must be regarded as an aberrant member of *Mediaster*, probably nearer *Nymphaster* than any of the other species.

Subfamily HIPASTERIINÆ Verrill, 1899.

Genus HIPASTERIA Gray.

Hippasteria Gray, Ann. N. H., VI, 1840, 279 (*H. europæa* Gray = *H. phrygiana* Parellus).

- a. Marginal plates well developed, subquadrate, not separated by encroaching abactinal or actinal intermediate plates; granules fairly or quite smooth.
- b. Pedicellariæ shorter and higher. Dorsal surface very spiny; as a rule no pedicellariæ on marginal plates; actinal pedicellariæ with oblong or subquadrate jaws; actinal intermediate plates not conspicuously tuberculate.

.....*phrygiana*

- bb. Pedicellariae low, long; a well-developed pedicellaria on the proximal superomarginals, and on most of the inferomarginal plates; papulae conspicuous, bag-like; actinal intermediate plates tuberculate; actinal pedicellariae very low, long..... *heathi*.
 aa. Marginal plates weak, irregular, oval or elliptical, the proximal usually separated by encroaching plates from the dorsal and ventral surfaces; actinal pedicellariae high, rather delicate, flaring at base and with narrow curved serrate tips; granules rugose or denticulate..... *californica*.

Hippasteria heathi, new species.

Rays 5. R = 78 mm.; r = 39 mm. R = 2r. Breadth of ray at base 42 mm.

General form, robust; disk large; rays short, tapering from a wide base to a blunt, recurved extremity; abactinal surface considerably inflated; a well-defined interrarial sulcus leading from marginal plates $\frac{3}{4}$ of distance to center of disk; interbranchial arcs wide, shallow, rounded; actinal area subplane.

Abactinal surface beset with widely spaced, robust, rigid, tapering, upright, bluntly pointed spines, 3.5 or 4 mm. in length; 1, or rarely 2, to the larger rather widely separated primary plates, the median radial and either adradial series of spines extending to tip of ray, but very irregularly; the other spines too irregularly distributed to form rows. Scattered all over abactinal surface many sessile, long, low, bivalved pedicellariae with smooth edges to the jaws; pedicellariae 1.5 to 3.5 mm. in length, 1.5 mm. wide, and a trifle less than 1 mm. high; rest of surface covered with spaced, small spherical, acorn-shaped and thimble-shaped granules of various sizes, immersed in and covered by a soft membrane which obscures the outlines of the plates; whole abactinal surface crowded with conspicuous obtuse, bag-like papulae about 2 mm. in length, the base being surrounded by a collar (the rim of the pore); these papulae especially numerous in the proximal radial regions.

Marginal plates not particularly conspicuous. Superomarginals 15 in number from median interrarial line, slightly convex, and confined to side of body; first plate larger than the rest, which are rather longer than high except at end of ray, where the reverse is true; upper edge of the series largely obscured by abactinal membrane; each plate on proximal half of ray (first to fifth or sixth) bearing a sessile bivalved pedicellaria and in addition 1 to 4 spines like those of abactinal surface, edge of plate (excepting usually the upper) being armed with 1 or 2 interrupted series of stout conical granules of various sizes; outer plates of series with a single central spine, and marginal granules in 1 or 2 irregular series. Inferomarginals corresponding in number to superomarginals and opposite them in proximal third of ray, but alternate on outer part; they encroach somewhat upon the actinal area, the lower margin being obscured on the disk by the membrane covering the general surface of the plates. Nearly all the plates bear a bivalved pedicellaria and, in addition, on the first 2 plates of the series a circle of 4 or 5 spines, like the superomarginal spines surrounding it, and on the rest 2 or 3, these situated on the aboral side of the plate. There are also on the border of each plate numerous stout conical granules mixed with small ones, the former occasionally having 1 or 2 enlarged into conical spinules, intermediate in size between the spines and larger granules. The pedicellariae of the marginal plates are exactly like those of the abactinal surface.

Adambulacral armature, consisting of 2 heavy cylindrical or slightly compressed blunt furrow spines, the adoral a trifle the smaller on outer half of ray; and on actinal surface, a transverse series of 2 similar spines, rather more tapered, the outer the shorter, occupying all the exposed surface, the outer spine reduced in size on the first few plates. Margin of plate surrounded by conical granules, 1 or 2 on the outer edge larger than the rest.

Mouth plates small, narrow; furrow margin very extensive; furrow spines 4, similar to those of adambulacral plates, the innermost slightly longer and most compressed; on actinal surface opposite the outer furrow spine 1 compressed spine nearly as long, and on the inner part of the plate usually another, considerably shorter, connected with the first by a linear series of several spaced, unequal, conical granules, which are continued beyond the outer spine to the end of the plate, there forming a group rather than a row.

Actinal interrarial areas large, 3 series of intermediate plates extending to the fourth inferomarginal, 2 to the fifth, and 1 to the ninth; each of the plates adjacent to the adambulacrals bearing a large, sessile, bivalved pedicellaria, 4 mm. in length, similar to those of dorsal surface, placed usually obliquely crosswise; numerous other interrarial plates also with a pedicellaria, usually somewhat smaller; plates also armed with 1 or 2 conical spinules or tubercles standing on the edge, often on either side of

the pedicellaria, in line with a peripheral series of large and small hemispherical or acorn-shaped granules; plates without pedicellariæ bearing 1 or 2 unequal thimble-shaped or acorn-shaped spines surrounded by a peripheral series of small granules, with 2 or 3 here and there larger than the others; all the actinal interradial spines shorter than the marginal.

Madreporic body small, circular, situated slightly nearer center than midway to margin; striations fine, ridges rather wide.

Locality: Station 4239, Clarence Straits, Alaska, 206 to 248 fms., coarse sand, rocky; bottom temperature 49°.

This species is named for Dr. Harold Heath, associate professor of zoology in Stanford University.

Hippasteria californica, new species.

Rays 5. $R=73$ mm.; r =about 35 mm. $R=2r$ approximately. Breadth of ray at base, about 40 mm.

Disk very broad, rather thinner than usual in this genus; rays tapering from a broad base arcuately to a bluntly pointed extremity; interbrachial arcs very wide, shallow, and rounded; abactinal surface considerably inflated, especially in the interbrachial region adjacent to margin; rays recurved, and in some specimens the interbrachial arcs appearing angular from this cause.

Abactinal surface armed with rigid upright spines and spinules much as in *phrygiana*, but the spines rather shorter and less numerous, on some specimens scarcely more than tubercles; pedicellariæ numerous, shorter and higher than in *phrygiana*, very broadly spatulate, with strongly denticulate rims; the granules, which are fairly smooth and not very prominent in *phrygiana*, in this species are multifid or denticulate, very rugose in appearance, and prominent, the investing membrane being thin and ineffective as a covering; papulae numerous, vermiform, absent from a narrow interradial area.

Marginal plates small and rather thin, irregularly oval or elliptical, longer than high except at end of ray, where the two dimensions are nearly equal. Superomarginals, 12 in number from interradial line to extremity of ray, confined entirely to side of body and rather inconspicuous, very irregular as to shape, successive plates frequently separated by small intermediate encroaching abactinal plates; each plate with a tapering blunt spine articulated rigidly to a central boss and a marginal series of rugose granules, there being also 1 or 2 smooth subconical granules on the general surface; occasionally, also, a pedicellaria just beneath the spine. Inferomarginals very similar to superomarginals, of the same number, but not opposite to them; similarly armed, but the pedicellaria very rare; actinal intermediate plates encroaching and separating most of the proximal inferomarginals.

Adambulacral armature consisting of (1) a single blunt spine, usually considerably compressed and somewhat tapering, situated on the angular furrow margin, with occasionally a shorter, similar adoral companion, or, 1 or 2 very short spinelets or compressed granules on either side of the single spine; (2) on the actinal surface a more robust, upright, tapering, blunt spine situated just external to the furrow spine, and just adoral to this usually a medium-sized pedicellaria, one jaw of which is broad serrate and rather deeply scoop-shaped, closing over the other, which is smaller, thicker, and not hollowed out; margins of plates bordered with the peculiar rugose granules, a few of which also stand on the surface.

Actinal intermediate areas large, 2 series of plates extending $\frac{3}{4}$ the length of ray, and a single series nearly to tip; most of the plates with a central high pedicellaria of a peculiar shape so far as this genus is concerned; jaws rather thin and wide at base, abruptly narrowing into the distal portion, which bends toward the other jaw and has a truncate, serrated edge; pedicellariæ thus in form more like those usual to the *Goniasterinae*, though much larger; plates bordered with a series of rugose granules, with several of the same size on general surface, where there are besides these a number of considerably larger, smoother, subconical granules, immersed like the rest in thin membrane. On some specimens these are almost wanting, on others they are prominent and compressed, sometimes subtubercular and thimble shaped.

Mouth plates prominent actinally; furrow spines 5 or 6, considerably compressed, the inner spines the larger and heavier; on actinal surface an incomplete series of three spines, parallel with the furrow, usually 1 near the inner angle and 1 or 2 near the outer end of the furrow series; remainder of surface covered with rugose spinelets, often curiously compressed or pinched, with denticulate edges, these forming a row on the median suture margin, and another adjacent to first adambulacral.

Madreporic body large, irregular, much as in *phrygiana*.

Locality: Type from station 4429, off Santa Cruz Island, Cal., 506 to 680 fms., green mud, black pebbles, broken stones.

CRYPTOPELTASTER, new genus.

Most nearly related to *Hippasteria*, from which it differs in having the whole abactinal surface covered with numerous flat, irregularly circular, oval, elliptical, triangular, polygonal, quadrate and boomerang-shaped scales, attached to the plates and smaller secondary ossicles by the middle of the under surface, leaving free the edges of the scales, which frequently overlap. These scales, though robust enough, have a very peculiar chaffy appearance and completely hide the outlines of the underlying plates, the larger of which bear each a short conical spine. Numerous long, low, bivalved pedicellaria on abactinal surface; marginal plates tumid, covered with irregular, polygonal, plate-like scales or granules and bearing a central tubercular spine; no odd interradiar; adambulacral plates with 1 actinal and 2 stout furrow spines, flattened or flaring at the tips, occasionally grooved or incipiently bifid or trifid; sometimes a large sessile bivalved pedicellaria replacing the furrow spines; actinal interradiar areas extensive, the plates covered with plate-like granules and central tubercles and tubercular granules; series adjacent to adambulacrals bearing large bivalved pedicellariae. Type, *Cryptopeltaster lepidonotus*, new species.

***Cryptopeltaster lepidonotus*, new species.**

Rays 5. $R = 105$ mm.; $r = 51$ mm. $R = 2. (+)r$. Breadth of ray at base, between second and third superomarginal, 50 mm. or less, according to degree of inflation of abactinal area.

Disk large; rays fairly well developed, tapering to a blunt tip, which is much recurved; interbrachial arcs very wide, and rounded; abactinal area much inflated on rays and radial areas of disk, also in each interradius adjacent to margin; actinal area subplane.

Abactinal surface covered with peculiar, flattened, scale-like granules, which are irregularly circular, oval, elliptical, triangular, polygonal, quadrate, boomerang-shaped, and of several other shapes which defy description, of greatly varying sizes, so closely placed that they often overlap a trifle; attached to the larger plates of the skeleton by the middle of their under surface, being entirely free around the edge; or, forming the flaring summit of many variously sized ossicles packed between the regular rows of rather widely separated primary plates. These scales might be likened to the flaring head of a wire nail. The exposed surface of many is raised into a low tubercular eminence. Primary plates superficially marked by a robust, low, conical spine, about the base of which is a series of elongated granules often curiously excavated on the edge, these spines decreasing in size toward edge of disk and end of ray, and grading into broad conical granules in the interradiar areas, where the primary plates are small, closely packed, and the secondary ossicles nearly wanting; on the ray a radial and 3 or 4 parallel series of spines on either side, all low (1.5 mm.), scarcely more than tubercles; long, low, bivalved pedicellariae (2.5-4 mm. in length) numerous on abactinal surface, especially on interradiar areas, center of disk, and proximal radial areas, each surrounded by a series of quadrilateral granules of various sizes; papulae numerous, especially on rays, but apparently absent from a very small interradiar area adjacent to marginal plates.

Superomarginal plates rather small, irregularly quadrilateral, higher than long in middle of interbrachial arc, but longer than high throughout most of ray; on account of the inflation of the abactinal surface these plates confined to side of ray, and the abactinal edge of each arched; each plate tumid and bearing in the center a rigid acorn-shaped or conical tubercular spine slightly larger than those of the median radial series; general surface of plates covered with polygonal granules similar to those of abactinal surface, the peripheral scales being elongated, a number on each plate convex or low conical. Superomarginals 26 or 27 in number from median interradiar line to extremity of ray. Inferomarginals slightly larger, and more nearly square on the ray where the upper series is oblong; in general each inferomarginal corresponding to a superomarginal, similarly covered with granules (most of which, exclusive of the peripheral series, are prominent or subconical), and bearing 1 or 2, rarely 3, tubercular spines in the center, all short and stubby; smaller plates intercalated here and there in the inferior series, apparently due to injury of some sort.

Adambulacral plates nearly square, each bearing 2 large, heavy spines on the margin, usually compressed and truncate at tip, or occasionally flaring, and, again, grooved at tip and incipiently bifid

or trifid; a large sessile bivalved pedicellaria occupying furrow margin of first plate, extending whole length of plate; a similar pedicellaria occurring frequently on other plates of the series; on actinal surface of each plate a robust spine just behind the furrow spines, which it greatly resembles, though a trifle shorter; this spine either bluntly tipped, compressed, or curiously wrinkled, and reduced to a small conical tubercle, a mere specialization of one of the granules, on those plates in which a pedicellaria replaces the furrow series; general surface of plate covered with irregular plate-like granules similar to those of the actinal intermediate plates.

Mouth plates fairly large; furrow spines 3, flattened, the inner flaring and hatchet-like though irregular; an odd spine at inner angle of the combined plates; one much smaller spine on actinal surface adjacent to outer furrow spine; surface of plate covered with 2 longitudinal (interradial) rows of flattened plate-like granules which diverge and partially surround the actinal spine, being much smaller toward the inner angle; these granules quadrate or pentagonal, and their surface sunken a trifle, then raised in a small low boss in the center.

Actinal interradian areas large; a single row of intermediate plates extending very nearly to tip; a second series $\frac{2}{3}$ the length of ray; a third very nearly as far; a fourth nearly half, and so on; plates adjacent to adambulacrals largest, elongated transversely, and more regular than the others, though far from regular themselves; most of them bearing a long bivalved sessile pedicellaria (4 mm.) not more than 0.5 mm. high, placed transversely or obliquely transversely, forming a very conspicuous series on either side of the adambulacral series and extending about half the length of ray; flat, oblong, or irregular granules surrounding them, the whole somewhat convex in appearance; a number of the granules with a subconical prominence in the center, the other intermediate plates bearing a central conical tubercle, surrounded by several low conical granules which grade into the flatter, plate-like granules toward the periphery of the plate, these granules resembling those of the abactinal surface in shape but not free on the edges.

Madreporic body fairly large, somewhat convex, irregular in outline, situated nearer center than midway to margin; striations deep, irregularly interrupted; anal opening surrounded by a cluster of bead-like granules.

Color in life, scarlet vermilion.

Locality: Station 4430, off Santa Cruz Island, 197 to 284 fms., black sand, pebbles.

Family SOLASTERIDÆ Perrier, 1884.

Genus LOPHASTER Verrill.

Lophaster Verrill, Amer. Journ. Sci. and Arts, 3d ser., XVI, 1878, 214 (*Solaster furcifer* Dübén and Koren).

Lophaster furcilliger, new species.

Rays 5. $R = 70$ mm.; $r = 16$ mm.; $R = 4.38r$. Breadth of ray at base, 18 mm.

Rays rather long, tapering from a narrow base very gradually to pointed extremity; disk rather small; abactinal surface convex on rays and disk; interbrachial angles narrow and acute; ambulacral furrow very wide and open.

Abactinal surface beset with paxillæ which have rather long (2-3 mm.) slender pedicels, with a capitate summit beset with numerous (20 or even more) long, delicate, glassy spiculiform spinelets, flattened, flaring and bifurcate at the tip, arranged in a glomerular tuft on the subglobose tip of the pedicel; these spinelets about 1 to 1.2 mm. in length and radiating in all directions; paxillæ largest on disk, decreasing in size toward end of ray; papulæ numerous.

Superomarginal paxillæ well developed and larger than abactinal except on outer $\frac{1}{4}$ of ray, where the two are about equal; well spaced and with stouter and longer (3.5 mm.) pedicels than the abactinal paxillæ, the spinelets being usually trifurcate. Inferomarginal paxillæ still stouter, about 23 in number from median interradian line to extremity of ray.

Adambulacral plates short and broad, with wide intervals between successive plates, the suture being wider than the length of exposed surface of plate; furrow series consisting of 4 spinelets at base of ray, which are soon reduced to 3, then to 2 beyond middle of ray, and finally to 1; these spinelets rather long, delicate, skin-covered and united for $\frac{1}{3}$ or $\frac{1}{2}$ their length by a web; when there are 4, they are graduated in length toward the adoral, which is shortest; when there are 3, the middle

is usually longest, and commonly the adoral when there are 2; the separate series well spaced from one another and the spinelets as long as or even longer than the width of the plate; on the actinal surface a series of 4, 3, or 2 longer and more robust, tapering, pointed spinelets, disposed in an oblique transverse series, and decreasing in length as they recede from the furrow, skin-covered, often having lateral expansions, and the bases united by membrane; when there are 3 or 4 spines, the outer is usually much shorter than the rest.

Mouth plates fairly large, spade-shaped, and prominent actinally; median suture wide, roofed with membrane; furrow spinelets 7 or 8, long, skin-covered, united for about $\frac{1}{3}$ - $\frac{1}{2}$ their length by a web, increasing very slightly in length toward the innermost, which is rather more robust than the others; near the middle of the suture margin a group of 3 or 4 much slenderer spinelets, which are shorter than those on furrow.

Actinal interradial areas very small, containing small intermediate plates, which bear small paxillæ, and, widely spaced, extend along the ray, here and there, between the inferomarginal and adambulacrals plates nearly to tip of ray.

Madreporic body small, convex, situated about midway between center of disk and margin.

Locality: Station 4425, between Santa Barbara and San Nicholas islands, 1,084 to 1,100 fms., green mud, sand, globigerina.

Family KORETHRUSTERIDÆ Danielssen and Koren, 1884.

Genus PERIBOLASTER Sladen.

Peribolaster Sladen, Narr. Challenger Exp., I, 616, 1885 (*P. folliculatus* Sladen).

Peribolaster biserialis, new species.

Rays 5. R=20 mm.; r=7.5r. R=2.6r. Breadth of ray at base, 8.5.

Abactinal surface convex, rather flexible; form stellate; rays rather short and robust, wider than high, tapering, the outer part somewhat slender and often recurved; interbrachial arcs acute, the rays being constricted slightly at the base; edges of ray rounded, due to inflation of abactinal integument; tube feet strictly biserial.

Abactinal plates stellate, and imbricate by means of rather long rod-like intermediate ossicles, forming a very open reticulate skeleton with wide interspaces for the papule; no serial arrangement to the plates, but the papular areas generally quadrate; each plate conspicuously convex and surmounted by a brush-like fasciole of about 5 delicate, glossy, sharp spinules about 3 mm. long, which are united into a compact group by a membrane, sometimes the spinules radiating a trifle; spinules decreasing in length toward tip of ray, but increasing slightly toward margin; papule long and conspicuous, 6 or 7 to an area.

Actinal surface paved with 2 longitudinal rows of band-like plates, which are comparatively wide and short; the adambulacrals bordering the furrow, and external to them a series of equally regular plates, probably the inferomarginals; adambulacrals much wider than long and separated by prominent sutures; each plate with a transverse series of 3 prominent spinules, sheathed individually in membrane, which extends beyond the tip in a short sacculus; each spinule surmounting a slight boss on the plate, one situated on the furrow margin, another on the extreme outer margin, and one exactly midway between the two; inner spinule 2 mm. long, and the other 2 successively slightly longer and stouter.

Inferomarginal (?) plates a trifle longer than adambulacrals and not quite so wide, so that they do not exactly correspond to the latter, even though the sutures are not so prominent; surface of each plate actinal in position and slightly convex, and the outer, lateral end bearing a prominent membrane-invested spinule, 3-3.5 mm. long, which superficially appears to stand in a linear series with the adambulacrals armature; inferomarginal spinules, of which about 35 can be counted to the side of each ray, decreasing in size toward extremity, where both marginal and adambulacrals plates with their armature are very small; about 10 lateral cruciform plates immediately adjacent to (above) inferomarginals, forming perhaps the superomarginal series.

Mouth plates very prominent actinally, the exposed surface rising toward the median suture; the combined pair thus with a very prominent but rounded beak about midway between inner and outer

angles, or a little nearer the outer; margin of each plate rounded, but somewhat angular where the furrow edge merges with that turned toward the mouth; general form of mouth plates strongly recalling that of *Pteraster* and allied genera, the median beak on the actinostomial margin, in line of the median suture, being present; armature consisting of 4 marginal spinules, that nearest the adoral beak being largest, the third situated on angle between furrow and actinostomial margin at a lower level in the furrow than the other spinules, and often directed across or down into the furrow, while the others are reflexed; fourth spine commonly standing somewhat on actinal surface; all enveloped in membrane, which is prolonged beyond the tip in a sacculus.

Actinal interradiar areas very small; apparently no actinal intermediate plates.

Madreporic body of medium size, situated about midway between center of disk and margin, irregularly circular in outline, with coarse, often branching, centrifugal ridges and narrower striations; anal opening somewhat eccentric, surrounded by low, cylindrical, granuliform spinelets; ambulacral furrows wide; actinostome not very wide, often completely closed over by mouth plates; tube feet with a button-like terminal disk.

Locality: Station 4410, between Santa Catalina and Santa Barbara islands, 178 to 195 fms., fine gray sand and rocks.

Family PTERASTERIDÆ Perrier, 1875.

Genus PTERASTER Müller and Troschel.

Pteraster Müller and Troschel, System der Asteriden, 1842, 128 (*Asterias militaris* O. F. Müller).

Pteraster jordani, new species.

Rays 5. $R = 75$ mm.; $r = 37$ mm. $R = 2r$. Breadth of ray at base, 37-42 mm. Thickness of ray at base, about 28 mm.

Form stellate, depressed; abactinal surface of rays and disk convex, actinal surface subplane; edges of ray rounded; rays tapering, with fairly straight sides, bluntly pointed, though sometimes swollen near tip and the extreme tip recurved, giving an entirely different appearance; interbranchial angles obtuse; a well developed lateral fringe present.

Supradorsal membrane rather thin, with no deposits of calcareous matter; paxillar spines very prominent; 2 spines to each paxilla (sometimes 1 or 3), 1 considerably longer than the other, protruding 3 or 4 mm. above general level of the membrane, but carrying the latter with it; pedicel very low, and the spine correspondingly rather longer than usual in this genus; fine criss-crossing muscle fibers exceedingly abundant, and the summits of the paxillar spines connected by faint muscular bands, which are nearly invisible in the type specimen but show with some distinctness in a smaller example; in the irregular meshes thus formed 1-3 large spiracula, these often absent; oscular orifice rather small.

Adambulacral plates with a transverse series of 3 spines and 1 spinelet, united by a web; inner member of the series quite small and situated slightly aborad from the others; the next three 4 or 5 times longer, and increasing slightly in size outward, united by membrane nearly to their tips, which are capped by a membranous sacculus; outer spine close to the corresponding actinolateral spine, to which it is united by membrane; aperture papillæ prominent, jawbone-shaped, free on the aboral margin. On a smaller specimen the inner small spinelet is absent, and in the type it is sometimes absent, especially in plates beyond the middle of the ray.

Armature of mouth plates consisting of a marginal series of 4 spines and spinelets, the inner long and slender, the next nearly as long, and the outer 2 much shorter; inner 3 united by membrane, and usually also the whole 4, but the outermost, which is shortest, sometimes standing alone; on the actinal surface commonly 1 long, slender spine about the size of the inner marginal, with which it stands in a linear series, directed over the outer end of the plate, this spine entirely free from the others.

Actinolateral spines rather short, the 9th or 10th the longest; membrane thin, and forming a lateral fringe with a slightly undulating edge, the spines not protruding beyond its margin; width of membrane only a trifle greater than that of furrow.

Ambulacral furrows broad; tube feet in 2 rows.

Locality: Station 4354, vicinity of San Diego, Cal., 642 to 650 fms., green mud.

Named for Dr. David Starr Jordan, president of Stanford University.

Genus *HYMENASTER* Wyville Thomson.*Hymenaster* Wyville Thomson, The Depths of the Sea, 1873, 120 (*H. pellucidus* Thomson).*Hymenaster quadrispinosus*, new species.

Marginal contour stellate. $R=24$ mm.; $r=12$ mm. $R=2r$. Breadth of ray at base, 14 mm.; interbrachial angles wide and very obtuse; rays tapering evenly to a pointed, recurved extremity, the lateral margins being nearly straight; abactinal surface nearly plane; actinal surface very convex, due to recurving of rays.

Supradorsal membrane rather thin, but tough, with a satiny luster; spinelets of paxillæ about 3-5, protruding but slightly, forming subconical prominences; muscle fibers very difficult to discern; spiracula not numerous, scattered over the proximal portion of radial areas, of fair size and each surrounded by a definite white ring; oscular orifice large; valves triangular, with a truncate summit, however; spinelets about 11 to each valve, the 7 central ones subequal, the laterals graduated; membrane of valves rather thick; on base of each valve at either side a well-defined triangular spiracular area about $\frac{1}{3}$ the height of the longer spines, containing 15-30 spiracula; in the membrane between adjacent valves numerous spiracula, which extend nearly to the distal edge of the valves; supradorsal membrane slightly raised along interradial lines.

Ambulacral furrows very wide and open, widest in the proximal third; armature of adambulacral plates consisting of an obliquely transverse series of 4 sharp tapering hyaline spinelets, graduated from the outer, which is longest and thickest, to the inner, which is about $\frac{1}{3}$ the length of the outer; just external to the latter and in line with the series is the broadly ovate, round-tipped aperture papilla, fitting tightly over the corresponding segmental aperture like a valve, the base of this papilla abruptly narrowed for articulation to the plate; the first papilla much larger than the rest and lying in the actino-lateral membrane.

Mouth plates rather narrow, with a prominent actinal surface and a rounded margin for the combined pair; armature consisting of (1) 3 short, subequal, tapering spinelets on the lateral margin, and (2) on the actinal surface near the median suture 2 rather prominent tapering hyaline spines, the inner standing fairly on the margin, and longer than the outer, which is in line with it. The inner spine is sometimes directed over the actinostome and might be considered as a furrow spine.

Actinolateral spines delicate and well spaced, tenth from the mouth longest; about 30-32 in all, the outer very short on account of the tenuity of tip of ray; no lateral fringe unless right at tip.

Color in alcohol rose pink; in life probably a deeper rose madder or scarlet.

Locality: Station 4387, off San Diego, Cal. (longitude of Point Conception), 1059 fms., mud.

Family ZOROASTERIDÆ Sladen, 1889.

Genus *ZOROASTER* Wyville Thomson.*Zoroaster* Wyville Thomson, The Depths of the Sea, 151, 1873 (*Z. fulgens* Wyville Thomson).

- a. Abactinal skeleton compact; papular areas small; 4 longitudinal series of plates between the adambulacral and infero-marginal series on proximal third of ray; spinulation not conspicuously sacculate *ophiurus*.
 aa. Abactinal skeleton rather open, with comparatively large papular areas; only 3 longitudinal series of actinal intermediate plates on proximal third of ray (or if fourth is present it is very rudimentary and bears no spines); spinulation conspicuously sacculate.
 b. Size large; abactinal papular areas large; skeleton between median radial and superomarginal plates irregular, reticulate; spinelets with thick, soft, saccular sheaths; abactinal plates granular *sacculatus*.
 bb. Size medium; a needle-like central spine on all plates except in the adradial series; abactinal plates covered with capillary spinelets *evermanni*.

Zoroaster ophiurus, new species.

Rays 5. $R=140$ mm.; $r=10$ mm. $R=14r$. Breadth of ray at base, 11 mm.

Disk small and convex; rays very long and slender, tapering from a narrow base to an attenuate extremity; abactinal surface of rays strongly convex, with a fairly prominent median radial ridge; spinelets and spinules exceedingly delicate; pedicellariæ of abactinal surface prominent.

Plates of abactinal surface of disk rather convex, the primary radials and basals most prominent, these covered with delicate and slender sharp spinelets, about 1 mm. in length, distinctly spaced,

among which are scattered numerous forciform pedicellariæ, longer than the spinelets, and of course much more robust; median radial series of plates more prominent than the rest and each bearing on a central prominence a thimble-shaped tubercle; abactinal and lateral faces of the ray gradually confluent by a well-rounded margin, the superomarginal plates not being prominent in any way; between superomarginal and adambulacral plates 5 longitudinal series of exactly similar plates—an inferomarginal and 4 actinal intermediate series—and all precisely similar to the superomarginals; on outer portion of ray the intermediate series successively reduced to 3, 2, and finally, at end of ray, to 1; each of these plates, including the 2 marginal series, bearing a very slender, delicate, sharp spinule, which increases in length toward the furrow, that on the proximal superomarginals being 2 mm. in length and that nearest the furrow on the same transverse series nearly 4 mm.; general surface of the plates covered with very delicate, short, spaced, often curved spinelets, and having 1 or 2 rather prominent pedicellariæ to each plate, forming fairly regular longitudinal rows along the ray, between successive series of plates; median radial plates bearing 2 to 5 pedicellariæ each; papulæ inconspicuous, 1 or 2 to the pore, usually 1; papular areas very small.

The prominent adambulacral plates with a transverse series of 3-5 spinelets; the inner 2 short, stout, and pointed, and borne on the furrow projection; the innermost with a terminal membranous expansion bearing 6 or 8 pedicellariæ of graduated sizes, the second with 1 similar, much larger pedicellaria, or occasionally 2, near the base of the spinelet; the next, or first actinal spinelet, longer and slender and pointed, the 2 following being successively shorter; on outer part of ray only 2 actinal spinelets commonly present, and the second furrow spinelet often missing. The alternate non-prominent plates have a small furrow spinelet, bearing 1 or 2 small pedicellariæ, situated near the adoral edge, and on the actinal surface a transverse row of 2 spinelets very similar to those of the prominent plates; a large pedicellaria sometimes stands at the outer end of the series.

Madreporic body convex, subtubercular, circular, situated 7 mm. from center of disk.

Locality: Station 4387 off San Diego, Cal. (longitude of Point Conception), 1,059 fms., mud.

MYXODERMA, new subgenus.

Differs from typical *Zoroaster* in having smaller median radial plates, either cruciform or stellate, and irregular adradial plates which are not compactly placed, but form an irregular, open, subreticulate skeleton at the base of the ray, leaving comparatively large papular areas, which have 2-4 papulæ. There are 3 series of intermediate plates between the inferomarginal and adambulacral series, instead of 4 as in *Zoroaster*. Spinelets (and in type species the spines also) invested with a pulpy sacculus, giving them a very robust, flabby, papilliform appearance. Type, *Zoroaster* (*Myxoderma*) *sacculatus*, new species.

Zoroaster (*Myxoderma*) *sacculatus*, new species.

Rays 5. R = 200 mm.; r = 17 mm. R = 11.7 r. Breadth of ray at base, 22 mm.

Disk convex; rays subcylindrical, robust, but slender, tapering from a narrow base to a pointed extremity, which is capped by a large terminal plate; all the plates spiniferous; membranous investment of spines and spinelets, thick, fleshy, and saccular; interbrachial angles very acute. In life the whole animal is very slimy.

On the proximal portion of the rays and on disk the abactinal skeleton is comparatively very open and subreticulate; plates cruciform and stellate, with fairly long processes by which they are joined, leaving extensive subquadrate papular areas; plates becoming less markedly lobed on the sides and ventrolateral region of the ray, and the papular areas then reduced in size as in typical *Zoroaster*; primary basals and radials stellate, their processes touching and slightly overlapping, and joining also the irregularly cruciform under basals; papular areas very wide in proportion to the plates, quadrate or triangular in shape; disk plates bearing a number of short, compressed, blunt spinules, articulated to rounded bosses on the surface. In life they, as well as the general surface of the plates, are covered with a thick, fleshy, rather viscous membrane. Prominent pedicellariæ thickly scattered over the disk, principally in the papular areas; abactinal skeleton of rays very open, and subreticulate, the lateral and actinal more nearly as in typical *Zoroaster*; median radial series of plates fairly regular, cruciform or rarely stellate, a trifle larger than the superomarginal plates, which are also cruciform, but shorter; between these two series, on either side, a very irregular longitudinal series of smaller triradiate or cruciform plates, which articulate and usually imbricate with the processes of the radial

and superomarginal series, either directly or by means of small intermediate ossicles, producing the peculiarly large abactinal papular pores characteristic of this species. Superomarginal series perfectly regular, the cruciform plates a little wider than long; between this series and the adambulacral plates an inferomarginal and 3 intermediate series present at base of ray (reduced to 2 on outer part and to 1 at tip), the plates forming regular transverse series as well as longitudinal; plates overlapping more and more as they near the furrow, so that the papular areas are successively reduced until absent toward the outer part of ray between the intermediate plates. On the outer portion of the ray the open character of the abactinal skeleton is largely lost, the adradial plates becoming more regular as the ray increases in tenuity. All the plates of the ray bearing a prominent spine, which is rather shorter on the adradial than on either the radial or superomarginal series; these spines terete or slightly compressed, tapering and pointed, and increasing in size toward the adambulacral plates, those of the inner actinal intermediate series being about 6 mm. long; median radial plates often bearing an accessory spinule, their spines about 3 mm. long, tapering and blunt; general surface of abactinal plates covered with small granules, widely scattered, but on the superomarginals spinelets begin to appear, which increase in number and in length toward the furrow; fair-sized pedicellariæ numerous on abactinal surface, but greatly decreasing in number on sides and actinal surface of ray; these usually found about the border of the papular areas. Whole surface of the plates, granules, spines, and spinelets covered with a thick, fleshy or jelly-like membrane, which is decidedly slimy in life; this investment conspicuous, especially on the spinelets; each spinelet with a thick, clavate, saccular sheath, with a rounded tip much larger than the spinelet, which is entirely hidden. On account of the size of this pulpy sheath the spinelets appear closely crowded. The larger spines also similarly invested, and appearing heavy and flattened; papulæ numerous, conspicuous, vermiform, 4 or 5 to an area on abactinal surface and 1 or 2 on sides of ray; papulæ usually longer than the abactinal spines; abactinal membrane frequently much wrinkled in alcohol, doubtless due to loss of water.

The prominent adambulacral plates have a conspicuous furrow keel. Their armature is as follows: (1) on tip of furrow projection a short terete spinelet, often curved, bearing a large pedicellaria with curved jaws, and 2 or 3 smaller companions, the latter sometimes absent; (2) on the exposed surface of the plate a transverse series of 3 or 4 slightly curved, tapering, pointed spinelets, which diminish in size as they proceed outward, the inner 2 subequal and standing on the actinal surface of the furrow keel; 1 or 2 shorter spinelets form an accessory transverse series along the adoral margin of the plate; these actinal spinelets invested in a thick pulpy membrane, which entirely obscures the outer spinelets of the series, giving them a blunt, clavate, papilliform appearance. The alternate non-prominent plates have a small spinelet on the margin bearing a pedicellaria (smaller than that of adjacent plates), and on the actinal surface, in 2 transverse rows, are 4 spinelets, about the size of the smaller spinelets of adjacent plates, and heavily invested with membrane.

Madreporic body small, convex, situated near entrance to the interbrachial sulcus; anal opening considerably to one side of center; terminal plate large, notched toward the terminal radial plate, wider than the ray just adrad, and bearing several small spines about the edge.

Color in life, a "salmon" buff.

Locality: Station 4517, Monterey Bay, Cal., 916 fms., mud.

Zoroaster (*Myxoderma*) evermanni, new species.

Rays 5. $R=140$ mm.; $r=11$ mm. $R=12.7r$. Breadth of ray at base, 11 mm.

Rays very long, and tapering gradually from a narrow base to a pointed extremity, which is capped by a small terminal plate; disk convex, the abactinal surface considerably higher than carinal ridge of ray; interbrachial angles very acute, the rays being frequently constricted at base.

Primary radial and basal plates of disk stellate with short processes; papular areas smaller than in the preceding species; primary apical plates bearing a central, short, pointed spine articulated to a prominent boss on the plate, and the general surface armed with much shorter, delicate spinelets also articulated each to a tiny granular prominence, and encased in a pulpy, thick membrane which covers also the general surface of the plates; spinelets well spaced, but on account of the pulpy sheath appearing fairly close together; median radial series of plates substellate, slightly larger than superomarginals, and each bearing a central boss, surmounted by a prominent, tapering, sharp spine about 4 mm. in length; plates of either adradial series smaller and irregular, but not so much so as in the preceding

species; papular areas, though comparatively large, smaller than in the preceding species, because the radial plates are relatively larger; a regular series of superomarginal plates, which are prominent and mark the boundary between abactinal and lateral faces of ray; between this and adambulacral series 4 longitudinal rows of regular plates, including an inferomarginal and 3 series of actinal intermediate plates, the latter reduced to 2 series at about middle of ray, and to 1 on outer fourth; each marginal and intermediate plate bearing a central, slender, sharp spine articulated to a boss, spines slenderer and longer than the median radial series, and forming regular transverse as well as longitudinal rows, decreasing very slightly in size toward the furrow. General surface of all the plates beset with spaced capillary spinelets of extreme delicacy, which are sheathed in pulpy membrane, so that in life they appear robust, papilliform, and blunt; the larger spines likewise sheathed, but the membrane thinner; abactinal surface with pedicellariæ about as long as the spinelets, usually 1 to each papular area, forming thus 2 longitudinal series between carinal and superomarginal plates; less numerous on the sides of ray; papulæ 3 or 4 to the area, except below inferomarginals and near end of ray, where there are usually but 1 or 2.

Prominent adambulacral plates with a slight prominence into furrow; armature consisting of a transverse series of 4 or 5 spinelets, the inner 2 standing well within the furrow, the innermost slightly the shorter and bearing a bunch of 4 or 5 small pedicellariæ; the outer 2 or 3 standing on the actinal surface and graduated in size outward; the inner of these much longer than the second furrow spinelet and very slender; the next slightly shorter, and the outermost similar to the delicate capillary spinelets of the intermediate plates. The alternate, nonprominent plates have a very small spinelet on the furrow margin near the adoral border, and on the actual surface 2 spinelets in a transverse series, the outer capillary, the inner very similar to the longest spinelet of the prominent plates. All the spinelets invested in membrane.

Madreporic body convex; situated near summit of interradial sulcus.

Locality: Station 4400, between San Diego and San Clemente Island, 500 to 507 fms., green mud.

This species is named for Dr. Barton Warren Evermann, assistant in charge, Division of Scientific Inquiry, U. S. Bureau of Fisheries.

Family BRISINGIDÆ G. O. Sars, 1875.

Genus BRISINGA Asbjørnsen.

Brisinga Asbjørnsen, Fauna Litt. Norvegie, andet Hefte, 1856, 95. (*Brisinga endecacnemus* Asbj.).

Brisinga exilis, new species.

Rays 10. R=250 mm.; r=10 mm. R=25r. Breadth of disk, 20 mm.; thickness, 4 mm.; breadth of ray at base, 5 mm.; at widest part of genital inflation, 6 mm. (R varies to 180 mm.).

Rays delicate, long, and slender, with a very attenuate, lash-like outer portion; costal ridges very prominent, narrow, well spaced, 10 or 11 in number, extending a little less than $\frac{1}{4}$ length of ray; disk small and thin, with a delicate abactinal membrane.

Abactinal membrane of disk containing rather rudimentary, spaced, delicate plates which bear 2 to 5 short, sharp, delicate spinelets disposed in a row or irregular group, and covered with a delicate membranous sheath; abactinal surface of disk low, not raised above level of rays; interradial plates small, slightly keeled, narrow, the rays fragile, and the abactinal membrane thin and devoid of prickles; costal ridges 9-11 in number, rather widely spaced, narrow, irregular, and prominent, composed of elongate plates which imbricate by their ends; these plates, in the proximal portion of the genital area at least, bearing 1 or 2 rather stout subconical prickles, and in life having each costal ridge overlaid by a cushion of pedicellariæ; ridges corresponding to about every other adambulacral plate, and between them, corresponding to the alternate plates, a transverse, prominent saccular band of pedicellariæ, these continued throughout the ray, beyond the costal region, with about 1 to every adambulacral plate; all prominent and in alcoholic specimens difficult to distinguish from the costal ridges unless one feels for the plates of the latter.

Adambulacral plates longer than wide and wider than high, with an excavated or concave furrow margin; armature consisting of (1) a very delicate furrow spinelet at adoral end of plate, surmounting a slight boss and armed with a terminal pad of minute pedicellariæ; (2) on actinal surface, rather

nearer aboral margin than center of plate, a much stouter and longer spine (about 4 mm.), covered with a rather thick membranous sheath, closely beset with pedicellariæ; (3) ankylosed to the side of every other adambulacral plate a small lateral plate bearing a spine about 7-9 mm. in length, which, like the others, is sheathed; actinal adambulacral spine shorter on plates, opposite to which there is a lateral spine.

Actinostome 12.5 mm. in diameter; mouth plates small, the combined width of the 2 plates being about equal to breadth of furrow at its mouth; plates with no conspicuous lateral processes into furrow; armature consisting of (1) a rather prominent, but slender and delicate, marginal spinelet situated at angle between furrow and actinostomal margins; (2) on actinal surface near center a still longer spinule, and on furrow margin, very near the first adambulacral, a very small spinelet sometimes present, all bearing subterminal groups of pedicellariæ.

Locality: Station 4398, off San Diego, Cal., 620 fms., green mud, rocks.

Genus FREYELLA Perrier.

Freyella Perrier, Première note, préliminaire sur les Echinodermes recueillis par le Travailleur et le Talisman, Ann. des Sciences Nat., Zoologie, XIX, 1885, 5.

Freyella fecunda, new species.

Rays 13. $R=330$ mm. (approximately); $r=13.5$ mm. $R\approx$ approximately $25r$. Diameter of disk over all, 27 mm.; of elevated portion, 24 mm.; thickness of disk, 5 mm. Diameter of ray at base, 6 mm.; at widest portion of genital inflation, 25 to 75 mm.; from base, 7.5 mm.

Rays very long, narrow, tapering gradually; a trifle narrower at base than throughout the very extensive genital region, which is not inflated; rays subcylindrical at base, depressed on genital region; latter extending nearly half length of ray; beyond genital region abactinal membrane collapsed upon ambulacral ridge, which can be seen through the translucent membrane; disk fairly large, abactinal surface slightly raised above level of base of arms; lateral spines of arms long and slender.

Edge of disk rounded and somewhat undulating in outline; abactinal membrane very tight and beset with equally spaced, small, terete, blunt spinelets, those about anal opening a trifle longer than the others; shape of spinelets due to a membranous sheath, the calcareous portion acicular; interradial plate rather high and narrow, confined to side wall of disk, inconspicuous; abactinal membrane of rays rather thin and papery, the plates being superficially invisible except in a thoroughly dried specimen; plates rudimentary, very thin, imbricating at least in the median radial region, irregular in outline, and consisting of a single layer of delicate calcareous network. In the extensive genital region the abactinal membrane is beset with minute, evenly spaced prickles, which are incased in membrane, giving them a superficially blunt appearance; these prickles much smaller than those of disk, and 1 or 2 to each plate, commonly 2; on outer part of genital region, where the plates are not so closely placed, the prickles are more widely spaced, and many of the plates are without them. Indistinct bands of microscopic pedicellariæ, from each lateral and adambulacral plate proceeding toward median radial line, where they break up; on the semi-transparent membrane of outer half or two-thirds of ray (beyond genital region), where there are no prickles, these bands of pedicellariæ more conspicuous, and extending entirely across abactinal surface, but frequently more or less irregular on median keel of ray; extending upward from the rudimentary marginal or lateral plates are a few plates stouter than the other abactinal ones, forming thus the rudiments of costal ridges.

Ambulacral plates longer than high, and in basal portion of ray nearly as wide as long; armature consisting of (1) 2 delicate spinelets situated at aboral end of the slightly excavated furrow margin, these sheathed in membrane and bearing numerous minute pedicellariæ; spinelets fairly long and reaching more than halfway across the wide furrow; throughout greater part of ray but 1 spinelet on the furrow; (2) on actinal surface near aboral end 2 spines forming an oblique transverse series with the furrow spinelet, the inner the shorter, about twice as long as the furrow spinelet, the outer from 2 to $2\frac{1}{2}$ times longer than the inner; outer spine about 10-11 mm. long; all sheathed in delicate membrane, forming a blunt saccular tip, all beset with microscopic pedicellariæ, and all uniformly slender and sharp; (3) partially fused to lateral face of alternate adambulacrals a lateral plate, bearing a long, slender spine (13 mm.) sheathed in membrane bearing microscopic pedicellariæ; on plates adjacent to lateral spine the actinal adambulacral spines much shorter than on the others; near base of ray

the larger actinal spine shorter and stouter, and gradually flaring at the tip, which is broad, truncate, and flower-like, as in *Brisinga cricophora*.

Actinostome rather wide, 16 mm. in diameter; mouth plates small, inconspicuous, rather narrow, with a flaring inner or free margin, the combined pair being shield-shaped; armature consisting of 3 or 4 membrane-invested, pedicellaria-bearing spinelets on the inner free flange-like margin of the plate, that nearest median suture the shortest, the rest evenly graduated in size outward; at aboral end of plate 1 or 2 similar spinelets reaching nearly across furrow; on actinal surface 2 much larger and heavier, pointed, sacculate spinules standing in a longitudinal linear series, the inner the longer, and slightly nearer the median suture; occasionally 3 spinules.

Madreporic body small, subtubercular, situated near margin of raised portion of disk, its borders beset with numerous spinelets.

Color in life: Abactinal surface of disk flame scarlet; rays "salmon pink" with a yellowish cast, much lighter than disk; edges of furrow pinker; spines "salmon color;" tube feet pinkish orange.

Locality: Station 4530, Monterey Bay, 958 fms., soft mud.

This species is particularly characterized by the very extensive genital region, which extends about half the length of ray, and by the exceedingly delicate abactinal plates.