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TWO NEW STARFISHES AND A NEW BRITTLE-STAR  
FROM FLORIDA AND ALABAMA

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During a brief visit to Key Largo, Monroe County, Florida, in September, 1947, Mr. Frank B. Lyman collected a few littoral echinoderms which he generously presented to the U. S. National Museum. Among these were two starfishes representing types not previously known from the Atlantic area. One of these is related to the species of the Indo-Pacific genus *Leiaster*, though it presents so many peculiarities that it may be regarded as representing a distinct generic type. The other is related to a small group of species of the genus *Ophidiaster* quite different from the two Atlantic species of the genus and heretofore supposed to be confined to the Indo-Pacific region.

During the investigations of the Fish and Wildlife Service steamer *Pelican* on the southeastern coast of the United States many interesting echinoderms were collected, among them a new species of the genus *Asteroporpa* most closely related to one from southeastern Australia and another from southern Japan. This is described beyond.

Among the other captures of special interest were the type specimen of *Luidia bernasconiae* A. H. Clark, related to a west African species; a large number of specimens of *Thyraster serpentarius* (Müller and Troschel), a starfish previously known from only a very few examples, which was dredged at many stations from Savannah, Georgia, south to Ormond, Florida, and also off Mobile, Alabama, and Cameron, Louisiana, in from 8 to 33 fathoms; and some specimens of *Arbacia punctulata* (Lamarek) which were bright olive green in color with white spines, from off Cape Canaveral, Florida, in 8 fathoms. Heretofore the green color was supposed to be characteristic of, and confined to, *Arbacia dufresnii* (de Blainville) of southern South America and the Falkland Islands, and *A. crassispina* Mortensen of Tristan da Cunha.

**Copidaster**, gen. nov.

*Diagnosis*.—A genus of Linckiidae with 5 slender cylindrical rays having a rigid skeleton and covered with a thick smooth skin that wholly conceals the underlying features; the abactinal plates are in

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regular longitudinal and transverse series; there are 7 longitudinal series throughout most of the ray, becoming 9 near the tip; the papular areas are large, in 8 series; there is one small madreporite; the adambulacral plates alternate large and small; in the proximal half of the rays alternate actinals are connected with the marginals by two plates, arranged tandem; the whole animal is completely covered with imbricating scales, very small on the papular areas becoming larger on the plates and largest on their summits; small clasp-knife pedicellariae are very abundant, on the abactinal as well as on the actinal surface.

*Genotype.*—*Copidaster lymani*, sp. nov.

*Range.*—Known only from southern Florida.

*Comparisons.*—This new genus appears to be most closely related to *Leiaster* which it resembles in its thick skin and in its adambulacral armature and pedicellariae. It differs from *Leiaster* in its complete covering of minute imbricating scales, in the occurrence of two plates instead of one between alternate actinals and marginals in the proximal half of the rays, and in the conspicuous alternation in size of the adambulacral plates.

*Copidaster lymani*, sp. nov.

*Description.*— $R = 85$  mm.,  $r = 9$  mm.; the five slender cylindrical rays are 11 mm. broad in the middle; in life they are covered with a thick smooth skin that conceals the underlying features.

There are 7 series of marginal and abactinal plates in the earlier portion of the rays. The carinal and marginal rows, which consist of about 45 plates (about the same number as in *Leiaster teres* of equal size) remain straight and regular to the arm tips. At about 20 mm. from the arm tips the row on each side of the carinals becomes irregular, and imperfectly and irregularly doubled; at about 20 mm. from the arm tips this confusion resolves itself into two regular rows on each side, making 9 rows in all. The plates are T-shaped rather than trilobate, the three arms being narrower than the three lobes of the plates of *Leiaster teres*, with approximately parallel sides and broadly rounded ends. They are considerably smaller than the papular areas between them. In *L. teres* they are of about the same size as the papular areas. Beyond the ends of the arms of the plates of the carinal row there is occasionally a small plate connecting the plate of the carinal row with the corresponding plate of the row on either side, as in *L. teres*. The stem and arms of the T are convex so that the ray shows 7 longitudinal ridges connected by numerous lower transverse ridges.

All the plates are completely covered with an investment of flattened scale-like granules imbricating outward and upward from the papular areas, distinctly suggesting the scales on the wing of a butterfly. They are very small on the papular areas, becoming larger on the plates. On the summit of the plates there is a group of from 6 to 20 (commonly about 15) similar but very much larger scales. In *Leiaster teres* the very few granules are lenticular and are embedded in the skin of the papular areas.

There are 8 series of papular areas. These are large and include from 12 to 20 (usually about 15) papulae. Near the tips of the rays these

decrease in number until there are only one or two, and usually none in the submarginal row.

Pedicellariae are exceedingly numerous. On the disk there are from 1 to 4, most commonly 2 or 3, in each papular area, usually situated on the margin. In the proximal third of the rays there are usually 2 pedicellariae in each papular area, one on each side; in the middle third there is usually only one, though sometimes more; and in the distal third the pedicellariae become scattered, although they persist almost to the extreme tip. In the interbrachial areas on the actinal surface they are even more numerous than on the abactinal surface. Beyond the row of contiguous outer adambulacral spines there are frequent pedicellariae situated between the furrow spines and those of the outer row and usually alternating with the spines in the latter. Some of these pedicellariae are much smaller than usual. These pedicellariae persist to about the end of the basal third of the rays.

The pedicellariae are small. The alveolae in which they are situated are about 1 mm. long, narrowly rhombic, mostly about 3 times as long as broad, with sharply pointed ends. The thin lateral borders, which in the dried specimens stand well above the general surface, in life can be brought together, completely concealing the enclosed pedicellaria. The jaws of the pedicellariae are about 0.3 mm. long. They are Y-shaped, the very slender stem of the Y, which ends in a sharp point, being half again as long as the distance across the somewhat thickened arms of the Y-shaped base. The jaws of the pedicellariae are laterally compressed so that in lateral view they are 4 or 5 times as long as their height at the base. They are straight and of uniform width in the proximal half, in the distal half tapering slightly and ending in a recurved glassy hooked point. Along the upper edge there are a few rounded glassy teeth. They closely resemble the blade of a clasp-knife, except that when folded back into the alveola the cutting edge is outward instead of inward.

The pedicellariae of *Leiaster teres* are of the same general type, but they are much fewer, confined to the actinal surface where there are about 6 in each interbrachial area, and the jaws appear to be straight, thicker, and without the hooked tip. The alveolae in *L. teres* are usually straight, but they may be obtusely angled in the middle.

The adambulacral plates are at right angles to the ambulacral groove. The first 15 or 16 are of the same size; those following alternate large and small, the larger ones being more than twice as broad as the smaller.

Following the adambulacral plates there is a continuous row of contiguous irregularly rounded actinal plates, one over each adambulacral. If these happen to be out of line so that there is a suture between two actinals above an adambulacral, the adambulacral is usually followed by a small plate intercalated between the lower angles of the actinal plates.

Following every alternate actinal plate in the proximal half of the arm are two plates connecting the actinals with the marginals. The plate adjacent to the actinals is broader than long, and the lower border, adjacent to the actinals, is more or less bilobed. The plate between this and the marginal is narrower, longer than broad, with broadly rounded ends. Its lower (adambulacral) end imbricates over the upper end of the preceding plate, and its upper end is overlapped by

the lobe of the marginal. In the distal half of the rays this upper plate disappears, and the lower plate becomes smaller and narrower and loses its two-lobed character. Only the plates of the row adjacent to the actinals are present in *Leiaster teres*.

Each adambulacral plate carries 2 long furrow spines of equal size with parallel sides and a broadly rounded tip. These are similar to the 3 furrow spines of *Leiaster teres*, but broader. On the outer end each of the 15 or 16 proximal adambulacrals bears a much larger rounded pointed spine, each of these spines being in contact with that following. Beyond this point similar spines occur on alternate adambulacrals. Between this row of spines and the furrow spines there are numerous non-contiguous scale-like granules imbedded in the skin.

The spines on the jaw plates continue the series of furrow spines and are not distinguishable from them.

The color (dry) is brown.

*Type*.—Cat. No. E. 7177, U. S. National Museum, from the outer reefs of Key Largo, Florida, collected by Frank B. Lyman in September, 1947.

*Notes*.—The type specimen of *Copidaster lymani* was examined by Professor Walter K. Fisher of Pacific Grove, California, and a photograph of it, accompanied by a detailed description, was studied by Dr. H. Engel of Amsterdam. I am much indebted to these two gentlemen for their comments.

The chief character distinguishing *Copidaster* from *Leiaster* is the complete covering of imbricating scales. Of somewhat less significance are the strong alternation in size of the adambulacrals, and the occurrence of two plates joining the actinals and marginals in the proximal half of the rays.

#### *Ophidiaster bayeri*, sp. nov.

*Description*.—R = 15 mm., r = 4 mm.; the arms are almost cylindrical slowly tapering distally, 3 mm. broad in the middle.

There are seven series of slightly tumid abactinal and marginal plates. These plates are slightly trapezoidal with broadly rounded angles, through the coating of granules appearing oblong, slightly longer than broad. They are arranged in regular longitudinal and transverse rows, each longitudinal row consisting of about 17 plates.

All the plates are completely covered with an investment of contiguous, or almost contiguous, roughened granules which are often higher than broad with an abruptly rounded tip. On the marginals these granules tend to be higher than on the abactinal surface, and they are also somewhat flattened. Each marginal bears in its center a conspicuously larger and higher tubercular granule or low tubercle, in the proximal portion of the rays usually 2 or 3. Each abactinal plate carries from 1 to 4 abruptly enlarged granules similar to those on the marginals though not so conspicuous.

The papular areas are in 8 series. They are small, including usually 3 papulae, sometimes, especially toward the ends of the rays, only 1 or 2.

There are no pedicellariae.

The adambulacral plates are strongly oblique, making an angle of nearly 45° with the ambulacral groove, with the inner ends more distal than the outer. They are all of the same size.

Following the adambulacral plates there is a continuous row of somewhat irregularly rounded contiguous actinal plates, one to each adambulacral. Alternate actinal plates are followed by a slightly smaller plate broader (parallel to the axis of the ray) than long that connects alternate adambulacrals with the marginals. In one case there is a very small supplementary plate intercalated between one of these plates and the marginal. These connecting plates are often, perhaps usually, displaced proximally so that they are situated over the line of union between two actinals.

Each adambulacral plate carries two furrow spines which are about twice as long as broad, strongly flattened with parallel sides and a broadly and evenly rounded tip. The distal is slightly smaller than the proximal, becoming markedly smaller in the distal portion of the rays. Just behind the furrow spines each adambulacral carries on the actinal surface a flattened spine similar to the larger furrow spine but about half again as large. On its outer end each adambulacral carries a much larger and stouter spine, broad and somewhat flattened with a rather sharply rounded tip. There are usually no granules between the furrow spines and those of the next row, but there may be one, on one or on both sides, between the outer edges of the spines of the second row and the furrow spines. The spines on the outer ends of the adambulacral plates are separated from those of the second or middle row by usually two rows of granules, but they lie closely against the spine of the middle row of the next following plate.

Each jaw plate carries 4 spines resembling the furrow spines but somewhat larger and more slender.

The color (dry) is brownish white, lighter below.

*Type*.—Cat. No. E. 7176, U. S. National Museum, from the outer reefs of Key Largo, Florida, collected by Frank B. Lyman in September, 1947.

It gives me much pleasure to name this species for Mr. Frederick M. Bayer who has presented the U. S. National Museum with many fine specimens of echinoderms from Florida and from Biak Island.

*Comparisons*.—The three rows of spines on the series of adambulacral plates distinguish this species at once from the two other species of *Ophidiaster* known from the Atlantic, *O. ophidianus* on the east coast and in the Mediterranean, and *O. guildingii* in the Caribbean region.

Five species of this general type are known from the Indo-Pacific, *O. granifer* Lütken, *O. tuberifer* Sladen, *O. ornatus* Koehler, *O. pusillus* Müller and Troschel, and *O. triseriatus* Fisher. *Ophidiaster bayeri* is distinguished from *O. tubifer*, *O. granifer*, and *O. pusillus* by the absence of pedicellariae. From *O. triseriatus* it is distinguished by not having the abactinal and marginal plates tumid or nodose with a naked central area, and from *O. ornatus* it is distinguished by not having the spines on the adambulacral plates separated by granules, and by having the spines of the two outer rows more or less alternating instead of in transverse pairs; also, the plates are less tumid, and the tubercular granules are less conspicuous.

When this specimen was received Professor Walter K. Fisher was visiting the National Museum, and I have to thank him for many helpful suggestions in regard to its relationships.

Three species of *Ophidiaster* in addition to *O. guildingii* have been

described from the southeastern coast and the Caribbean Sea, all from deep water. These are *O. floridae* Perrier, 1881; *O. alexandri* Verrill, 1915; and *O. pinguis* H. L. Clark, 1941. These represent different stages in the development of the species described by Dr. Hubert Lyman Clark in 1921 as *Hacelia superba*, and are all synonyms of *Hacelia floridae* (Perrier).

Genus *Asteroporpa* Oersted and Lütken

*Remarks.*—The discovery in the Gulf of Mexico of a new species of *Asteroporpa* representing a group of species heretofore known only from the west Pacific is interesting, though in view of the paucity of our knowledge regarding the species of the subfamily Astrochelinae it is not especially surprising.

The first known species of *Asteroporpa* was described by Oersted and Lütken in 1856 from the West Indies under the name of *Asteroporpa annulata*. In 1859 Professor Lütken described a second species from the West Indies which he called *A. affinis*. In 1862 Dujardin and Hupé redescribed these two species and added a third, *A. dasycladia*, from Guadeloupe.

Theodore Lyman in 1882 recognized *A. annulata* and *A. affinis*, placing *A. dasycladia* as a synonym under *A. annulata*.

In 1909 Dr. Hubert Lyman Clark described *A. australiensis* from a single specimen from off Wollongong, New South Wales, and in 1911 he described *A. hadracantha* from 22 specimens from various localities off southern Japan.

In a survey of the species of *Asteroporpa* published later in 1911 Dr. Ludwig Döderlein recognized four species, *annulata* (with *dasycladia* as a synonym), *affinis*, *australiensis*, and *hadracantha*. Dr. H. L. Clark in 1915 recognized as valid species *annulata* (with *affinis* and *dasycladia* as synonyms), *hadracantha*, and *australiensis*, and described a new species, *A. pulchra*.

From the material at hand it would seem that *annulata* and *affinis* are quite distinct. In *annulata* the radial shields are narrow so that the arms appear to be continued inward to near the center of the disk, the transverse elevated bands on the arms and radial shields are broad, as broad as the interspaces between them, and the oral side is completely covered with granules, which are much larger in the interradial regions than elsewhere; whereas in *affinis* the radial shields are broad, much broader than the arm bases, the transverse elevated bands on the arms and radial shields are narrow, much narrower than the interspaces between them, and the oral side is sparsely granulated, the granules in the interradial areas not differing appreciably from the others.

In these features *A. affinis* appears to be quite constant, though it is variable in others. For instance, there are usually five bands of enlarged granules across the radial shields, but there may be as many as eight or nine; usually the three outer bands across the radial shields are hook-bearing, but sometimes only the outermost bears hooks; and, though usually regular, some of the bands may be interrupted, or represented only in part. The granules in the central portion of the disk are usually rounded and smooth, but more or fewer of them may be pointed and tipped with a slender spine. The color varies from very dark with the elevated ridges whitish in strong contrast to uniform light dull yellowish.

*Asteroporpa lindneri*, sp. nov.

*Diagnosis.*—A species of *Asteroporpa* in which the hook-bearing transverse ridges on the radial shields and arms are bordered on each side by a continuous row of contiguous enlarged granules and are slightly elevated above the general surface of the disk and arms; the radial shields are crossed in the outer portion by three bands of hook-bearing granules; and the granulation is coarse, the inner bands crossing the radial shields being composed of usually a single row of globular granules which are much larger than those on either side, while the interspaces between the bands are broader than the bands themselves.

*Description.*—The disk is 12 mm. in diameter and the arms are about 75 mm. long. The pairs of radial shields are 4.5 mm. broad at their outer ends, tapering to 1 mm. in breadth at their inner ends near the center of the disk. On the periphery of the disk the interradial margins are deeply concave, reaching a depth of 2 mm. within a line connecting the ends of two adjacent pairs of radial shields. On the aboral surface the interradial areas are deeply sunken so that the radial shields rise high above them. From a width of 2 mm. they taper inwardly to a point between the inner ends of the pairs of radial shields.

The arms at the base are narrower than the outer ends of the pairs of radial shields, about 3 mm. broad. They are considerably lower than the outer ends of the radial shields, which are curved broadly downward to them. The arms taper moderately for about the first 20 mm., then progressively more gradually to the extremely slender and almost filiform tip.

The entire surface of the animal is covered with rounded granules. In the interbrachial areas on the aboral side these granules are low, some convex and some flattened, and of different sizes and shapes, forming a sort of mosaic pavement. There is a tendency for rather large flattened granules to be surrounded by a circle of much smaller and more globular ones forming a sort of reticulation, but this is not very regular. In a broad band around the edge of the disk the smaller elevated granules become more numerous, so that here the granulation appears somewhat more dense. On the lateral surface of the disk and in the interradial angles on the oral surface the small granules increase considerably in size so that there is little difference between them and the larger ones, and here both are more or less strongly convex.

The oral surface of the disk is covered with a fairly uniform investment of approximately hemispherical granules which are considerably smaller than those on the adjacent portions of the interradial areas. They are mostly of about the same size with a few smaller ones intermixed, but become very small on the mouth plates. On the oral side of the arms after the second group of arm spines they become smaller, more irregular in size, and more scattered, after the proximal third of the arms becoming very small and widely scattered. In the distal portion of the arms they are very small and few in number.

On the pairs of radial shields on the aboral side the granules increase in size from the inner to the outer ends. The radial shields are crossed by five bands of enlarged granules of which the three outer are double. The innermost band consists of a single or partially double row of large, high, usually roundedly pointed granules which is bordered on each side

by smaller but similar ones. The second band consists of a usually more regular single row of large high granules bordered on each side by a row of smaller ones. Between the first and second and second and third bands is a pavement of much smaller rounded tubercles. The three outer bands consist of two regular transverse rows of large granules between which are two rows of smaller though equally high granules each of which bears on its elevated summit a glassy hook. The granules between the third and fourth bands are larger than those between the first and second and second and third bands, and those between the fourth and fifth bands are nearly as large as the granules of the bands themselves.

Above each pair of side arm plates the arm is crossed by a band consisting of two regular transverse rows of enlarged and rounded granules between which is a double row of smaller but somewhat higher granules, each with a glassy hook at the summit. These bands are separated by an irregular single or more or less double row of smaller and lower granules. There is at best little difference between the granules of the bands and those between them, and often none so that the double rows of hook-bearing granules are simply separated by three or four more or less irregular rows of similar low polygonal granules. Distally the granules become smaller and the double rows of hook-bearing granules higher and more prominent. In the terminal portions of the arms the granules are reduced to small delicate flat plates with the hook-bearing bands standing up conspicuously above them, forming more or less high collars across the arms.

The hooks are crescentic with the lower horn of the crescent usually rounded and swollen; the attachment is by a broad base near the lower horn. Many of them agree with the hooks of *Asteroporpa annulata* as figured by Döderlein. They are rather variable. Usually they are slender and sharply pointed, but they may be stout, especially in the lower two-thirds. The concave side of the crescent is frequently extended by a thin flange with a straight or slightly concave outer edge that extends from the lower horn nearly to the upper point. There is frequently an accessory point a little more than half way from the lower to the upper horn. This is usually small, but may be long and slender or short and broad. Occasionally it forms the upper border of the filmy extension of the inner side of the crescent.

The first tentacle pore is without any tentacle scales (or arm spines). The second has just below it, and extending outward to the edge of the arm, a comb of 3-5 (usually 4) short, stout, subequal spines each with one or more slender and sharp spinules at the tip. Beneath the next pore is a comb of 4 or 5 similar spines. After about four pores the outermost, or outer two, spines become transformed into tubercles bearing articulated crescentic glassy hooks resembling in general those of the aboral surface of the arm, so that there are only three spines. Later other spines become modified so that finally only the innermost spine is left, and in the terminal portion of the arm all the spines are transformed into tubercles topped by glassy hooks.

Color, dried from alcohol, brownish white, slightly darker and more yellowish below, the interradial areas grayish.

*Type*.—Cat No. E.7178, U. S. N. M., from *Pelican* station 137-1, in the Gulf of Mexico southeast of Mobile, Alabama (lat. 29° 30.0' N. long. 87° 29.5' W.); 49 fathoms; March 1, 1939.

It gives me much pleasure to name this species for Dr. Milton J. Lindner who when in charge of the investigations by the *Pelican* assembled an unusually interesting collection of Caribbean echinoderms.

*Comparisons*.—This new species belongs to that section of the genus in which the hook-bearing transverse bands are bordered on each side by a regular row of enlarged granules. Heretofore species of this section were known only from *Thetis* station 48, off Wollongong, New South Wales, in 55-56 fathoms (*A. australiensis*), and from *Albatross* stations 3727, 3730, 3764, and 4936, off southern Japan, in 34-103 fathoms (*A. hadracantha*). The new species appears to be most closely related to *A. hadracantha* from which, however, it is easily distinguished by its coarser granulation.

#### KEY TO THE SPECIES OF ASTEROPORPA

- a.<sup>1</sup> Transverse double bands of hook-bearing granules on the arms standing up as high narrow ridges which are about as broad as, or narrower than, the intervals between them, and are not bordered on each side by a regular row of contiguous enlarged granules; hooks large, usually with a long accessory tooth
- b.<sup>1</sup> All the transverse bands of enlarged granules on the arms bear a double row of minute glassy hooks
  - c.<sup>1</sup> Pairs of radial shields narrow with the sides almost parallel but little broader at the outer ends than the arm bases, separated by depressed interbrachial triangles that run inward to an apex between their inner ends; elevated hook-bearing ridges about as broad as the intervals between them; granulation below dense, forming a complete plating, the granules in the interradial areas larger than the others, sharp tipped, and rather widely scattered *annulata*
  - c.<sup>2</sup> Pairs of radial shields broad, very obliquely wedge-shaped or almost triangular, the outer angles nearly contiguous and the outer ends much broader than the arm bases; interbrachial granulation narrow and not extending inward so much as half way to the inner ends of the radial shields; elevated hook-bearing ridges on the arms narrow, about half as broad as the intervals between them; granulation below very sparse, the granules widely scattered, and uniform.
- b.<sup>2</sup> On the arms double transverse bands of enlarged granules bearing hooks alternate with single transverse bands of granules without hooks *affinis pulchra*
- a.<sup>2</sup> Transverse double bands of hook-bearing tubercles on the arms bordered on each side by a regular row of contiguous enlarged granules, the quadruple bands composed of enlarged and hook-bearing granules only slightly elevated above the general surface of the arms and much broader than the intervals between them; hooks much smaller, usually without an accessory tooth
  - b.<sup>1</sup> Radial shields with a single band of hook-bearing granules along the distal border; four broad and conspicuous bands of enlarged granules across the radial shields, followed inwardly

by a much narrower and irregular one; color conspicuously contrasting, dark with the bands of enlarged granules light

*australiensis*

b.<sup>2</sup> Radial shields with three bands of hook-bearing granules across the outer portion; five to seven bands or rows of enlarged granules across the radial shields; color nearly or quite uniform

c.<sup>1</sup> Granulation coarse, the radial shields crossed by usually five bands of enlarged granules of which the three outer are double, enclosing a double row of hook-bearing granules; two inner bands crossing the radial shields each composed of a single more or less regular row of globular granules which are much larger and higher than those on either side, these bands narrower than the interspaces between them

*lindneri*

c.<sup>2</sup> Granulation fine, the radial shields crossed by seven bands of enlarged granules of which the three outer are double, enclosing a double row of hook-bearing granules; four inner bands of enlarged granules crossing the radial shields composed of several irregular rows of granules which are not much larger than the granules between the bands, these bands much wider than the interspaces between them

*hadracantha*

EXPLANATION OF PLATE

FIGURE 1.—*Copidaster lymani*, gen. et sp. nov., abactinal view; the ray on the left has been partially cleaned to show the plates; the type specimen, x 2.

FIGURE 2.—*Copidaster lymani*, actinal view; the ray on the left has been cleaned; the type specimen, x 2.

FIGURE 3.—*Ophidiaster bayeri*, sp. nov.; the type specimen, x 2.

