

TROPHODISCUS, A NEW SEA STAR FROM KAMCHATKA.

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The new genus and species described herewith belongs to the family Astropectinidae, and stands near to *Leptychaster*, especially to *Leptychaster propinquus* and *L. anomalus*. In *Leptychaster*, or rather in those species of the genus found in the northern hemisphere, the gonads have a very characteristic distribution which so far as now known is not found elsewhere among starfishes. In the great majority of sea stars the gonads are confined to the interradial region and usually form a single tuft or cluster of tubules on either side of the interbrachial septum. In *Leptychaster* this is true of the ovaries only, while the testes form a series of clusters hanging from the genital stolon, and extending about a third the length of the ray measured along the side. In the new genus, as well as in *Dipsacaster*, *Tethyaster*, and several other genera of the Astropectinidae both the ovaries and testes are so distributed, without any apparent difference, other than the cellular structure. The gonads are, therefore, serially arranged.

Trophodiscus may be distinguished from the shorter-rayed species of *Dipsacaster* by the uncovered, relatively smaller madreporic body, by the interruption of the papular area along the midradial line (where, in *Dipsacaster* the papulae are normally largest), and by the wholly unarmed inferomarginals (except *D. anoplus* Fisher). No species of *Dipsacaster*, so far as known, broods its young.

TROPHODISCUS, new genus.

Characters.—Near to *Leptychaster* Smith, but differing in having both ovaries and testes serially arranged along each side of the proximal half of the ray. Form stellato-pentagonal; with conspicuous marginals, large compact paxillae, carinated actinal intermediate plates, and a pectinate furrow armature; no enlarged marginal spines; an incomplete interradial series of actinal intermediate plates; madreporic body uncovered; papulae absent from center of disk and a very narrow radial area. Young carried on back of the female, among the paxillae.

Type.—*Trophodiscus almus*, new species.

TROPHODISCUS ALMUS, new species.

Description.—Rays 5. $R = 43$ mm., $r = 26$ mm., $R = 1.65 r$; cotype: $R = 39$ mm., $r = 25$ mm., $R = 1.56 r$. General form stellato-pentagonal with short, broad rays, arcuate interbrachia, and slightly to decidedly swollen abactinal area, broadly margined by the short, wide inferomarginal plates; rays evenly tapered beyond the base to a bluntly pointed extremity.

When the abactinal integument is not stretched the paxillae are very compactly placed. They are largest at about the middle of R (at base of ray proper), whence they decrease in size only slightly laterally, but gradually toward the end of the ray, where the crown is only one-half to one-third the width of the largest paxillae. Inside a circular area bounded by the madreporic body the paxillae rapidly become smaller toward the center of the disk. The large paxillae have a convex crown of 20 to 30 subtruncate, or round-tipped slightly clavate spinelets, about 4 to 5 times as long as their breadth at tip and about 2 to 2.5 times the length of the stout, slightly flaring pedicel of the paxilla. The 10 to 15 spinelets on the convexity of the tabulum are a trifle stouter than the peripheral ones.

The abactinal plates, or bases of the paxillae, viewed from the coelomic side show two principal forms. Those of the central area of disk and a median band along the ray are subcircular or very broadly elliptical, the margin being slightly crenulated or incipiently lobed in most cases. The plates touch each other or even slightly overlap. On the disk they are more crowded than on the outer part of the ray. On the lateral areas of rays and disk the plates are more widely spaced and have 4, 5, or 6 distinct but irregular lobes. Along a narrow zone next the marginal plates the abactinal plates quickly become smaller, with short, overlapping lobes.

The papulae are absent from the center of the disk and a very narrow midradial band, upon which a papula will sometimes encroach. They are best developed wherever the abactinal plates have well-marked lobes.

Supermarginal plates 19, forming a broad, slightly raised, beveled margin or frame to the abactinal surface. The plates are short and relatively broad, and decrease regularly in width toward the end of ray. They are covered with fairly large polygonal granules, which form an irregular tessellation and increase slightly in size toward the outer, rounded end or edge of the plate. The granules are rather squamiform in appearance, except the peripheral which are slenderer and spiniform.

Inferomarginal plates 19, slightly broader than the superomarginals and extending laterally beyond them a variable but short distance (not more than a fourth the width of the superomarginals; in the type less), so as to define the ambitus in the interbrachium at least. In-

feromarginal granules squamiform, increasing in size toward the outer margin of the plate where they are larger than the corresponding superomarginal granules. The marginal plates have deep fasciolar grooves between their specialized raised ridges. The grooves in the interbrachium are about three-fourths the width or thickness of the intervening ridges, and on the rays about one-half. Unless the granules are removed the grooves are entirely hidden.

Actinal intermediate plates arranged in very regular series leading from the adambulacral plates to margin, and also in about six series parallel to the adambulacrals. There is an odd interradiar series, starting outside a pair of plates opposite the outer end of mouth plates and nearly reaching the margin. The plates have elliptical, transversely oriented pedicels or tabula (separated by fasciolar channels), bearing a paxilliform group of 15 to 18 peripheral and about 12 to 18 stouter central spinelets. The spinelets are short, clavate, and are more or less bent or dressed toward the margin, the ends of the central spinelets being obliquely truncated and somewhat flaring.

Adambulacral plates with a somewhat tabulate surface, there being a well-defined groove between this and the adjacent actinal intermediate plates, and a slightly deeper groove separates consecutive plates. The armature consists of a peripheral series of about 13 spines of which 6, or 5, stand on the furrow margin and form a regular comb. These spines are roughly four-sided and bluntly pointed, or round-tipped (the end being beveled), and the adoral, as well as sometimes the aboral, are shorter than the central four. The other peripheral spinelets are a little longer than the adjacent actinal intermediate spinelets. Four to six subambulacral spines form usually two series, or a group. In the type there are often two well-defined longitudinal, subambulacral series of four or five spines each, as well as several on the outer edge of the plate.

Mouth plates prominent and rather narrow at the outer end, and flaring to form a broader lanceolate inner half. Marginal spines about 12, largest at the inner end. There is a series of short spines along the median suture margin, a similar series along the center of each plate, and a series of slenderer spinelets along the margin adjacent to the first adambulacral. First adambulacral moderately compressed.

Madreporic body subcircular, convex, not hidden by paxillae. It is situated nearly midway between the center and inner margin of the superomarginal plates. Striae irregularly radiating, branched. The margin is overhung more or less by paxillae, but these do not spring from the surface as in *Dipsacaster*. Anal aperture small but distinct. Gonads, both ovaries and testes, in small branched tufts hanging from a genital rachis which lies nearly midway between median radial line and the margin. The tufts extend about half the length of ray meas-

ured along side. Hepatic coeca short, with few thick, saccular, lateral pockets. Intestinal coecum small, saccular. Interbrachial septum membranous. Superambulacral plates present. Tube-feet pointed; ampullae large, double.

The large saccular stomach consists of only a single chamber, there being no trace of a dorsal division. The short hepatic coeca are arranged about equidistantly on the circumference. In the stomach is a bivalve—a *Yoldia* or related form—22 by 12 mm. It is remarkable that such a large body could be swallowed.

Young.—Among the paxillae of the abactinal surface are 28 young starfishes, and in addition the forms where three others have been. These vary in size from 3 to 8 mm. in diameter, and their distribution coincides exactly with that of the gonads. Another curious circumstance: The largest young are found nearest the interradiial line, while the others with a few exceptions are graduated in size distad, just as the tufts of the gonads are. The smallest young are nearly covered by the overarching paxillae, but as they increase in size the paxillae are pushed aside and the intervening abactinal membrane is stretched to extreme thinness. Viewed from the coelomic side, the young, which form a sort of excrescence impinging upon the coelomic space, can be seen through the semitransparent integument. The young have no organic connection with the parent. Since they lie immediately over the apertures of the gonads, it is possible that they grow by feeding upon ova which are extruded for that purpose. Or, there is a possibility that they may use coelomic fluid received through a papular pore, produced by the simple process of digesting the papula itself. The abactinal membrane is thin enough so that fluid might be actually drawn through it if the stomach could perform a sucking process. Lastly, the tips of the rays are usually turned upward a bit so that food currents might readily conduct microscopic organisms to the mouth along the ambulacral groove. An examination of the stomach of one of the larger individuals did not reveal the exact nature of the food. The stomach was full of a material, apparently solidified by alcohol, in which I was able to distinguish what appeared to be fragments of cells, but no silicious or calcareous remains.

The stomach of a small individual was partly everted. The cotype, a male, has no young on the abactinal surface.

Sladen, in the Asteroidea of the *Challenger* expedition,¹ has figured a specimen of *Leptychaster kerguelenensis* Smith, with numerous young on the abactinal surface. In this species the young leave the arcade-like spaces among the paxillae, and remain on the surface of the paxillae with their actinal side outward.

Type.—Cat. No. 37029, U.S.N.M.

¹ *Challenger* Asteroidea, 1889, pl. 31, fig. 1.

Type-locality.—Albatross station 3644, southeast coast of Kamchatka, lat. $51^{\circ} 16' N.$; long. $157^{\circ} 48' W.$, 96 fathoms, black sand, bottom temperature 33.1° Fahrenheit; 2 specimens.

Location of the gonads in Leptychaster.—In four species of the genus *Leptychaster*, which I have been able to examine, the testes differ in distribution from the ovaries. In *L. arcticus*, *L. pacificus*, *L. propinquus*, and *L. anomalus* (the last three being North Pacific species) the ovaries are in a single tuft close to the interradial septum—a pair, thus, in each interbrachium. In some specimens the branches may extend far along the ray, but they are attached in only one place, as stated above. In the male the gonads form a series of independent tufts of tubules, parallel with the margin, and distributed for a third to nearly a half the length of ray, according to the size of the specimen. The distribution of the testes in the above species of *Leptychaster* is therefore similar to the distribution of both ovaries and testes in *Trophodiscus*, *Dipsacaster*, *Ctenopleura*, *Tethyaster*, *Thrissacanthias*, and other genera. This condition of the gonads is apparently characteristic of the genus *Leptychaster*, although of course, it will doubtless be found to be true of other genera. The reason I did not discover this when working up my North Pacific Asteroidea, Part I, was the fact that I dissected then only a single example of each species, which happened in all cases to be a female. Recently, at the United States National Museum, I found “serial gonads” in a specimen of *L. arcticus*, from station 21, Cashes Ledge. A specimen from station 4779 (North Pacific) has serial gonads and is a *male*, while a *female* from station 5047 has strictly interradial, nonserial, gonads.

This arrangement of the gonads holds true in all specimens examined, namely:

Leptychaster propinquus, 2 males and 3 females; station 4788.

L. anomalus, 1 male, station 4233; 1 female, station 4280.

L. pacificus, 1 male, station 3223; 2 females, station 2862.

EXPLANATION OF PLATES.

All figures are of *Trophodiscus almus*.

PLATE 28.

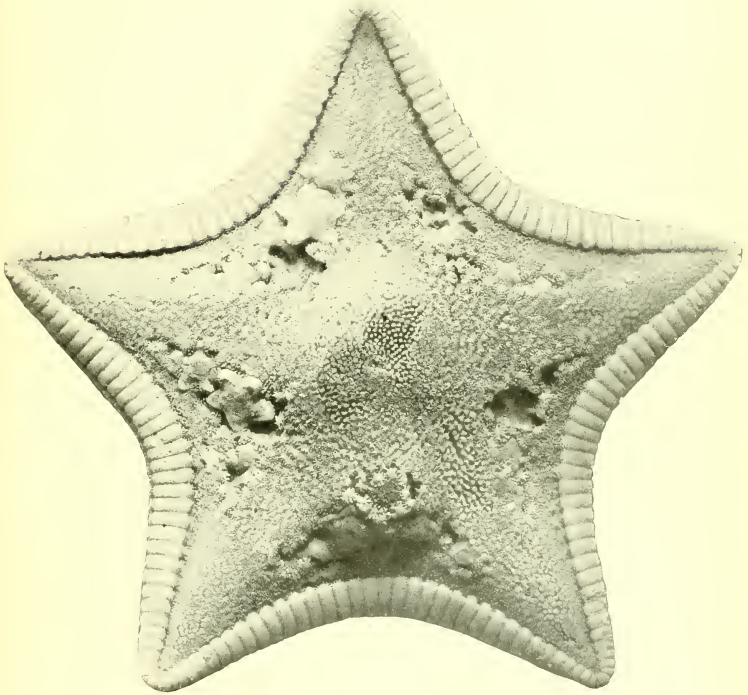
Abactinal surface of the holotype, showing the young among the paxillae.

PLATE 29.

Actinal surface of the paratype.

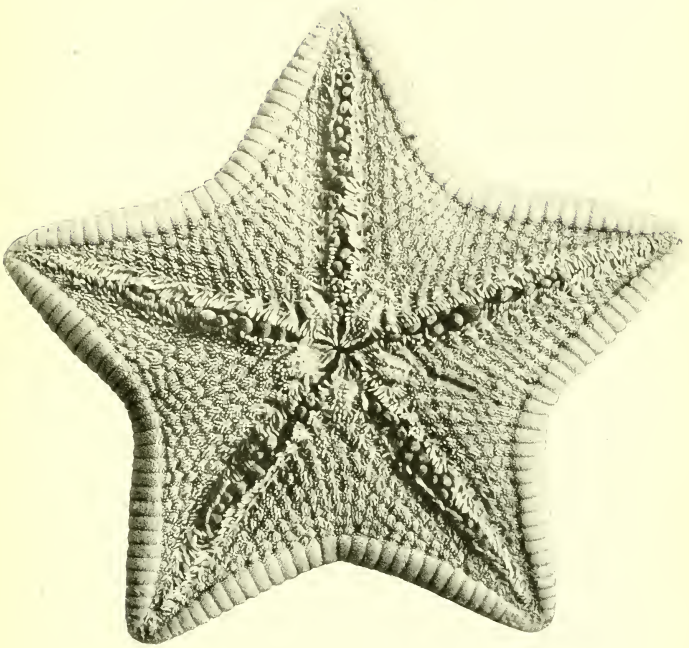
PLATE 30.

Base of ray and portion of disk, enlarged to show the young. The arrows point to very small young.



ABACTINAL SURFACE OF *TROPHODISCUS ALMUS*.

FOR EXPLANATION OF PLATE SEE PAGE 371.



ACTINAL SURFACE OF *TROPHODISCUS ALMUS*.

FOR EXPLANATION OF PLATE SEE PAGE 371.



RAY AND DISK OF TROPHODISCUS ALMUS.

FOR EXPLANATION OF PLATE SEE PAGE 371.

