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Solasterids in Japanese Waters¹⁾

By

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(With 2 Plates and 7 Textfigures)

From Japanese waters six species of *Solasters* have been previously reported by several authors; *S. paxillatus* Sladen, *S. borealis* (Linné), *S. dawsoni* Verrill, *S. diamesus* Djakonov, *Crossaster papposus* (Linné) and *Crossaster japonicus* (Fisher). While examining the material deposited in the late Prof. S. Goto's collection including Albatross' specimens in 1906 and partly on specimens collected by Prof. T. Uchida and Messrs. S. Sato, S. Koyama and S. Inuo, the present writer could examine nine species, two of which being new to science and three of them newly recorded in Japanese waters. In this report the writer has come to the conclusion that Fisher's *C. japonicus* is a forma of *papposus*, thus in Japanese waters the following ten species of Solasterids were found.

Solaster endeca (LINNÉ)

Solaster stimpsoni VERRILL

Solaster dawsoni VERRILL

Solaster dawsoni var. *intermedius*
n. var.

Solaster paxillatus SLADEN

Solaster diamesus DJAKONOV²⁾

Solaster borealis (LINNÉ)

Solaster Uchidai n. sp.

Crossaster papposus (LINNÉ)

Crossaster papposus forma *japonicus* (FISHER)

The writer must express, here, his cordial thanks to Prof. T. Uchida for his kind guidance and for placing his unpublished material and Goto's specimens at the writer's disposal.

Solaster endeca (LINNÉ)

(Pl. XXIII, figs. 5-7)

Solaster endeca; FISHER, 1911, p. 307, pl. 81, figs. 1, 2, 4; VERRILL, 1914, p. 244, pl. 9, figs. 2, 3, pl. 87, figs. 4-4b, pl. 89, fig. 1.

1) Contributions from the Akkeshi Marine Biological Station, No. 24.

2) The species could not be found in the collection.

The writer examined three specimens of *Solaster* which are referable to the present species. The measurements and localities are as follows:

Station	R	r	R:r	Rays in number	Locality	Depth	Nature of bottom	Collection
—	67mm	25 mm	2.7	8	Rakuma	—	—	S. Sato
5004	78mm	32 mm	2.4	8	Gulf of Tartary	38 fms	green mud	Albatross, 1906
5003	121mm	45 mm	2.7	8	Gulf of Tartary	35 fms	fine green sand, green mud	Albatross, 1906

Disc large, rays rather short, broad, eight in number. An example obtained from Rakuma, South Saghalien has rays of moderate length, not so broad as in Albatross specimens.

The description of the example (Station 5004) is as follows:

Aboral paxillae small and crowded, each with five to ten skin-covered spinelets. The paxillae on sides of ray are a little larger than those on disc and the midradial portion of ray, arranging in oblique transverse series. Aboral ossicles small, closely crowded and imbricated, leaving small papular areas each with one or two papulae.

The marginal plates seem to be relatively diverse in feature in individuals. The inferomarginals are distinctly larger than the others, low, transversely

elongated, nearly uniform in size, though those near the arm tip being small, numbering about 60 on the side of ray. These plates bear each about 19 to 24 small spinelets. The superomarginal paxillae are much smaller than the inferomarginals, mostly situated directly above and close to the latter. They are one-half to one-third the size of the inferomarginals, roundish or subquadrate in form. They are somewhat larger than the adjacent aborals, carrying about 13–15 spinelets. In an example (Station 5003) the superomarginals are opposite to the interspace between two inferomarginals and in size they are very small and hardly distinguishable

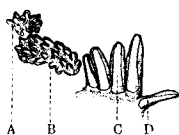


Fig. 1. *Solaster endeca*;

A, superomarginal paxilla,
B, inferomarginal paxilla,
C, subambulacral comb,
D, furrow spines. 8×.

from the adjacent aborals. In the Rakuma specimen the superomarginals alternate with the inferomarginals, and are a little larger than the neighbouring aborals.

Oral interradial area rather large. A series of paxillae extends to about the middle of the free part of ray. Interradial area crowded with paxillae bearing seven to ten spinelets.

In this Asiatic example (Station 5004) the adambulacral spines are fewer than those described by Verrill and Fisher for North Pacific and Atlantic specimens. Furrow spines conspicuously shorter than the subambulacral spines, two in the proximal portion of ray and only one in the distal portion. When there

are two spinelets, the adoral one is usually slenderer and shorter. The subambulacral comb is slightly curved, not straight, composed of four skin-covered spines gradually decreasing in length from the inner ones toward the outer ones. Mouth plate with five or six oral spines, of which the adoral two at the apex of plate are stoutest and longest, then decreasing in length distally. On the surface of the plate there are three to five suboral spines arranged in a series or somewhat irregularly, not in two rows as in the type specimen. The specimen (Station 5003) has one or two furrow spines, but the subambulacral comb is composed of more numerous spines than in the above stated specimen. In the middle portion of ray there are arranged five to seven subambulacral spines in a slightly curved series, but in the proximal portion of ray the spines increase in number, 12 to 25. The arrangement is variable; in two rows, occasionally in clusters or the inner ones in a row and the outer ones in two rows or clusters. The inner two spines are long and stout, but the rest are small, a little longer than or subequal to the adjacent oral lateral spinelets. In the Rakuma example there are one, two or three furrow spines, when two present the adoral one is smaller and when three present the middle is the longest. Subambulacral spines four to six in a curved series. Mouth plates with six orals and four suborals in a series.

Madreporite large with several paxillae on its surface, situated midway between the centre of disc and the margin.

Distribution. Widely distributed in North Pacific and Atlantic Oceans.

Solaster stimpsoni VERRILL

(Pl. XXIII, figs. 8, 9)

Solaster stimpsoni; FISHER, 1911, p. 311, pl. 82, fig. 3, pl. 83, figs. 1-5; VERRILL, 1914, p. 254, pl. 10, figs. 1, 2, pl. 11, figs. 1, 2, pl. 15, figs. 1, 2, pl. 46, figs. 1-1c, pl. 94, fig. 2, pl. 95.

A ten rayed specimen obtained by Prof. T. Uchida from the North Pacific coast of Honsyu. It measures 88 mm in R, 27 mm in r and R about 3.3 r. The specimen resembles the present species in general appearance, though the aboral paxillae are smaller and the suboral spines of mouth plate are more numerous than in the present species.

Disc of moderate width, rays tapering, long and slender. Aboral paxillae small, crowded, those on the disc being smaller and more crowded than on rays. The large paxillae have each about two to five central and nine to twelve marginal webbed spinelets. The paxillae are arranged in very oblique transverse rows at the sides of ray, but they show an appearance of longitudinal arrangement in the distal portion of ray. Aboral plates three- or four-lobed, imbricating each other. Papulae single, rarely double in an area.

Inferomarginal plates much compressed, rather prominent, each bearing a large number of spinelets mostly in two rows. The superomarginals close to

the inferomarginals are exceedingly smaller than the latter, very slightly larger than the adjacent aborals.

Oral interradiar areas rather large, paxillae each with two to eight spines. A series of the paxillae extends barely to the middle portion of ray.

Furrow spines slender and acute, webbed in the basal half portion, numbering two in the middle and distal portion of ray and three or four in the proximal portion. When four spines occur, the middle two are much longer than the lateral ones. Subambulacral comb composed of five or four spines in a slightly curved series. Mouth plate with ten oral spines, the adoral three being long and stout and the others on the side of the plate much smaller. Suboral spines not arranged in a single series, numbering ten to twelve, the adoral four or five arranged in a series and the aboral ones in two rows or irregularly set.

Madreporite rather small, situated about midway between the margin and the centre of disc.

Distribution. North Pacific regions and southern Bering Sea.

Solaster dawsoni VERRILL

(Pl. XXIV, figs. 7, 8)

Solaster dawsoni: FISHER, 1911, pl. 84, figs. 1, 2, pl. 86, figs. 1, 2, pl. 113, fig. 1; VERRILL, 1914, p. 249, pl. 46, figs. 5-5b, pl. 90, fig. 1, pl. 91, figs. 1, 2, pl. 92, fig. 1; UCHIDA, 1928, p. 796, pl. 32, fig. 1.

The present species was already reported by Fisher ('11) and Uchida ('28) from Simusiru, Mutsu Bay and Osyoro (Hokkaido). The writer examined eight specimens of the present species, the measurements and localities being as follows:

Station	R	r	R:r	Rays in number	Locality	Depth	Nature of bottom	Collection
4987	32 mm	11 mm	2.9	10	Kamoi-misaki	59 fms	rocky	Albatross, 1906
—	93 mm	27 mm	3.4	11	Yellow Sea	60-80m	—	S. Inuo
—	96 mm	30 mm	3.2	11	Yellow Sea	60-80m	—	S. Inuo
—	107 mm	39 mm	2.7	11	Yellow Sea	60-80m	—	S. Inuo
4807	115 mm	41 mm	2.8	11	Cape Tsiuka	44 fms	shells, coarse gravel	Albatross, 1906
4803	123 mm	37 mm	3.3	11	Cape Tsiuka	47 fms	sand, shells, coarse gravel	Albatross, 1906
—	124 mm	40 mm	3.1	11	Yoiti	—	—	Hayashi
—	174 mm	53 mm	3.3	11	Osyoro	—	—	Goto

Disc moderately large, rays ten or eleven in number. Aboral paxillae more distinctly spaced than in *endeca*. The paxillae are large, tabulate in form, roundish or elliptical in contour, those on the disc are arranged irregularly, decreasing in size toward the sides and end of ray, where they are comparatively small and arranged somewhat radially. The spinelets of paxillae are variable in number, depending on size; size, however, seems to vary in different localities. A specimen (Station 4808) has, on large paxillae of disc, 14-16 peripheral and 5-7 central short spinelets so immersed in membrane that only the tips protrude. The summit of the group is flat and the central spinelets are generally

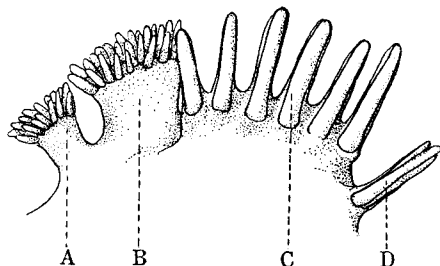


Fig. 2. *Solaster dawsoni*;

A, superomarginal plate, B, inferomarginal plate,
C, subambulacral comb, D, furrow spines. 7×.

shorter and smaller than the peripherals which are nearly equal in length. But in an example obtained from Yoiti, one of the central spinelets of the paxillae is the largest, protruding from the spinelets-group in the proximal portion of ray and disc. Aboral skeleton composed of irregular 3- or 4-lobed plates and the connecting ossicles. Papulae numerous in the meshes of the skeleton, five to ten or more in each papular area, gradually decreasing in number toward the distal and lateral portions of ray, but a large specimen (R 74 mm) has twenty or even more papulae for an area on the disc.

Marginal plates numerous, separated by their own length or less, larger than in *endeca*. The superomarginals are opposite to the inferomarginals and exceedingly smaller than the latter, occasionally alternate with each other in the distal portion of ray. In form they are similar to the adjacent aborals but in size larger than the latter, each with about 15-20 spinelets. The inferomarginals are transversely oblong and with 20-25 or even more subequal spinelets.

Oral interradial areas very small, each containing about 20 plates; each plate with 5-12 spinelets longer than those of aboral paxillae.

Adambulacral spines long and bristling. The furrows are long, tapering, skin-covered, united by a web, mostly three or four in number, proximally four or five, distally three or two. Subambulacral comb straight, composed of five to seven stout, bluntly pointed membrane-sheathed spines, and the outermost one is shorter and slenderer. Mouth plates broader than in *endeca*, oral spines

8-9 in number, the inner two being long and stout, then gradually decreasing in length toward the distal end. Suboral spines in a row, 3-4 in number, the inner one being longest.

Madreporite conspicuous, situated midway between the margin and the centre of disc, bearing several paxillae around the margin.

Young specimen. A specimen (R 32 mm) was examined. Aboral paxillae closely crowded, not so distinctly spaced as in large specimens, each bearing 12-16 spinelets. Marginal plates low, not so prominent as in adult specimens, but arranged in two series. Superomarginals opposite to the inferomarginals, about one-half the size of the latter, and larger than the adjacent aborals. The superomarginals with 8-10 spinelets and the inferomarginals with 12-16 spinelets. Oral interradiar areas very small, the paxillae with 5-6 spinelets. Subambulacral combs each composed of 4-5 spines in a straight series, and furrow spines 4 or 3 (distally 2) in number. Mouth plates, with 8 oral and 6 suboral spines in a series. Madreporite small, situated midway between the centre of disc and the margin.

Distribution. Monterey Bay, California to the Aleutian Islands, thence along the Asiatic coast to the Kurile Islands, Hokkaido, northern Honsyu and Yellow Sea; through Bering Strait to Point Franklin.

Solaster dawsoni var. *intermedius* n. var.

(Pl. XXIV, figs. 9, 10)

A dry specimen obtained by Mr. S. Koyama from off Miyako was examined. The specimen is closely related to *S. dawsoni* in the oral appearance and to *S. stimpsoni* in the aboral appearance. The specimen is very similar to *S. dawsoni arctica* Verrill, but differing in paxillae having fewer spinelets. The specimen resembles *S. diamesus* Djakonov, but differs in the structure of aboral skeleton. The specimen may be regarded as a new variety of *S. dawsoni*. It measures 83 mm in R, 29 mm in r, R about 2.9 r, rays ten in number.

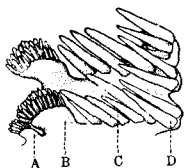


Fig. 3. *Solaster dawsoni* var. *intermedius* n. var. ;

A, superomarginal plate,
B, inferomarginal plate,
C, subambulacral comb,
D, furrow spines. 8×.

Aboral paxillae small, numerous, in the central area of disc they are slightly more widely spaced and a little larger than those in the periphery of disc and rays. Paxillae on the sides of ray smaller than those in the central portion, and are arranged in more or less in longiseries. Large paxillae with ten to fifteen small, subequal spinelets. Aboral plates small, crowded, irregular in form.

The inferomarginals are relatively large, prominent, strongly compressed, similar to those of *dawsoni*, but a little lower than the latter, each bearing

about 35–40 spinelets in mostly three transverse series. The supermarginals opposite to the inferomarginals are small, about as large as the adjacent aboral paxillae.

Oral interradial areas very small as in *dawsoni*, the paxillae with a little longer spinelets than the aborals, about 10 or more in number.

The armature of adambulacral plates is closely similar to that of *dawsoni*. Furrow spines relatively long, mostly two in number, when three present, the adoral one being smaller. Subambulacral comb straight, composed of five or six spines, occasionally four. Mouth plates each with seven or eight graded stout oral spines, suboral spines seven or eight in one or two series.

Madreporite small, surrounded by several paxillae, situated about midway between the centre and the margin of disc.

Solaster paxillatus SLADEN

(Pl. XXIV, figs. 5, 6)

Solaster paxillatus: SLADEN, 1889, p. 452, pl. 71, figs. 1–3, pl. 72, figs. 1, 2;

FISHER, 1911, p. 315, pl. 87, figs. 1, 2, pl. 88, figs. 1, 2, pl. 113, fig. 3.

The present species was first recorded by Sladen (1889) from south of Yeddo (Tokyo), 345 fathoms in depth. Six specimens of the present species were examined, measuring as follows:

Station	R	r	R:r	Rays in number	Locality	Depth	Nature of bottom	Collection
—	36 mm	12 mm	4	9	Ukijima	350 fms	—	Mituskuri, 1903
—	38 mm	14 mm	2.7	9	Numa	330 fms	—	Mituskuri, 1903
—	86 mm	23 mm	3.7	9	Misaki	—	—	Goto, 1911
5055	62 mm	21 mm	3	9	Omai Saki	124 fms	green mud, gray sand, broken shells, pebbles	Albatross, 1906
5055	73 mm	27 mm	2.7	9	Omai Saki	124 fms	„	Albatross, 1906
5055	76 mm	35 mm	2.2	9	Omai Saki	124 fms	„	Albatross, 1906

Disc not so elevated as in *S. Uchidai* n. sp., rays narrower and longer than those of the latter species, but in some specimens rays considerably broad at the base. Interradial streaks more or less free from paxillae as in *borealis* and *Uchidai*, but not usually. Aboral paxillae numerous, small, low, closely set, not so widely spaced as in *Uchidai*. The paxillae are immersed in membrane, subtabulate with a roundish crown of small slender spinelets, num-

bering 15-30. On the peripheral half of disc and rays the paxillae are arranged in very oblique transverse rows, but the longitudinal arrangement is not evident. Aboral plates along lateral sides of ray regularly four-lobed, imbricating each other. The meshes each contain mostly one or two papulae, not several as in *borealis*. No isolated ossicles in the mesh.

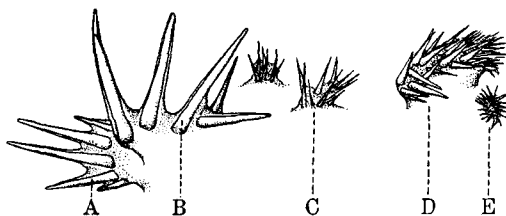


Fig. 4. *Solaster paxillatus*;

A, furrow spines, B, subambulacral comb,
C, oral lateral paxilla, D, inferomarginal plate,
E, superomarginal plate. 7×.

Marginal plates in two series and of very unequal, the superomarginals alternating with the inferomarginals. The superomarginals are considerably larger than the adjacent aboral paxillae. The inferomarginals are large, paxilliform, lower and more numerous than in *borealis*, bearing a large number of short skin-covered spinelets on a much compressed fan-shaped pedicel with a curved outer summit. The spinelets in the inner end are large and in two series, then rapidly decreasing in length toward the outer end, where they are in three or four series and the same size as the spinelets of superomarginal paxillae.

Oral interradial areas larger than in *borealis*, with spaced low paxillae bearing short slender spinelets numbering about four to ten or more. A series of small intermediate plates bearing one to several spinelets extends over half the length of ray.

Furrow spines short slender, webbed at the base, five or six in number near the mouth, then four along the greater part of ray, then reduced to three or two in the distal part. Subambulacral spines long and stout, webbed at the base, arranged in a transverse series curved aborad, six or five in number at the base of ray, then reducing in number toward the arm tip. These spines are slenderer than in *borealis*. Mouth plates slightly narrower than those of *borealis*, with nine to ten webbed oral spines, the innermost two or three being longer than the rest. Suboral spines membrane-sheathed, numbering ten or more, the adoral four or five in a lineal series being longer and stouter than the outers in two or three series.

Madreporite tolerably large, situated about midway between the margin and the centre of disc, surrounded by several paxillae.

Distribution. From the northern Pacific coast of Honsyu, Japan to Bering Sea, thence to the vicinity of Kadiak Islands, Alaska.

***Solaster borealis* (FISHER)**

(Pl. XXIV, figs. 1, 2)

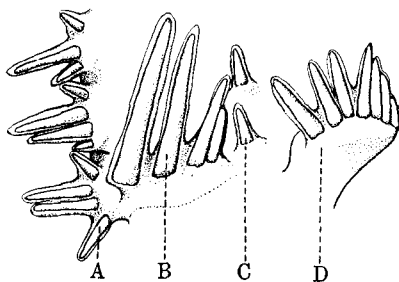
Crossaster borealis: FISHER, 1906, p. 134.*Solaster borealis*: FISHER, 1911, p. 320, pl. 91, figs. 1-3, pl. 92, figs. 1, 2, pl. 113, figs. 2, 2a.

The writer examined a dry specimen of the present species obtained by Mr. S. Koyama from off Miyako, the depth being uncertain. The specimen is in exceedingly unsatisfactory condition, but comparing with two typical specimens of *borealis* deposited in the late Prof. Goto's collection, the specimen is probably referable to the present species. The measurements are as follows:

Station	R	r	R:r	Rays in number	Locality	Depth	Nature of bottom	Collection
—	59 mm	20 mm	2.9	10	off Miyako	—	—	S. Koyama
5044	75 mm	27 mm	2.8	12	off Otiisi-Saki	309 fms	gray sand, coral sand	Albatross, 1906
5038	123 mm	39 mm	3.2	10	Urakawa	175 fms	fine black sand, brown mud, broken shells	Albatross, 1906

The description of one example (station 5044) is as follows:

Aboral integument covering skeleton and paxillae. Paxillae small, spaced, numerous, each with a low tabulum surmounted by one to six (mostly one to four) slender, tapering spinelets. Papulae prominent, numerous, one to seven (mostly three or four) in each area. The bare interrarial streaks are well marked. Aboral skeleton forming meshes composed of three or four-lobed plates and rod-like, connecting ossicles (not numerous). One or two isolated ossicles are existing mostly in the meshes of disc and arm base.

Fig. 5. *Solaster borealis*;

A, furrow spines, B, subambulacral comb,
C, oral lateral spine, D, inferomarginal plate. 7×.

Superomarginal plates indistinguishable from the adjacent aboral paxillae. Inferomarginal plates very prominent, well spaced, 20 to 23 on each side of ray, with fairly high pedicels each bearing a transverse series of seven to

ten stout tapering pointed skin-covered spines and occasionally one or two small spines stand adorally out of the series.

Oral interrarial area rather small. The plates are small, irregularly arranged in rows between the winkles, each bearing one or two small skin-covered spinelets. The plates adjoining adambulacral plates extend beyond three-fourths the length of ray.

Adambulacral plates each armed with a palmate furrow series of three or four (proximally five, distally two), slender, tapering skin-covered spines united together for about half their length by a web, the laterals being shorter. Subambulacral comb composed of three or four much longer, stouter skin-covered spines in a transverse series. Mouth plates each with a webbed series of ten or eleven oral spines and on the surface of the plate near the inner end there is a stout spine, sometimes adding one or two accessory spinelets, but suboral spines occasionally entirely absent.

Madreporite exposed, small, situated at the inner end of an interrarial streak.

Distribution. From off San Diego, California, to Bering Sea, thence to Hokkaido and northern Honsyu, Japan.

Solaster Uchidai n. sp.

(Pl. XXIV, figs. 3, 4)

Five specimens were examined. These specimens are not referable to any already known species. The present species is partly related to two *Solasters*, *borealis* and *paxillatus*, but the present species is easily distinguishable from *borealis* in the spinulation of aboral and oral paxillae; in having lower and more numerous inferomarginal paxillae in alternating with superomarginals and in furrow spinelets. From *paxillatus* differs the species in having broader rays and more widely spaced paxillae and in the spinulation of inferomarginal plates. These specimens seemingly form a new species of *Solaster*. The writer has the pleasure of naming this species in honour of Prof. Tohru Uchida. The measurements and localities are as follows:

Station	R	r	R:r	Rays in number	Locality	Depth	Nature of bottom	Collection
5047	56 mm	20 mm	2.8	10	off Kinkasan	107 fms	dark gray sand, broken shells, pebbles	Albatross, 1906
5047	78 mm	28 mm	2.8	10	"	"	"	"
5047	90 mm	34 mm	2.6	11	"	"	"	"
5091	61 mm	22 mm	2.8	11	off Jogasima	197 fms	green mud, coarse black sand, pebbles	"
—	84 mm	33 mm	2.5	11	north Pacific coast of Honsyu	—	—	Uchida

Disc large, swollen, elevated, rays swollen aborally, relatively short, gradually tapering, ten or eleven in number, R ranging from 2.5 to 2.8 r. Interradial streaks present, but not so well marked free from paxillae as in *borealis*. Aboral paxillae fairly large, widely spaced, with ten to twenty small, nearly equal short spinelets heavily invested with integument. They gradually decrease in size toward the arm tip. The paxillae on the disc are irregularly arranged, more widely spaced and larger than those on rays, where the paxillae

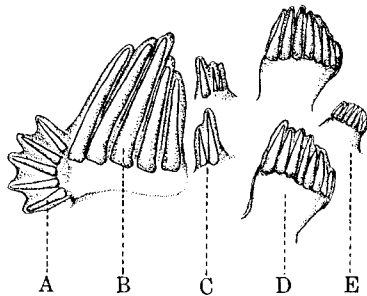


Fig. 6. *Solaster Uchidai* n. sp.;

- A, furrow spines, B, subambulacral comb,
C, oral lateral paxilla, D, inferomarginal plate,
E, superomarginal plate. 7×.

are arranged more or less in longiseries. Aboral plates with irregular 3, 4, or 5 lobes, each plate imbricating with each other by the length of a lobe, the regular meshes thus formed in the rays. Papulae mostly single, occasionally two and on the disc one to five pores occur in a papular area.

Marginal plates in two series, the superomarginals alternating with inferomarginals as in *paxillatus*. The superomarginals are much smaller than the inferomarginals and nearly equal to the adjacent aborals. The inferomarginals are prominent, resembling those of *borealis*, but more numerous and lower than the latter, numbering 22–25 along the side of a ray (R 56 mm). The pedicels are much compressed, each with 7–11 short, skin-covered spines arranged in a curved series.

Oral interradian areas smaller than in *paxillatus*, with spaced low paxillae thickly covered by integument, bearing several slender spinelets which decrease in number toward the arm tip. The plates arranged irregularly in rows, the innermost series extending beyond two-thirds the length of ray.

Adambulacral plates wider than long, separated by more than their own width. Furrow spines covered by skin short and slender, mostly five in number (proximally 6–7 and distally 3–4). Subambulacral comb slightly curved aborad, composed of stout, long membrane-sheathed spines, the outermost one being shortest, mostly five in number, three or four in the distal portion of ray. Mouth plate similar to those of *borealis*, with 10–11 oral spines, adoral three longer and stouter than the rest. Suboral spines situated near the end of plate,

one to five in number, arranged in a series, but rarely absent. The most adoral one is stout and long.

Madreporite small, situated about halfway between the margin of disc and the centre, surrounded and partly obscured by 5-6 large paxillae.

Crossaster papposus (LINNÉ)

(Pl. XXIII, figs. 1-4)

Crossaster papposus: VERRILL, 1914, p. 252, pl. 5, fig. 2, pl. 8, figs. 1, 2, pl. 9, fig. 4, pl. 49, fig. 4; UCHIDA, 1933, p. 551, 1 fig.

Solaster papposus: FISHER, 1911, p. 325, pl. 94, figs. 1-6.

The writer examined a large number of *Crossasters* deposited in the Onagawa and Goto's collections and several obtained from Toyama Bay and off Miyako. These specimens are grouped in two forms, *papposus* and *japonicus*, so there is no doubt that typical *papposus* occurs in Japanese waters.

The following list shows the measurements and localities of *papposus*-form.

Station	R	r	R:r	Rays in number	Marginal plates in number	Furrow spines in number	Locality	Depth	Nature of bottom	Collection
H.156	30 mm	15 mm	2	11	8-11	5	Takasiro Saki	—	—	Onagawa
4987	34 mm	17 mm	2	11	9-11	4-5	Kamoi Mizaki	59 fms	rocky	Albatross, 1906
—	35 mm	15 mm	2.3	9	12-14	4-5	off Miyako	—	—	—
4987	36 mm	16 mm	2.3	11	11-12	3-4	Kamoi Mizaki	59 fms	rocky	Albatross, 1906
4987	36 mm	18 mm	2	10	11-12	4	Kamoi Mizaki	59 fms	rocky	Albatross, 1906
4987	42 mm	19 mm	2.2	11	11-13	3-4	Kamoi Mizaki	59 fms	rocky	Albatross, 1906
—	42 mm	16 mm	2.6	11	12-14	5-6	Toyama Bay	—	—	—
4993	57 mm	25 mm	2.3	11	11-13	4-5	Bomasiri Shima	142 fms	green mud & gravel	Albatross, 1906

Disc large, a little swollen, oral side subflattened. Rays relatively short, gradually tapering, variable in number, commonly ten or eleven, rarely nine.

The description of one example (R 30 mm) is as follows:

Aboral skeleton forming a widely open reticular structure with pincillate paxillae widely spaced and intervening papulae numerous, one to ten or even more in an area, according to the size of papular areas. Paxillae each with a

short, stout pedicel and many slender spinelets increasing in length from the periphery of pedicel to the centre. The spinelets are longer than the pedicel. The spinulation of paxillae is considerably variable in examples. Carinal paxillae not distinctly prominent, but some of them being a little larger than the others.

Marginal paxillae prominent, usually well spaced by more than their own width, numbering eight to eleven on the side of a ray. In form the marginals resemble the aborals or transversely elongated, occasionally proximal two or three much compressed in fan-shape. The spinelets are long and slender, not decidedly shorter than the subambulacral spines in a comb. Oral interradial area small with one or two small paxillae.

Furrow spines composed of five slender webbed spinelets, the adoral one being smaller than the others. The transverse subambulacral comb consists of six to eight tapering stouter spines. The inner end of the comb curves aborad. Mouth plates with 11-12 oral spines, adoral five being longer and stouter than the others, and just behind the series are found five or six stouter suboral spines in a series.

Madreporite small, situated about midway between the centre and the margin of disc.

Distribution. Circumpolar: North Pacific and Atlantic Oceans; on Asiatic coasts to Okhotuk Sea, Japan Sea and North Pacific coast of Honsyu, Japan.

Note on *Crossaster japonicus*.¹⁾ According to Fisher's description, *japonicus* resembles in general appearance *papposus*, but differs in several important details. "*Solaster japonicus*, new species, differs from *Solaster papposus* in having more numerous and less prominent marginal plates, and seven to nine furrow spinelets (four in North Pacific *papposus*). Rays ten rarely nine". The furrow spinelets are joined by a web nearly to the tip, the edges of the web forming around the end of each spinelet a flattened pad or flap. This web is joined by the transverse web of the actinal comb, a peculiarity not observed in North Pacific *papposus*". The writer examined 24 specimens of *japonicus*-form which obtained from the same locality with *papposus*-form, but *japonicus*-form in the writer's hand are all from Japan Sea, not from the Pacific coast of Honsyu. So far as the limited number of specimens, *japonicus*-form occurs in deeper water than in *papposus*-form, but it is not constant, for Fisher recorded *japonicus* in depth from 60 to 245 fathoms. In *papposus* the rays are mostly eleven or ten, rarely nine, but in *japonicus* mostly ten, rarely nine. In *japonicus* the ratio of R:r is slightly larger than that in *papposus*. The measurements and localities of *japonicus* are given below.



Fig. 7. *Crossaster papposus*; adambulacral armature. 8×.

1) Fisher, W. K., 1911, p. 329, pl. 95, figs. 1, 2, pl. 113, fig. 4.

Station	R (mm)	r (mm)	R:r	Rays in number	Marginal plates in number	Furrow spines in number	Locality	Depth (fms)	Nature of bottom	Collection
4814	35	15	2.3	10	25	5-6	off Sado Is.	429	brown mud	Albatross, 1906
4819	43	16	2.6	10	25-27	5-6	Hime Saki	245	fine brown mud	Albatross, 1906
4981	52	19	2.7	9(?)	26-28	5-6	Benkei Misaki	406	green mud	Albatross, 1906
4981	63	25	2.6	10	27	5-7	Benkei Misaki	406	green mud	Albatross, 1906
4981	67	24	2.8	10	25-27	5	Benkei Misaki	406	green mud	Albatross, 1906
4820	74	30	2.5	10	26-28	5-6	Sawa Saki	536	green mud	Albatross, 1906
4991	75	30	2.5	10	25-26	4-7	Bomashiri Shima	325	green mud	Albatross, 1906
4992	94	38	2.5	10	34-36	5-7	Bomashiri Shima	325	green mud	Albatross, 1906

As is shown in the list, the furrow spines are fewer than in Fisher's description. The furrow spines are not remarkably different in number between two species, *papposus* and *japonicus*. In *japonicus* the adambulacral armature is covered with thicker integument than in *papposus*. The transverse web by which the furrow spines are joined to the subambulacral comb, is found, but the web is occasionally rudimentary. Marginal plates more numerous and less prominent than in *papposus*, but occasionally nearly same as large as in *papposus*. The inferomarginal plates are separated each other at a distance less than their own width and appear to have a tendency to be more widely spaced in the middle portion of ray than in the proximal and distal portions. In some specimens the marginal plates show the intermediate appearance between two species, *japonicus* and *papposus*. Such aberrant specimens are very difficult to determine. The writer doubts if *japonicus* is a distinct species and is of the opinion that *japonicus* is to be regarded as a forma of *papposus*.

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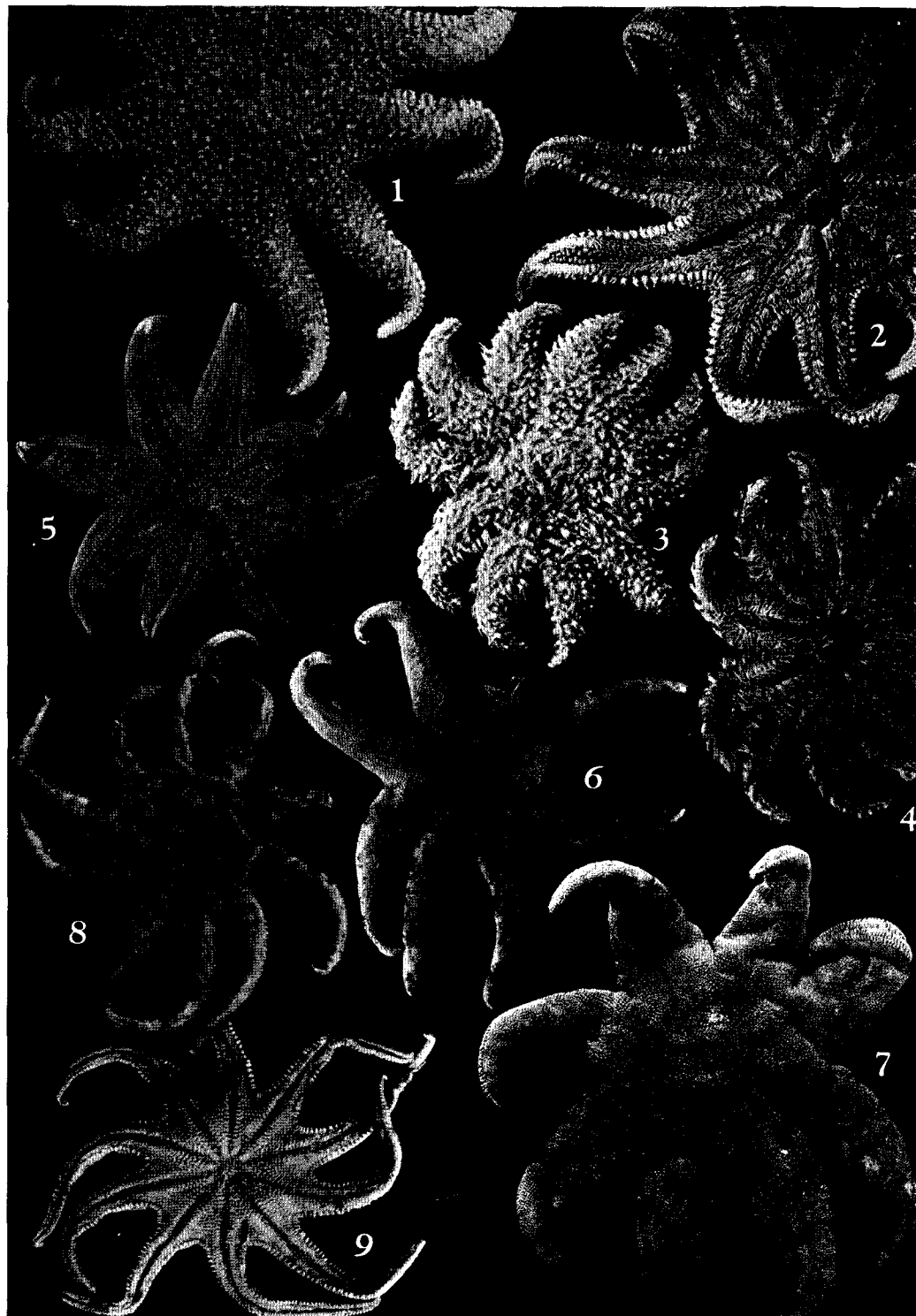
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Explanation of Plate XXIII

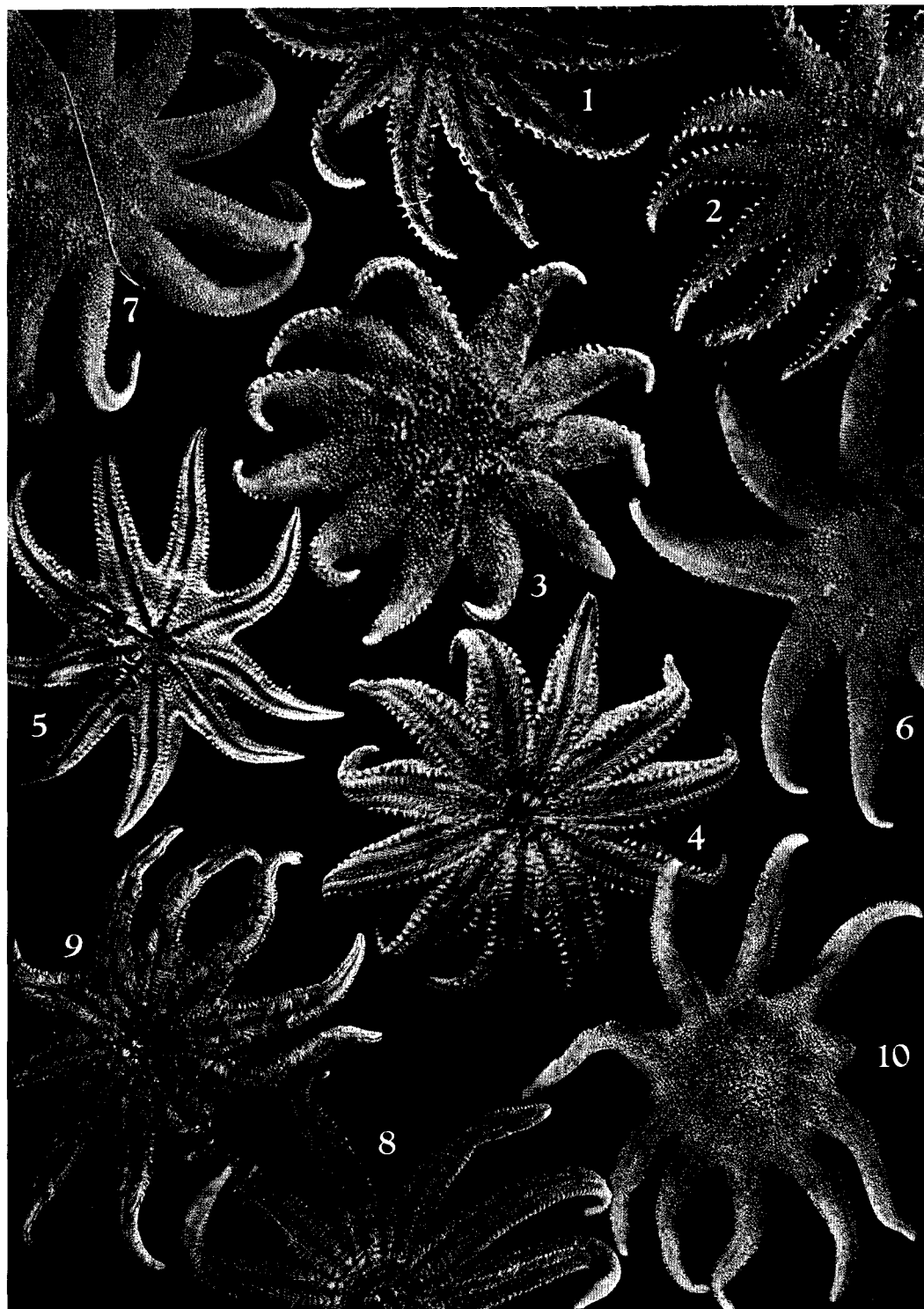
- Fig. 1. *Crossaster papposus* forma *japonicus*; aboral side. $1/2 \times$.
- Fig. 2. *Crossaster papposus* forma *japonicus*; oral side. $1/2 \times$.
- Fig. 3. *Crossaster papposus*; aboral side. $1/2 \times$.
- Fig. 4. *Crossaster papposus*; oral side. $1/2 \times$.
- Fig. 5. *Solaster endeca*; oral side. $2/5 \times$.
- Fig. 6. *Solaster endeca* obtained from Rakuma; aboral side. $2/5 \times$.
- Fig. 7. *Solaster endeca*; aboral side. $2/5 \times$.
- Fig. 8. *Solaster stimpsoni*; aboral surface. $2/5 \times$.
- Fig. 9. *Solaster stimpsoni*; oral side. $2/5 \times$.

Explanation of Plate XXIV

- Fig. 1. *Solaster borealis*; oral side. $1/2 \times$.
- Fig. 2. *Solaster borealis*; aboral side. $1/2 \times$.
- Fig. 3. *Solaster Uchidai* n. sp.; aboral side. $1/2 \times$.
- Fig. 4. *Solaster Uchidai* n. sp.; oral side. $1/2 \times$.
- Fig. 5. *Solaster paxillatus*; oral side. $1/2 \times$.
- Fig. 6. *Solaster paxillatus*; aboral side. $1/2 \times$.
- Fig. 7. *Solaster dawsoni*; aboral side. $2/5 \times$.
- Fig. 8. *Solaster dawsoni*; oral side. $2/5 \times$.
- Fig. 9. *Solaster dawsoni* var. *intermedius* n. var.; oral side. $2/5 \times$.
- Fig. 10. *Solaster dawsoni* var. *intermedius* n. var.; aboral side. $2/5 \times$.
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