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A Note of a Japanese Sea-Star, *Astropecten ludwigi* De Loriol

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(With 1 Plate and 3 Text-figures)

Concerning the Japanese species, *A. ludwigi* De Loriol, Fisher ('13) first pointed out that the sea-star is a member of the genus, *Ctenopleura*, then a little later Döderlein ('17) proposed that the sea-star is to be reduced to Sladen's species, *Astropecten formosus*.

I had an opportunity to examine a good serial specimens of *Ctenopleura* obtained from Sagami Bay. These specimens were collected by His Majesty the Emperor during about thirt-five years ranging from 1920 to 1955. The specimens examined may be grouped in two: The one is certainly referable to be *Astropecten ludwigi* De Loriol, and the other is closely related to *Ctenopleura ludwigi* (De Loriol) of Fisher ('13). At the first glance both the Japanese forms seem to be the same, but undoubtedly not the case, each being a distinct form. Fisher's *ludwigi* is not identical with the species, but a form of *Ctenopleura*, new to science, and also De Loriol's *ludwigi* is not able to be included in *Astropecten*, but *Ctenopleura*. The confusion might be caused owing to the scantiness of material. I will note here the form of Fisher's *ludwigi* under the name of *Ctenopleura fisheri* n. sp.

I must express my cordial thanks to Prof. Thoru Uchida for his kind guidanec and for placing the material at my disposal.

***Ctenopleura fisheri* n. sp.**

Ctenopleura ludwigi: Fisher, 1913, p. 608.

Astropecten formosus (in part): Döderlein, 1917, p. 63, pl. 1, figs. 2-3, pl. 7, figs. 2-2b, 3, 3a.

The specimens examined are measured as shown in Table 1.

The description based upon the large specimen (R 100 mm) is as follows;

Disc relatively large, rays tapering evenly from the base to the tip. R about 4r.

Paxillae fairly large, those in rays arranged in transverse series, 5 of which corresponding to every 2 superomarginal plates at the base of ray, but 5 to 7 at the middle portion. The paxillae on disc and those along the midradial portion

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Table 1

Station Nos.	R	r	R : r	Supero-marginals in number	Breadth of arm base	Breadth of ray at the middle
59	100 mm	25 mm	4.0	35-37	30 mm	21 mm
47	100 mm	22 mm	4.5	39		
57	85 mm	23 mm	3.0	35	27 mm	18 mm
47	80 mm	21 mm	3.8	33		
59	77 mm	20 mm	3.9	31	24 mm	15 mm
10	75 mm	19 mm	3.9	34	23 mm	16 mm
64	65 mm	17 mm	3.8	30	20 mm	14 mm
59	63 mm	18 mm	3.5	29	20 mm	13 mm
59	58 mm	16 mm	3.6	27	20 mm	12 mm
64	56 mm	16 mm	3.5	26	18 mm	12 mm
62	55 mm	14 mm	3.2	29	17 mm	12 mm
57	53 mm	16 mm	3.3	27	18 mm	12 mm
64	52 mm	15 mm	3.4	28	17 mm	12 mm
64	47 mm	14 mm	3.3	28	16 mm	11 mm
64	40 mm	13 mm	3.0	24	14 mm	9 mm
64	27 mm	8 mm	3.3	23	10 mm	6.5 mm

of ray are slightly larger and more widely spaced than those in the either side of ray, but those situated in the centre of disc are much smaller and crowded, where the anus is found. The spinelets of paxillae are variable in number according to the size of them. In the middle portion of ray, the large paxillae bear each 3 or 4 subequal, blunt, slender central spinelets surrounded by 10 or 11 peripheral ones in a series. The peripherals are similar to the centrals in size and form. Small paxillae each with 4 to 6 peripheral spinelets, wanting the centrals.

Papulae generally 6 around a paxilla, but absent from the narrow midradial area of ray. The dorsal plates in the papular areas are isolated, longer than wide and slightly lobed.

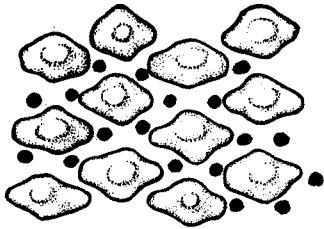


Fig. 1. *Ctenopleura fisheri* n. sp.; dorsal plates in the papular area of ray, viewed from coelomic side. $\times 12$.

Superomarginal plates 35 to 37 in number. At the interradial angles, the superomarginals are much higher than broad, about 6 mm in height, then gradually decrease in height and at the same time increase in length and breadth towards the middle portion of ray, where the plates are nearly as high as broad and about three-fourth as long as broad. The outer side of

the superomarginals are round and convex, not forming any external edge. Those are each armed with a transverse series of short, conical spines located in the abcentral portion of the plate. The series is somewhat discontinuous, and 3 to 7 spines are found there. When 5 or 6 spines are present, the 2 or 3 are generally situated near the inner end of the plate and the rest 3 or 4 in the outer portion,

somewhat apart from the former, but sometimes they are arranged in a continuous series. In interbranchial angles the spines are fewer. In the specimen (R 58 mm) there are mostly 3(2) spinelets in the middle portion of ray, 2 of which located near the outer end of the plate and the 1 near the inner end. The inner spinelets are often absent in plates. In the specimen (R 27 mm) these spinelets are absent in the proximal 4 or 5 plates. In the middle portion of ray, 1 or 2 spinelets are found near the outer end of the plate, but the inners still absent.

The superomarginal plate is uniformly covered with very small blunt spinelets closely placed. Those in the abcentral portion of the plate, subdivided by the transverse series of the superomarginal spines, are subequal in size. Those in the adcentral portion are slightly coarser than the abcentrals. These spinelets are arranged in more or less oblique transverse series, slightly increasing in size towards the series of the superomarginal spines, but decreasing in density. Near the superomarginal spines and in the outer portion of the plate, the spinelets are delicate and slender.

Inferomarginal plates much broader than long, each bearing a vertical oblique comb of 3 to 4 or 5 closely placed, sharp, slightly flattened curved spines. The comb is similar to the lateral comb of *Persephonaster*. The innermost spine or the next are the longest and the outermost generally short and slender. Along the abcentral border of the plate, there is a series of 2 or 3 short, much compressed, spaced spines in the middle portion of ray, but often 4 in the proximal portion and 1 in the distal portion. The inferomarginal plates are covered with obvate spatulate scales arranged more or less in oblique transverse series. The 3 or 4 scales near the comb often become spiny form, arranging in a series parallel to the comb.

Terminal plates relatively small, bilobed.

Ventrolateral plates extending to the 4th inferomarginal plate, 7 or 8 in number. The plates are each armed with 9 to 15 short, slender peripheral spines and 1 or 2 lanceolate central ones.

Adambulacral plates generally 3 corresponding to every 2 inferomarginal plates. The first adambulacral plate is very narrow, and the ventral surface divided into two ridges separated from each other by a narrow longitudinal groove for the greater part. The spines are short, subequal in length, about 20 in number. Those are regularly arranged in two rows, each corresponding to the ridge of the plate. The innermost spine facing to the furrow is single, much longer and thicker than the rest. Behind the double series of the spines, there are 5 to 8 spines in the remainder surface of the plate, which are arranged in two irregular rows. The second adambulacral plates bear each 6 or 7 furrow spines arranged in two rows. The unpaired innermost spine and the following 2 or 3 in the abcentral row are thick and flattened, truncated at the tip. The 3 or 4 in the adcentral row are short and slender, pointed at the tip, but the innermost spine of the row is not short and slender, but similar in form to the adjacent abcentral. Following the furrow spines are found 8 or 9 subequal, slightly flattened short spines having

an appearance of a fascicular pedicellaria. Behind the spine-group there are 6 or 7 slender pointed spines arranged in a horse shoe-shape bordering the remainder portion of the plate and in the central space are located 1 or 2 more robust flattened spines.

In the middle portion of ray, the adambulacral armature consists of generally 4 strongly flattened, robust furrow spines with truncated tip; the one facing to the furrow, the following 2 in the adcentral side and the remainder one in the abcentral side. The innermost spines is the largest, with its edge to the furrow. Separating from the furrow spines by a rather conspicuous space is found a fascicular pedicellaria in the abcentral surface of the plate. The organ is composed

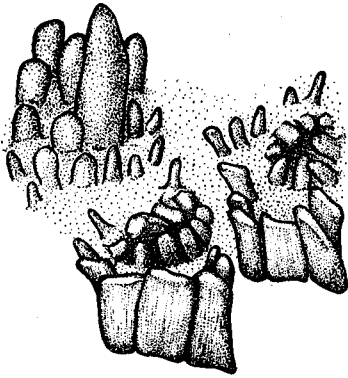


Fig. 2. *Ctenopleura fisheri* n. sp.; adambulacral armature in the 12th and 13th plates. $\times 12$.

of 6 to 10 subequal small spines in a circle enclosing a central space. These spines are often arranged in double rows parallel to the furrow. In badly preserved specimens the organ may be misjudged as a cluster of short spines. Along the adcentral and outer borders of the plate are found 3 to 6 flattened, short spines being slightly longer than the pedicellarian spines. The pedicellaria often appears to be encircled by the furrow spines and the marginal short ones. The pedicellarian spines and the marginals are subequal to or very slightly longer than the adjacent inferomarginal scales.

In the small specimen (R 63 mm) the furrow spines are 3 or 4 in number, and the pedicellaria situated in the abcentral portion of

the plate is composed of 6 or 7 short spines, and 3 to 5 similar spines placed in the adcentral border of the plate. These spines are slightly longer than the adjacent inferomarginal scales. In the specimen (R 27 mm) the proximal adambulacral plates are each armed with 5 or 4 flattened furrow spines, and the median 3 are larger than the rest. The pedicellaria composed of 5 or 6 spines is located in the abcentral surface of the plate, and 1 to 3 subequal spines placed along the outer and adcentral borders. In the middle portion of ray, the furrow spines are generally 3 in number, and 3 to 5 spines standing in the abcentral surface of the plate have a tendency of pedicellarian formation. The occurrence of the pedicellaria is a notable feature in the present species.

Mouth plates rather long and narrow, each with two ridges. The plate is armed with a large number of spines arranging in considerable regular rows. The main ridge adjacent to the median suture is occupied with 2 rows of the spines. The first (inner) row consists of 11 or 12 flattened robust spines. The innermost spine is very thick and longer than the others, then the spines decrease in size towards the abcentral end of the plate, where the spines become again large and thick, assuming a lanceolate form. The spines in the second (outer)

row are a little shorter and more slender than those of the first row, 10 to 12 in number. The 2 adcentral spines are usually short and slender, forming a pedicellaria together with the adcentral spines of the adjacent row on the secondary ridge of the plate. The oral pedicellaria is consisted of 4 to 6 small spines and placed at the outer side of the prominent innermost spine of the first row. The pedicellarian formation in mouth plate is not a remarkable feature in the present species, because the organ is wanting in small specimens. Just outer the second row of the spines is found the third row composed of 7 or 8 small spinelets in the abcentral half portion of the plate. Along the furrow margin of the secondary ridge are 5 flattened spines, and the inner 2 or 3 are smaller than the rest, forming an oral pedicellaria as stated above. Deep in the groove between the mouth plate and the first adambulacral plate, there is a short series of 4 to 6 much small spinelets.

Madreporite rather large, more or less exposed, situated a little nearer the superomarginal plates than the centre of disc. The madreporite itself bears low, small round tipped, minute tubercles on its ridges, but the tubercles are often wanting in specimens.

Localities. Stations 10, 47, 57 and 59 off Hayama, Sagami Bay; Station 62 off Enoshima, Sagami Bay, 50-60 m in depth; Station 64 off Hayama, Sagami Bay, 110 m in depth.

Remarks: The present sea-star is somewhat related to *Ctenopleura astropectinoides* Fisher in the Philippine Seas, which seems to be distinct from the present

Table 2

<i>C. ludwigi</i> (De Loriol)	<i>C. fisheri</i> n. sp.
Dorsal plates of elongated lozenge form touched with each other.	Dorsal plates spaced, not touched by the lobes.
Paxillar area of ray broad. Paxillae large, the large ones on disc with 10 to 13 central spinelets and 17 to 19 peripherals. Those in the middle of ray with 4 or 5 central spinelets and 12 or 13 peripherals.	Paxillar area of ray narrower. Paxillae smaller, the large ones on disc with 3 or 4 central spinelets and 10 to 12 peripherals. Those in the middle of ray with 2 or 3 central spinelets and 10 or 11 peripherals.
Superomarginal plates in interradial angle high, 8 mm in height, spineless. Superomarginal spines mostly in a continuous transverse row.	Superomarginal plates in interradial angle lower, 6 mm in height, spiniferous. Superomarginal spines more conspicuous, mostly in discontinuous or continuous rows.
Subambulacral pedicellariae usually absent. Furrow spines stout, the median 3 having an appearance of <i>Astropecten</i> -type.	Subambulacral pedicellariae usually present. The median 3 of furrow spines not forming <i>Astropecten</i> -type.

form judging from the original description.

Astropecten formosus Sladen is due to meagre knowledge, except the original description, though Döderlein ('17) proposed that *Astropecten ludwigi*¹⁾ De Loriol and *Ctenopleura ludwigi*²⁾ mentioned by Fisher ('13) are undoubtedly synonymous with the old Japanese *Astropecten*. It, however, seems to me that his opinion is very doubtful, for both the forms (R 100 mm) can be distinguishable from each other. Their characters are contrasted in the Table 2.

Judging from Döderlein's description, it may be scarcely possible to determine which of them belongs to *A. formosus*, and also whether the old *Astropecten* is really *Ctenopleura*. Especially such a determination may be quite difficult, when the specimens are junior. The type specimen of *A. formosus* measures only 14.5 mm in R and 5.2 mm in r. Thus I would not adopt here his opinion for *A. formosus*. It seems to me that *A. formosus* still remains in uncertain, though the original description is very excellent.

Ctenopleura ludwigi (De Loriol)

Astropecten ludwigi: De Loriol, 1899, p. 21, Taf. 2, fig. 4; Goto, 1914, p. 174, pl. 4, figs. 70-79.

Astropecten formosus (in part); Döderlein, 1917, p. 63, pl. 1, figs. 2-3, pl. 7, figs. 2-2b, 3, 3a.

Astropecten japonicus: Ives, 1891, p. 211.

Persephonaster setoensis: Hayashi, 1938, p. 273, pl. 1, figs. 1-4.

The present species was first mentioned by Ives ('91) from Japan under the name of *Astropecten japonicus* Müller et Troschel. According to De Loriol it is again mentioned by the same writer in the following year. Its first description as a distinct species is however due to De Loriol ('99). Fisher ('13) pointed out that the present species is a member of *Ctenopleura*, and in the next year Goto ('14) gave a full description of the species in his monograph under the name of *Astropecten ludwigi*. A little later Döderlein ('17) mentioned that the present species including Fisher's *ludwigi* is to be reduced to Sladen's species, *Astropecten formosus*. As I already stated, his opinion is however doubtful. Fisher's form, *Ctenopleura ludwigi*, is a distinct species, new to science, distinguishable from *A. ludwigi*. It seems to me that *A. formosus* is still an uncertain species in Japan. Moreover, it is to be noted here that all the specimens of *ludwigi*-form examined by me have anal pore and serial gonads parallel to marginal plates, not restricted in interradius and the furrow spines are not usually 3 as in *Astropecten*. There are no doubts the present form not belonging to *Astropecten* or *Persephonaster*, but *Ctenopleura*. The anus is so small that the presence of it perhaps might be overlooked by previous authors in the surface view.

On the other hand, if my opinion for *A. ludwigi* is valid, *Persephonaster setoensis* reported by me may be reduced to the present form. There are no remarkable differences between them, and I have ascertained the form having serial gonads.

The specimens examined by me are measured as shown in Table 3.

1) The form is *Ctenopleura ludwigi* in the present paper.

2) The form is *Ctenopleura fisheri* n. sp. in the present paper.

Table 3

Station Nos.	R	r	Superomarginal plates in number	Breadth in arm base	Breadth of ray at 10th superomarginal plate
29	110 mm	30 mm	37	34 mm	22 mm
34	100 mm	28 mm	38	29 mm	21 mm
47	52 mm	16 mm	27	17 mm	12 mm
16	27 mm	9 mm	24	10 mm	—

The description based upon the specimen (R 100 mm) is as follows :

Disc slightly larger than that of *C. fisheri*. Rays also a little broader.

Paxillae fairly large, except the centre of disc where those are very small and anal pore is found. Those in disc and midradial portion of ray are larger than in *fisheri*. The large paxillae on disc bear each 10 to 13 central spinelets surrounded by 17 to 19 peripheral ones, and the large paxillae in rays each with 2 to 5 central spinelets and 11 to 13 peripherals. The dorsal plates are more or less 4-lobed, touching with each other by the lobes and more or less crowded than in *fisheri*.

Superomarginal plates similar to those of *fisheri* in appearance. The exposed surface is round and convex. The plates in interbrachial angles are much high, measuring 8 mm in height and 9 mm in the specimen (R 110 mm), but those in *fisheri* are 6 mm high in the specimen (R 100 mm). The superomarginal spines are short, conical or slightly compressed and mostly arranged in a continuous series in each plate, increasing slightly in size outwards, 7 or 8 in number. Proximal 3 or 4 plates in interbrachial angle are generally free from the spines. The superomarginals are thickly covered with small spinelets. Those in the adcentral portion of the plate subdivided by the series of superomarginal spines are coarser than in the abcentral portion, and the spinelets adjacent to the series of the spines become scaliform, though decreasing in size towards the peripheral portion of the plate.

The inferomarginal plates are similar to those of *C. fisheri* and covered with round tipped scales arranged more or less in oblique transverse series. Those are very slightly coarser than in *C. fisheri*. At the rounded outer end of the plate is found an oblique vertical comb composed of 4 or 5 closely placed, long slender, sharp slightly flattened spines. The comb is similar to that of *Persephonaster*. Along the abcentral border of the plate, there is a series of short, flattened, well

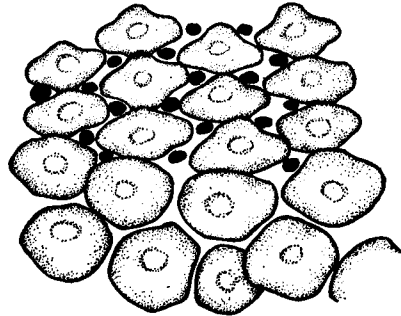


Fig. 3. *Ctenopleura ludwigi* (De Loriol) ; dorsal plates of ray, viewed from coelomic side. $\times 12$.

spaced spines. The spines are generally 4 in number in the middle portion of ray and have a tendency of becoming long towards the inner portion of the plate.

Ventrolateral plates arranged in a series, extending to the 4th inferomarginal plate, about 10 in number. These plates are each armed with 1 to 3 lanceolate central spines and 12 to 16 peripheral spines surrounding the former.

Adambulacral armature distinctly differs from that of *C. fisheri*. There are no subambulacral pedicellariae. The furrow series consists of 5 compressed stout truncated spines. The median 3 are longer and stouter than the other 2. Among them the median is the longest, with its flattened edge to the furrow, and the lateral spines have each a shallow groove at the outer side of the tip. Both the lateralmost spines of the series are occasionally much smaller than the median 3, about half as long as the latter, and located somewhat slightly behind the medians. In such a case, the furrow series has an appearance of *Astropecten*-type, though not so carinate as in *Astropecten*. The usual number of the furrow spines seems to be 5 in the present species. Following the lateralmost furrow spines are arranged rather spaced spines in a horse shoe-shape along the lateral and outer margins of the plate. These spines are similar to the former in size and form, gradually decreasing in size outerwards. In the central space stand 1 to 3 a little larger truncated spines.

Mouth plates bear each a large number of spines. The oral series on the accessory ridge of the plate is composed of 7 or 8 truncated spines, the large sometimes with a shallow groove in the outer side of the tip. The innermost spine is much long and broad, then gradually decreasing in size towards the abcentral portion of the plate. On the main ridge of the plate are found 2 series of conspicuous spines. Adjacent to the median suture and succeeding to the innermost spine of the oral series are situated 12 to 15 conspicuous robust spines in a series. They are much compressed, acornshape or truncated at the tip. Just outer the series are 12 or 13 compressed, truncated or round tipped spines, which are slightly smaller than those of the inner series. Between the series and the oral series is found another series of 8 to 13 small spines.

Madreporite tolerably large, naked, situated nearer the superomarginal plates than the centre of disc. Madreporite itself with many small bluntly pointed tubercles on the ridges.

Localities. Stations 16, 29 and 47 off Hayama, 6 to 20 fms: Station 34 off Nishiura, Sagami Bay.

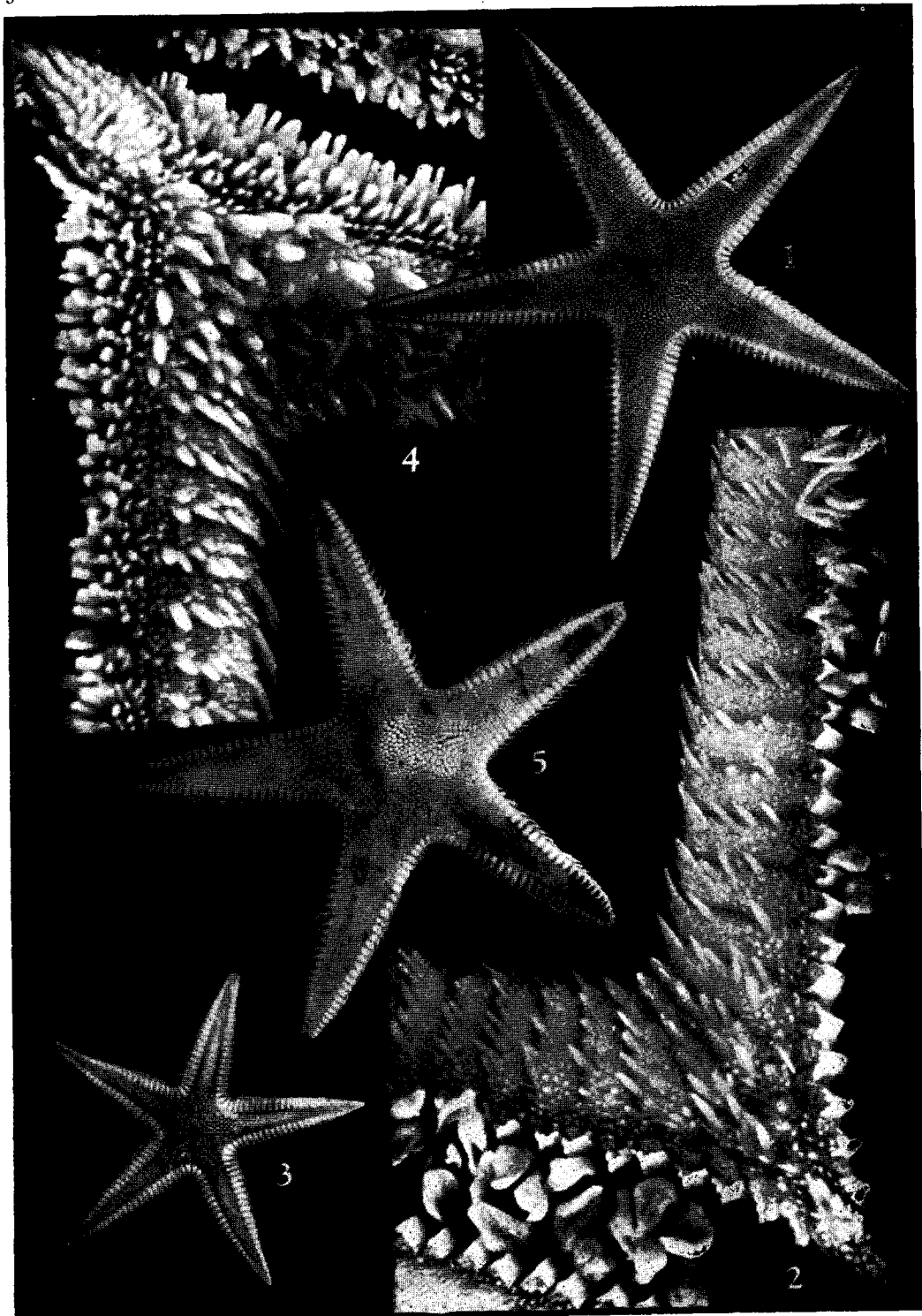
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Explanation of Plate I

- Fig. 1. Dorsal side of *Ctenopleura fisheri* n. sp. About 1/2×.
- Fig. 2. A portion of the ventral side of *Ctenopleura fisheri* n. sp. About 2.5×.
- Fig. 3. Dorsal side of *Ctenopleura fisheri* n. sp. About 1/2×.
- Fig. 4. A portion of the ventral side of *Ctenopleura ludwigi* (De Loriol). About 2.5×.
- Fig. 5. Dorsal side of *Ctenopleura ludwigi* (De Loriol). About 1/2×.



R. Hayashi: A Note of Astropecten ludwigi