



Three new sea stars (Asteroidea: Solasteridae & Pterasteridae) from the Aleutian Islands

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Abstract

Two new species of *Solaster*, and a new species of *Pteraster* are described from the nearshore waters of the Aleutian Islands and compared to congeners from the region. *Solaster hexactis* **sp. nov.**, *S. spectabilis* **sp. nov.**, and *Pteraster willsi* **sp. nov.**, are distinguished by the characteristics of the paxillar, marginal and adambulacral spines, and (in *Solaster*), the number of rays. The distributions of the new species and keys are provided.

Key words: *Solaster*, *Pteraster*, Biodiversity, New species, AKMAP, Alaska

Introduction

Since the monograph of W.K. Fisher (1911), little taxonomic research on sea stars in the Aleutian Islands has been published with the exception of A. H. Clark (1939), and the recent works by Clark and Jewett (2010; 2011). Fisher (1911) recognized seven species of *Solaster* Forbes, 1839, which had ranges that include the Aleutian Islands: *S. endeca* (Linnaeus, 1771); *S. stimpsoni* Verrill, 1880; *S. dawsoni* Verrill, 1880; *S. paxillatus* Sladen, 1889; *S. hypothyris* Fisher, 1910; *S. papposus* (Linnaeus, 1767); and *S. borealis* (Fisher, 1906). Similarly, D'yakonov (1950) included four species of *Solaster* with distributions that presumably include the Aleutians: *S. endeca*, *S. stimpsoni*, *S. dawsoni*, and *S. paxillatus*. Recent work on the molecular phylogeny of the Valvatacea by Mah and Foltz (2011) removes the family Solasteridae from the order Velatida, and places it in the order Valvatida.

Fisher (1911) and D'yakonov (1950) both listed six species of the genus *Pteraster* Müller and Troschel, 1842, with ranges that include the Aleutians: *P. militaris* (O. Müller, 1776); *P. marsippus* Fisher, 1910; *P. temnochiton* Fisher, 1910; *P. tessellatus* Ives, 1888; *P. pulvillus* Sars, 1861; and *P. obscurus* (Perrier, 1891) (with *P. octaster* Verrill, 1909 as synonym).

The present report describes three new sea stars from the Aleutian Islands, two in the genus *Solaster*, *S. hexactis*, **sp. nov.** and *S. spectabilis* **sp. nov.** and one in the genus *Pteraster*, *Pteraster willsi* **sp. nov.**

In 2006–2007 the Alaska Department of Environmental Conservation (ADEC) and the University of Alaska, Fairbanks conducted the Alaska Monitoring and Assessment Program (AKMAP), sampling the nearshore (< 20 m) waters of the Aleutian Islands, mainly by scuba divers. In the course of this survey numerous new species of marine organisms were discovered (Kawai *et al.* 2008; Clark & Jewett 2010; Eash-Loucks *et al.* 2010; Clark & Jewett 2011), including the three new species described here.

Methods

Specimens of sea stars were collected during AKMAP in 2006–2007, and subsequent scuba dives in the region by R.N. Clark in June of 2008. Sea stars were photographed and gathered *in situ* using a variety of digital cameras with underwater housings. Specimens were fixed in 10 % buffered formalin for 24–48 hours, and air dried.

More than 300 lots of additional material taken in trawl samples during NOAA/NMFS Aleutian Islands trawl surveys by R.N. Clark (1994–2004), and by NOAA and University of Washington personnel (2006–2010) were also examined.

AKMAP stations are expressed as AKALE06-0010 (example), where AKALE stands for Alaska Aleutians, 06 is the year 2006, and 0010 is the random-selected specific station number. NOAA/NMFS trawl survey data are also expressed as a series of numbers (*i.e.* 147-200401-194) where 147 refers to the chartered fishing vessel M/V (R/V) *Gladiator*, 200401 indicated the year and survey number (some vessels perform multiple surveys in a single year), and 194 refers to the specific trawl number. Additional Survey data are available upon request from Mr. Russell Nelson, NOAA/NMFS, Alaska Fisheries Science Center, RACE Division - F / AKC1, 7600 Sand Point Way NE, Bldg. 4, Bin C15700, Seattle, Washington 98115-0070.

The characters most heavily relied upon for differentiations of species were the spination of the abactinal (primarily on the disc and upper, proximal portions of the rays), adambulacral and oral plates. Once the particular numbers, morphologies and range of variation of these spines (or spinelets) were determined, they were found to be very consistent and reliable in determining species. The spine counts on the adambulacrals are from the central 2/3 of the ray; very proximal plates often have more spines, while distal plates usually have a slightly reduced number. The number of rays in *Solaster* spp. was found to be very consistent and useful for diagnosis as well.

Abbreviations used in the text: USNM (National Museum, Smithsonian Institution); LACM (Natural History Museum of Los Angeles County); CASIZ (California Academy of Sciences, Invertebrate Zoology); UAF (University of Alaska Fairbanks, Aquatic Museum); NOAA, National Oceanic and Atmospheric Administration; AB (Auke Bay Marine Laboratories; NOAA); and NMFS (National Marine Fisheries Service).

Taxonomic account: after Lambert (2000) and Mah & Foltz (2011)

Asteroidea de Blainville, 1830

Valvatida Perrier, 1884

Solasteridae Viguiet, 1878

Solaster Forbes, 1839

Solasteridae with one series of well developed marginal paxillae, the superomarginals always markedly smaller than inferomarginals; abactinal skeleton of cruciform or stellate plate, either closely placed or forming by means of slender intermediate ossicles, an open meshwork. Abactinal pseudopaxillae spaced or crowded, small to large, fascicular, tabulate, or penicillate. Actinal intermediate plates extending more or less along the ray. Rays more than five. (modified from Fisher, 1911).

Type: *Asterias endeca* Linnaeus, 1771 (by original designation).

Solaster hexactis sp. nov.

Figures 1–7

Type locality: Alaska, Aleutian Islands, W of Buldir Island (52°18.50 N, 175°49.00 E), 325 m.

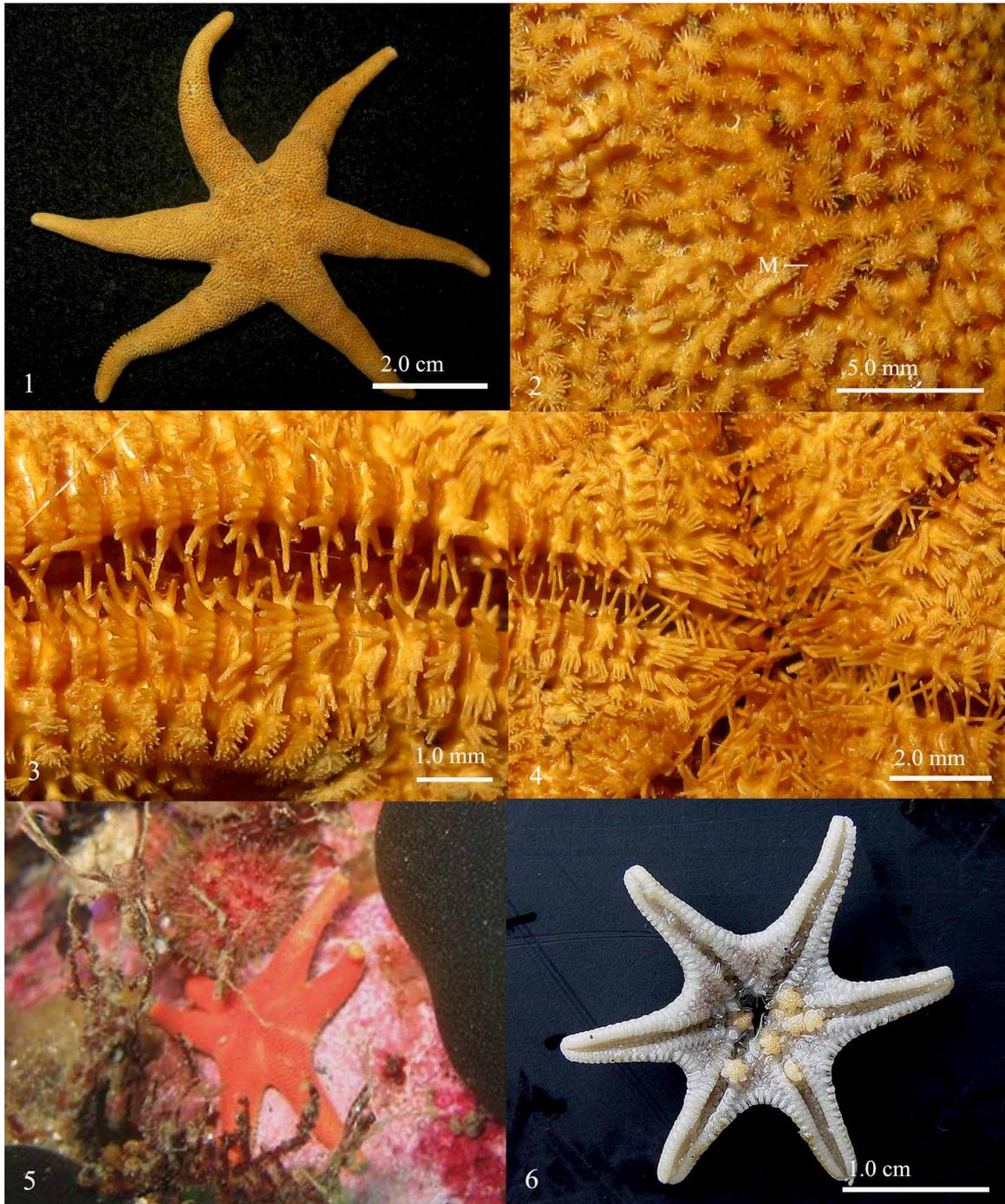
Type material. Table 1.

Description. Small six-rayed form, Holotype, R = 41 mm, r = 15 mm. R: r = 1:2.7 (range 1:1.7 to 1:2.7); disc relatively small, rays moderately long, tapering to rather blunt tips. Dorsal side (Fig. 1) moderately inflated. Papular pores numerous, small, occurring singularly or in pairs; papulae rather small. Abactinal plates cruciform, imbric-

cating; Pseudopaxillae relatively large, bearing 20–40 spinelets with thorny tips; Madreporite very small, only about twice as large as pseudopaxillae, radially grooved, surrounded and obscured by six pseudopaxillae (Fig. 2). Superomarginals only slightly larger than aboral pseudopaxillae. Inferomarginal plates about three to four times as wide as long, spaced about one half length apart, and usually slightly off set from the adjacent supramarginal; fan shaped, bearing about 50+ spinelets. Ventral side flattened; Oral interradial areas relatively wide, and bearing 40–65 overlapping oblong plates with short pseudopaxillae bearing five to eight spinelets; synactinal series extending about one fifth of ray length. Adambulacral plates (Fig. 3) about four times as wide as long, slightly curved, and slightly tapering distally, spaced a little more than one length apart; bearing a bristling curved actinal series of six to eight (five in very small, < R 10 mm specimens) moderately long, stout, tapering, membrane covered spines of about equal length, the tips of which are thorny, and a furrow series of two (one in very small, < R 10 mm specimens) long, slender, tapering, membrane covered spines, webbed at the base; base of spines rather bulbous. Paired oral plates (Fig. 4) shovel-shaped, each bearing five to seven long, slender, membrane covered marginal spines, webbed at the base, with thorny tips, and four to eight (normally seven) short, slender, un-webbed sub oral spines. Living color of shallow-water specimens dull red (Fig. 5), deep-water specimens are uniformly white or pale tan, oral side cream.

TABLE 1. Type material: *Solaster hexactis* sp. nov.

Type	Deposition & No. of Specimens	Collection Site	Collection Depth, m	Collection Date	Collector & Method
Holotype	LACM 1997-168.008, dry	W of Buldir Island 52°18.50 N, 175°49.00 E; NMFS 23-199701-243	325 m	9 August, 1997	R. N. Clark, trawled, R/V <i>Dominator</i>
Paratype	USNM 1153699 1 specimen, dry	Petrel Bank 52°30.29 N, 179°58.62 E; NMFS 23-199401-145	284-289 m	9 July, 1994	R. N. Clark, trawled, R/V <i>Vesteraalen</i>
Paratype	USNM 1153700 1 specimen, dry	W of Tanaga Island 51°38.20 N, 178°15.59 W; NMFS 23-199701-139	179 m	15 July, 1997	R. N. Clark, trawled, R/V <i>Dominator</i>
Paratype	CASIZ 184725 1 specimen, dry	W of Kiska Island 51°54.31 N, 176°35.89 E; NMFS 23-199701-202	272 m	1 August, 1997	R. N. Clark, trawled, R/V <i>Dominator</i>
Paratype	LACM 1997-223.001 1 specimen, dry	W of Buldir Island 52°18.47 N, 175°48.16 E; NMFS 23-199701-242	255 m	9 August, 1997	R. N. Clark, trawled, R/V <i>Dominator</i>
Paratypes	LACM 1997-156.005 4 specimen, dry	S Kiska Island 51°27.70 N, 178°35.00 E; NMFS 23-199701-181	384 m	27 July, 1997	R. N. Clark, trawled, R/V <i>Dominator</i>
Paratype	UAF 8138 1 specimen, dry	E of Buldir Island 52°20.09 N, 176°21.92 E; NMFS 23-1997-246	232 m	10 August, 1997	R. N. Clark, trawled, R/V <i>Dominator</i>
Paratype	LACM 2000-211.001 1 specimen, dry	S of Herbert Island 52°32.36 N, 170°04.46 W; NMFS 200001-41	233 m	27 May, 2000	K. P. Maslenikov trawled, R/V <i>Dominator</i>
Paratypes	LACM 2007-122.001 2 specimens, Eth.	Adak Island 51°45.35 N, 176°25.43 W; AKALE07-A0021	11 m	10 July, 2007	R. N. Clark, scuba
Paratype	LACM 2007-123.001 1 specimen, Eth.	Umak Island 51°53.42 N, 175°58.28 W; AKALE07-0013	8 m	14 July, 2007	H. Chenelot, scuba
Paratypes	LACM 2002-080.002 2 specimens, Eth.	SSE of Seguam Island 52°02.5 N, 172°15.08 W; NMFS 94-200201-194	169 m	18 July, 2002	R. N. Clark, trawled, R/V <i>Vesteraalen</i>
Paratype	LACM 2010-037.001 1 specimen	S of Ulak Island 51°21.19 N, 178°55.78 W; NMFS 143-201001-172	173 m	27 July, 2010	K. P. Maslenikov trawled, R/V <i>Sea Storm</i>



FIGURES 1–4. *Solaster hexactis* sp. nov. Holotype (LACM 1997-168.008). Fig. 1, Whole animal, aboral view; bar = 2.0 cm. Fig. 2, Close-up, aboral surface (M = Madreporite); bar = 5.0 mm. Fig. 3, Adambulacral area; bar = 1.0 mm. Fig. 4, Close-up, oral region; 2.0 mm.

FIGURE 5. *Solaster hexactis* sp. nov. Paratype (LACM 2007-123.001). Live, *in situ.*, Umak Island, 8 m; image: Héloïse Chenelot, 14 July, 2007. R = approximately 2.5 cm.

FIGURE 6. *Solaster hexactis* sp. nov. Paratype (LACM 2002-080.001). Live animal, with brood; Bar = 1.0 cm.

Distribution. Aleutian Islands (Fig. 7), from West of Buldir Island, (175°49 E) to Seguam Pass (172°40 W).

Habitat. Occurs at depths of 8–384 m, on black sand, gravel, cobble and pebbly bottoms. In shallow water, it may be found on the undersides of loosely piled cobbles or on the coralline algae (*Clathromorphum nereostratum* & *Lithothamnion* spp.) covered bedrock, with bottom temperatures of 4.2–6.0°C.

Etymology. From the Greek *hex* meaning six, in reference to the number of rays.

Remarks. With its six rays, *Solaster hexactis* sp. nov. probably would not be confused with any of its conge-

ners. All other known members of *Solaster* have seven (normally eight) to 15 rays. It could possibly be mistaken for a member of the Echinasteridae genus *Henricia*. However, it is easily distinguished by the armature of the adambulacral plates, which are obviously solasterid in form, with a single transverse row of actinal spines, and a single, horizontal row of two or more furrow spines. Very young specimens (< R 8 mm) of *S. hexactis* **sp. nov.** might be confused with another six-rayed solasterid (Gale *et al.* 2008), the tiny and rather similar appearing, *Aleutiaster schefferi* A. H. Clark, 1939, but may be separated by the spination of the abactinal, oral, marginal and adambulacral plates.

Reproduction. On 18 July, 2004, a single brooding specimen (Fig. 6) (LACM 2002-080.001) was trawled SSE of Seguam Island, at 169 m on a black sand substrate (*leg.* R. N. Clark, R/V *Vesteraalen*, 18 July, 2002). The specimen with an R of 1.4 cm contained eight tiny six-rayed juveniles (R = 1.0 mm) attached to the oral and proximal adambulacral region.

Solaster hexactis **n. sp.** is the first member of this genus found to brood its young under the disc, a behavior shared by several members of the echinasteriid genus *Henricia*, and the asteriid genus *Leptasterias*, but to our knowledge unknown amongst the Solasteridae.

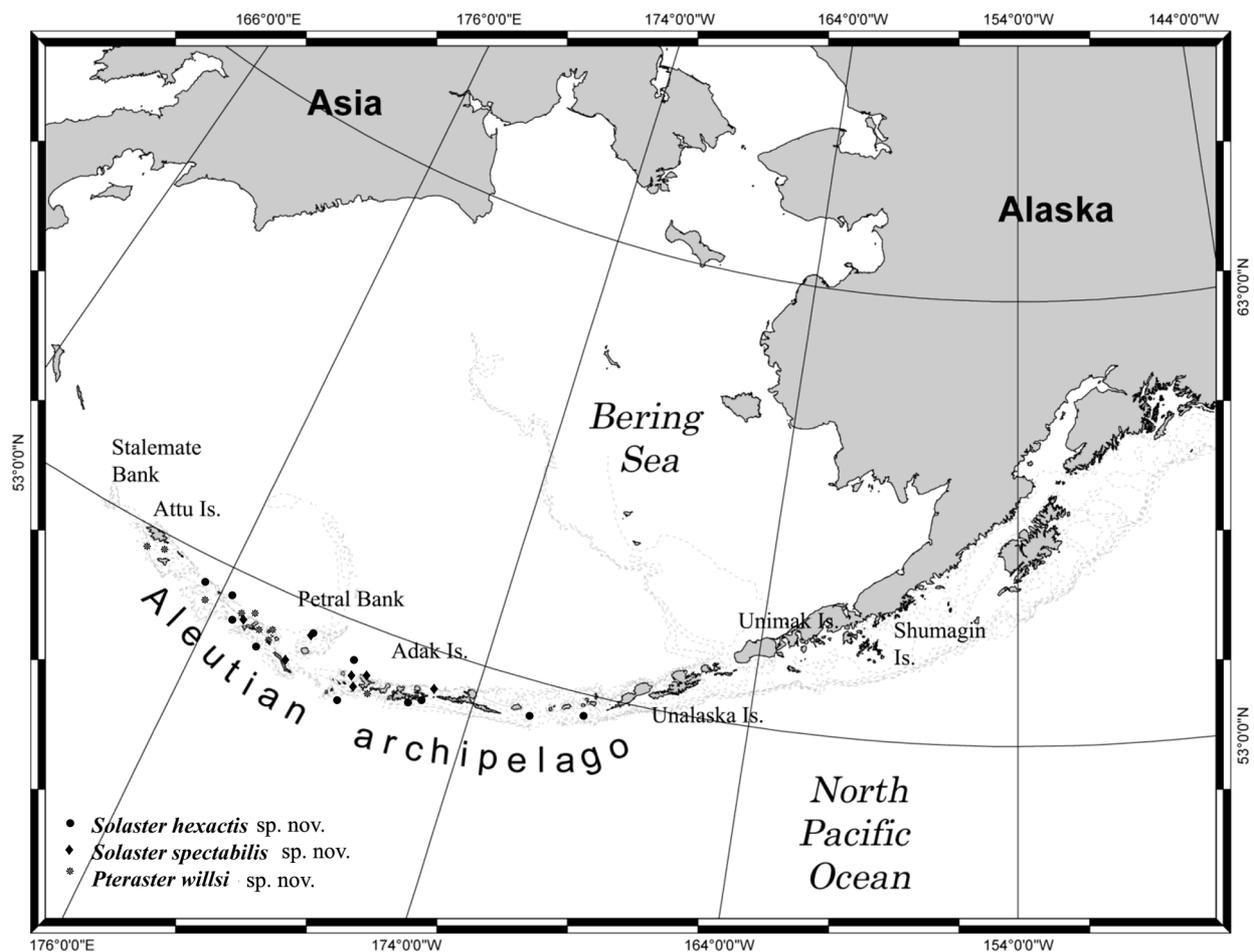


FIGURE 7. Distribution map for *Solaster hexactis* **sp. nov.** (●); *Solaster spectabilis* **sp. nov.** (◆); *Pteraster willsi* **sp. nov.** (*).

***Solaster spectabilis* sp. nov.**

Figures 7–12

Solaster dawsoni non Verrill, Fisher, 1911: 313 (*pars*); D'yakonov, 1950: 59 (*pars*); Kessler, 1985: 197 (*pars*).

Type locality. Alaska, Aleutian Islands, SW of Tanaga Island (51°44.50 N, 178°07.68 W), 95 meters.

Type material. Table 2.

TABLE 2. Type material: *Solaster spectabilis* sp. nov.

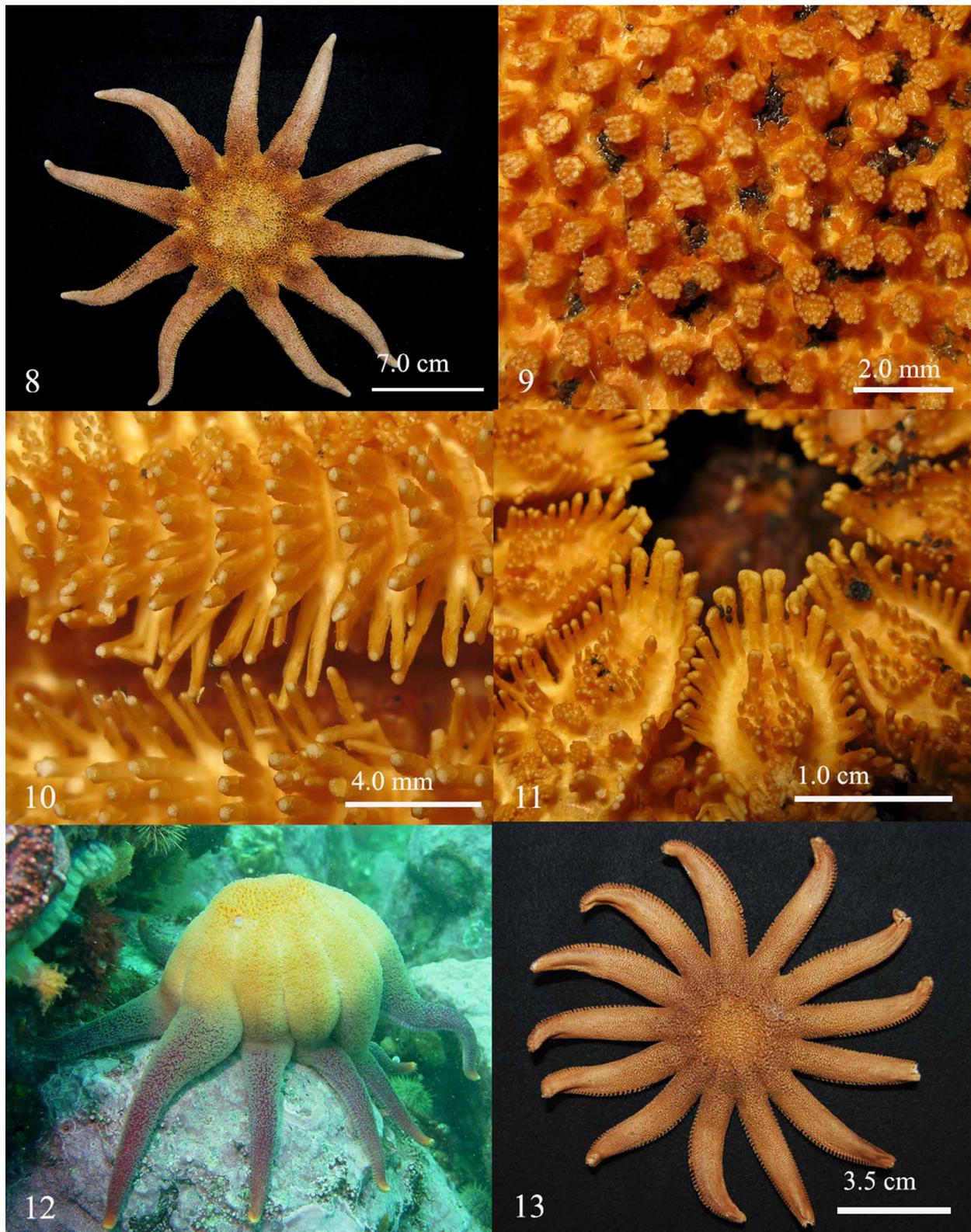
Type	Deposition & No. of Specimens	Collection Site	Collection Depth, m	Collection Date	Collector & Method
Holotype	LACM 1997-154.014, dry	SW of Tanaga Island 51°44.50 N, 178°07.68 W; NMFS 23-199701-137	95 m	15 July, 1997	R. N. Clark, trawled, R/V <i>Dominator</i>
Paratype	USNM 1153698 1 specimen, dry	W of Tanaga Island 51°46.69 N, 178°10.66 W; NMFS 23-199701-140	103 m	17 July, 1997	R. N. Clark, trawled, R/V <i>Dominator</i>
Paratype	LACM 1997-220.001 1 specimen, dry	W of Tanaga Island 51°46.69 N, 178°10.66 W; NMFS 23-199701-140	103 m	17 July, 1997	R. N. Clark, trawled, R/V <i>Dominator</i>
Paratype	CASIZ 184724 1 specimen	W of Kiska Island 52°05.6 N, 177°42.6 E; NMFS 23-199701-197	130 m	31 July, 1997	R. N. Clark, trawled, R/V <i>Dominator</i>
Paratype	LACM 1997-217.002 1 specimen, dry	W of Tanaga Island 51°46.55 N, 178°10.81 W; NMFS 23-199701-133	108 m	14 July, 1997	R. N. Clark, trawled, R/V <i>Dominator</i>
Paratype	LACM 1994-173.001 1 specimen, dry	N of Atka Island 52°08.55 N, 175°16.99 W; NMFS 94-1994-156	212 m	12 July, 1994	R. N. Clark, trawled, R/V <i>Vesteraalen</i>
Paratype	UAF 8137 1 specimen, dry	Kirilof Bay, Amchitka Is 51°25.85 N, 179°13.40 E; AKALE07-0016	7 m	2 July, 2007	R. Brewer, scuba
Paratype	LACM 2007-119.001 1 specimen, dry	N. side of Tanaga Island 51°50.69 N, 177°51.21 W; AKALE07-0050	13 m	6 July, 2007	R. Brewer, scuba
Paratypes	LACM 2010-038.001 2 specimens, Eth.	Petrel Bank 52°13.09 N, 179°58.12 E; NMFS 143-201001-146	93 m	19 July, 2010	N. Roberson, trawled, R/V <i>Sea Storm</i>

Description. Large ten-rayed form (rarely 11), Holotype, R = 135 mm, r = 43 mm; R:r = 3.1. Disc broad, rays relatively long, tapering to slender tips. Dorsal side (Fig. 8) moderately inflated, rather thin. Papular pores numerous, in groups of two or three; papulae relatively large. Abactinal plates small, Y or cruciform, closely imbricating. Pseudopaxillae (Fig. 9) small, spaced and bearing 12–25 short spinelets. Madreporite relatively large, with irregular convolutions, surrounded by ten pseudopaxillae (some of which are with in the madreporite itself).

Superomarginals about twice as large as pseudopaxillae and bearing 30–45 spinelets. Inferomarginals fan-like, about four times as large as superomarginals, and located directly adjacent to them; about four times as wide as long, with 65–80 membrane-sheathed spinelets, grading distally. Oral interradial areas small, with about 50–55 oral intermediate plates; synactinal series extending just past interradial angle. Adambulacral plates (Fig. 10) with bristling straight actinal series of six to eight moderately long, rather stout, blunt (sometimes spatulate), membrane-sheathed spines (distal one usually much smaller than the others), the proximal one of which is displaced distally, to between the distal and central furrow spines; furrow series of three long, stout, blunt spines webbed about half way; adoral spine often shorter than the other two. Paired oral plates (Fig. 11) with 11–12 thick, blunt, often flattened, membrane-sheathed marginal spines, webbed half way or more, the first three much longer than the others; 12–17 suboral spines, in two rows or a group.

Living color variable, the “typical” color phase has a yellow or orange disc and purple rays (Fig. 12). Other specimens may be solid orange, white or purple, others are cream or tan with pink stripe on the lower half of the rays or purple with red stripes radiating from the center of the disc to the tips of the rays.

Distribution & habitat. *Solaster spectabilis* sp. nov. appears to be restricted to the central Aleutian Islands (Fig. 7), from Chuginadak Island (169°30'W) to near Kiska Island (176°E), from 7–212 m on boulder, cobble sand, gravel and shell hash bottoms.



FIGURES 8–11. *Solaster spectabilis* **sp. nov.** Holotype (LACM 1997-154.014). Fig. 8, Whole animal, aboral view; bar = 7.0 cm. Fig. 9, Close-up, aboral surface; bar = 2.0 mm. Fig. 10, Adambulacral area; bar = 4.0 mm. Fig. 11, Close-up, oral region; bar = 1.0 cm.

FIGURE 12. *Solaster spectabilis* **sp. nov.** live, *in situ*. Kuluk Bay, Adak Island, 12 m. image: R. N. Clark, 22 June, 2007; R = approximately 15.0 cm.

FIGURE 13. *Solaster dawsoni* Verrill, 1880 (R. N. Clark collection); (*leg.* R. N. Clark, 8 May, 1999; Captains Bay, Unalaska Island, scuba, 13 m.

Etymology. The name *spectabilis* is Latin and means notable or showy, in regards to the many spectacular color morphs.

Remarks. *Solaster spectabilis* **sp. nov.** appears to be one of the Aleutian forms regarded by Fisher (1911:15) as *Solaster dawsoni* (Fig. 13). The two species are superficially similar, but *S. spectabilis* **sp. nov.** differs in 1) having ten, rarely 11 rays, compared to 12–14 in *S. dawsoni*; 2) in *S. spectabilis* **sp. nov.** aboral pseudopaxillae bear 12–18 marginal and 3–9 central spinelets, often bunched together, in *S. dawsoni*, they bear 10–26 marginal and 0–3 spaced central spinelets; 3) actinal series of adambulacrals of *S. spectabilis* **sp. nov.** has six to eight spines, as opposed to three to five in *S. dawsoni*; and 4) coloration, *S. spectabilis* **sp. nov.** has a number of spectacular color morphs, whereas *S. dawsoni* occurs in only very basic, nearly uniform tones. The number of rays in *Solaster spectabilis* **sp. nov.** is remarkably consistent, of nearly fifty specimens observed (many observed in the field and released) all had ten rays except for two (LACM 1997-220.001 & CASIZ 184724) which have eleven. Data for *Solaster dawsoni* derived from Aleutian Islands specimens in the R. N. Clark collection, and from Lambert, 2000.

In addition to morphological differences, the geographic ranges also differ. *Solaster dawsoni* is found from California, north and west to the east side Samalga Pass (NW end of Umnak Island) (Clark & Jewett, 2010). *Solaster spectabilis* **sp. nov.** is found from east side of Samalga Pass (the Islands of Four Mountains) west to near Kiska Island.

The diet of these two species differs also, *S. dawsoni* is well known as a sea star predator, feeding on a number of species, including other *Solaster* spp., the massive *Pycnopodia helianthoides* (Brandt, 1835), and even members of its own species (Lambert 2000). In contrast, *S. spectabilis* **sp. nov.** appears to feed predominantly on sea urchins (*Strongylocentrotus* spp.). Five specimens were observed feeding on urchins when collected (including a Paratype, USNM 1153698). One specimen was feeding on a small *Pteraster* **sp. nov.** (R.N. Clark, unpub.).

Solaster spectabilis **sp. nov.** also superficially resembles *Solaster arctica* Verrill, 1914, but may be easily distinguished by 1) spinelets of aboral pseudopaxillae longer, 0.8–1.0 mm and bearing 5–10 short, stout apical thorns, to 0.1 mm in length in *S. spectabilis* **sp. nov.**, the pseudopaxillar spinelets of *S. arctica* are 0.5–0.6 mm in length, and bear 5–8 slender spicules to 0.2 mm in length; 2) more numerous spines in actinal series of adambulacrals, 7–8 compared to 5–6 in *S. arctica*; 3) the furrow series of spines in *S. spectabilis* **sp. nov.** has 3 spines, two of sub-equal length and a third, shorter spine, 1/2 to 3/4 as long as the other two, the furrow series of *S. arctica* has two more or less equal length spines, and rarely a third, much shorter spinelet (1/2 or less the length of the others).

Discussion. *Solaster arctica* Verrill, 1914 (Type USNM 7624) was described as a subspecies of *Solaster dawsoni* Verrill. Fisher (1930) appeared to agree with Verrill, but suggested that it was probably an Arctic race of the latter. This assessment was followed by Mah (2010) as *Solaster dawsoni arctica* Verrill, 1914, but incorrectly states that it was originally described as a variety of *S. dawsoni*. We herein raise this taxon to full species, based upon the original description, as well as specimens collected by the authors from SW of the type locality, in the Chukchi Sea, (Arctic Ocean) and in the central Aleutian Islands, at Tanaga Island.

Solaster arctica differs from *Solaster dawsoni* by 1) number of rays, 10, in all known specimens, whereas *S. dawsoni* varies from 12–14; 2) in *S. arctica* spinelets cover the dorsal surface of the pseudopaxillae, in *S. dawsoni* most of the spinelets are restricted to the periphery of the pseudopaxillae, the central areas often are completely bare, or have only 1–3; 3) pseudopaxillar spinelets of *S. arctica* 0.5–0.6 mm in length, bearing 5–8 apical spicules to 0.2 mm in length, pseudopaxillae in *S. dawsoni* 0.2–0.4 mm in length with 3–5 short, often blunt apical thorns 0.05–0.08 mm in length; 4) maximum known radius for *S. arctica* is 9.3 cm, while *S. dawsoni* reaches 20 cm in radius.

The distribution of *Solaster arctica* appears to be restricted to the Arctic (NE Chukchi Sea), and colder regions of the Bering Sea, south to the central Aleutian Islands.

Key to the shallow water (< 20 m) species of *Solaster* in the Aleutian Islands.

- 1a Rays six; R to 4 cm; adambulacrals with a curved transverse series of 6–8 slender, bristling spines, and 2 long, slender furrow spines; color in life uniformly reddish to pale tan. *Solaster hexactis* **sp. nov.**
- 1b Rays, more than eight; R frequently greater than 10 cm. 2
- 2a Rays 12–15; adambulacrals with a nearly straight transverse series of 4–6 rather thick spines, and a furrow series of 3–4 shorter spines; color in life often nearly uniform brown or orange tones, disc sometimes slightly paler, and/or with fine darker specks or mottling. *Solaster dawsoni*

2b	Rays 10–11	3
3a	Adambulacral furrow spines standing nearly as high as actinal series	4
3b	Adambulacral furrows spines short, about half as high as actinal series	5
4a	Adambulacral plates with actinal series of 5 (occasionally 6); spines of abactinal pseudopaxillae 1.5–2 times pedicel height, and bear 5–8 slender apical spicules to 0.2 mm in height; color in life typically salmon on disc, rays purplish or fuchsia	<i>Solaster arctica</i>
4b	Adambulacrals with actinal series of 7–8 spines; spines of abactinal pseudopaxillae about 1–1.2 times pedicel height, and bear 5–10 stout apical thorns to 0.1 mm in height; color in life typically yellow /orange disc with purple rays, sometimes uniformly white, orange or purple	<i>Solaster spectabilis</i> sp. nov.
5a	Disc broad, rays typically short, broad, soft, inflated; R:r usually 2.0–3.0; aboral pseudopaxillae small, round, with 5–9 spines; color in life often uniformly red, yellow, orange or purple, sometimes with broad purple radial stripe.	<i>Solaster endeca</i>
5b	Disc small, rays long, slender; R:r typically 3–5.0; aboral pseudopaxillae round to oval, with 9–13 spines; color in life orange, yellow or red, with prominent blue-gray or purple radial stripe, rarely solid dark navy blue	<i>Solaster stimpsoni</i>

Taxonomic account: after Lambert (2000) & Mah and Foltz (2011)

Asteroidea de Blainville, 1830

Velatida Perrier, 1884

Pterasteridae Perrier, 1875

***Pteraster* Müller and Troschel, 1842**

Pterasteridae having muscle bands in the supradorsal membrane, but these as a rule not regularly reticulated; adambulacral armature in the form of transverse webbed combs; actinolateral spines forming a free, independent lateral fringe, not merged in actinal floor; supradorsal membrane frequently (but not invariably) with small spiracula.

***Pteraster willsi* sp. nov.**

Figures 7, 14–20

Type locality. Alaska, Aleutian Islands, Rat Islands, West of Kiska Island (52°02.066 N, 176°27.04 E), 162 m.

Type material. Table 3.

Description. Small, stellate form, Holotype (Fig. 14); disc broad, rays relatively long, tapering, disc plump, inflated R = 30 mm, r = 22 mm R:r = 1.36, (range 1:1.3–1:1.9). Supradorsal membrane (Fig. 15), relatively thin, firm, papillose. Abactinal plates 4–5 lobed; paxillar columns (Fig. 16), short (height less than half the length of paxillar spines), relatively thick, crowned with 5–7 long, slender spines, the tips of which protrude through the supradorsal membrane, and are covered by a fleshy papilla. Madreporite small, spherical, located beneath the supradorsal membrane, near the osculum. Osculum conspicuous, closed by five palmate valves, each formed by 4 large robust spines, along the facing edge of a large stout paxillae bearing about 16 spines. Spiraculae small, very numerous.

Adambulacral plates (Fig. 17), with L-shaped series of 5–7 webbed spines, distal 3–4 sub-equal, arranged transversely to groove, proximal 1–3 much smaller, set along groove, and a long actinolateral spine, flattened and sometimes bifurcated at the distal end; immersed in actinal membrane. Actinolateral fringe relatively wide, tapering. Each half of jaw plate (Fig. 18), bears 6–7 slender, webbed, grading spines, not continuously webbed to the adjacent plate, and a single large, triangular suboral spine. Tube feet in two rows.

Color of living specimens: from deep water uniformly white, sometimes with orange-tipped ocular spine tips, shallow water specimens (Fig. 19), uniformly bright orange.

Distribution. Known from the central and western Aleutians (Fig. 7), Kanaga Island (178°26' W) to near Attu Island (172°57 E).

Habitat. Rocky and pebbly bottoms, rich in sponges and hydrocorals, 11–166 m with a bottom temperature of 3.7° to 6°C.

Etymology. It is with great pleasure that we name this species in honor of Dr. Irvin A. Wills (deceased) of John Brown University, Siloam Springs, Arkansas. For nearly four decades Dr. Wills served JBU as Professor and Head of the Department of Biology where he mentored thousands of biology students, including Stephen C. Jewett.

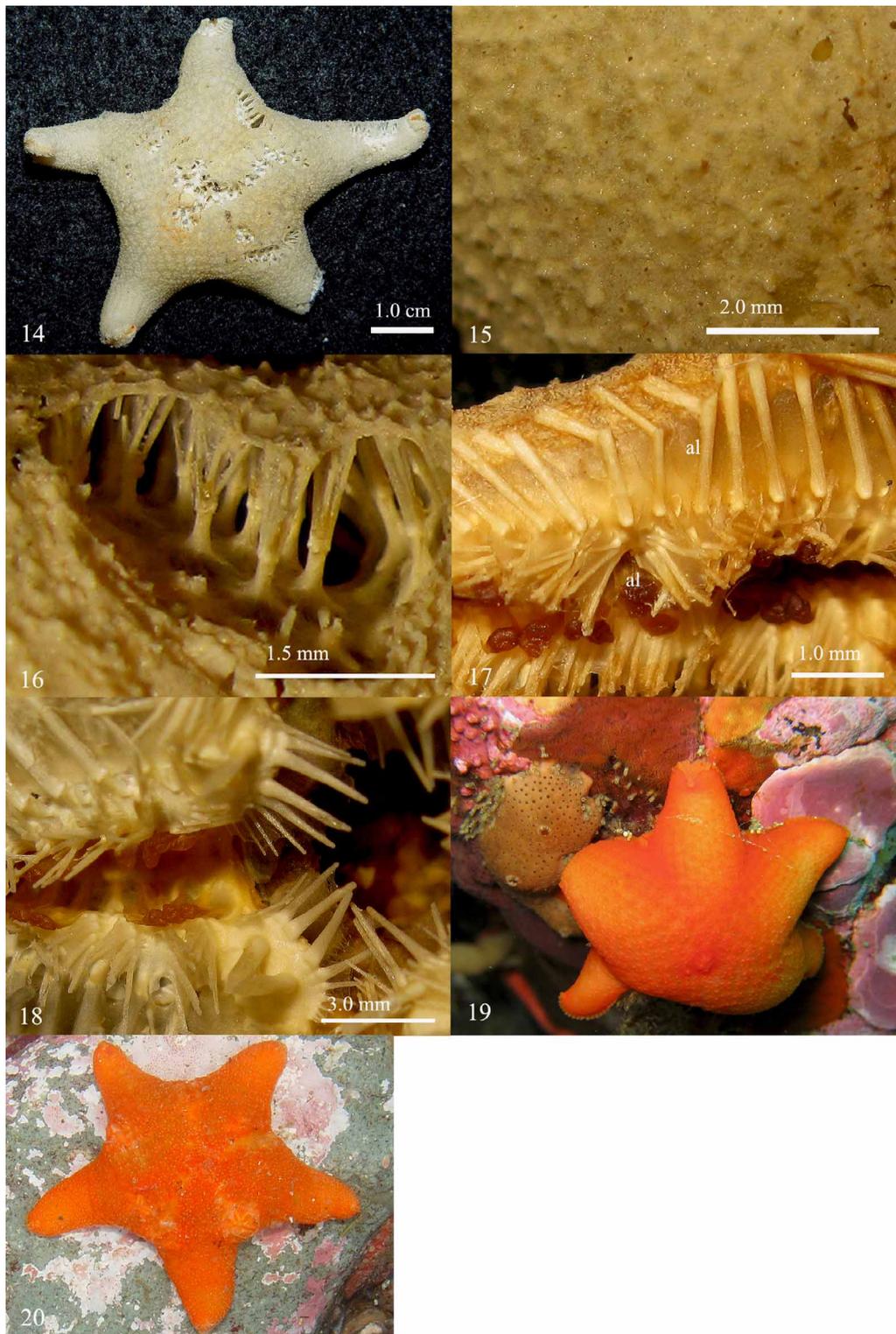


FIGURE 14. *Pteraster willsi* sp. nov. Holotype (LACM 2002-101.001). Whole animal, aboral view; bar = 1.0 cm.

FIGURES 15–18. *Pteraster willsi* sp. nov. Paratypes (LACM 1997-222.001). Figure 15, Close-up, aboral surface; bar = 2.0 mm. Figure 16, Close-up, nidamental chamber, pseudopaxillae/spines and supradorsal membrane; Bar = 1.5 mm. Figure 17, Close-up, adambulacral area (ad = adambulacral spines; al = actinolateral spine); Bar = 1.0 mm. Figure 18, Close-up, oral region; bar = 3.0 mm.

FIGURE 19. *Pteraster willsi* sp. nov. Paratype (LACM 2007-120.001). Live, *in situ*, Rat Island, 14 m. Image: Héloïse Chenelot, 1 July, 2007. R = approximately 1.7 cm.

FIGURE 20. *Pteraster willsi* sp. nov. Paratypes (LACM 2007-118.002). Live, *in situ*, Vega Bay, Kiska Island, 14 m. Image: R. N. Clark, 29 June, 2007. R = approximately 2.0 cm.

TABLE 3. Type material: *Pteraster willsi* sp. nov.

Type	Deposition & No. of Specimens	Collection Site	Collection Depth, m	Collection Date	Collector & Method
Holotype	LACM 2002-101.001, dry	W of Kiska Island 52°02.06 N, 176°27.97 E; NMFS 94-200201-77	162 m	16 June, 2002	R. N. Clark, trawled, R/V <i>Vesteraalen</i>
Paratype	LACM 2002-101.002, 1 specimen, dry	W of Kiska Island 52°02.06 N, 176°27.97 E; NMFS 94-200201-77	162 m	16 June, 2002	R. N. Clark, trawled, R/V <i>Vesteraalen</i>
Paratype	USNM 1153701, 1 specimen, dry	N of Kiska Island 52°04.29 N, 177°15.33 E; NMFS 23-199701-199	130 m	31 July, 1997	R. N. Clark, trawled, R/V <i>Dominator</i>
Paratype	USNM 1153702, 1 specimen, dry	N of Agattu Island 52°20.58 N, 173°31.64 E; NMFS 23-199701-231	86 m	6 August, 1997	R. N. Clark, trawled, R/V <i>Dominator</i>
Paratypes	CASIZ 184726, 2 specimens, dry	E of Kiska Island 52°01.81 N, 177°43.57 E; NMFS 23-199701-196	110 m	31 July, 1997	R. N. Clark, trawled, R/V <i>Dominator</i>
Paratypes	CASIZ 184727, 2 specimens, dry	S of Attu Island 52°29.30 N, 172°57.50 E; NMFS 23-199701-210	166 m	2 August, 1997	R. N. Clark, trawled, R/V <i>Dominator</i>
Paratypes	LACM 1997-222.001, 6 specimens, dry	SW of Buldir Island 52°14.94 N, 175°14.90 E; NMFS 23-199701-239	141 m	8 August, 1997	R. N. Clark, trawled, R/V <i>Dominator</i>
Paratypes	LACM 2007-118.002, 3 specimens, dry	Vega Bay, Kiska Island 51°54.86 N, 177°26.86 E; AKALE07-0017	14 m	29 June, 2007	R. N. Clark, scuba
Paratype	LACM 1997-179.003, 1 specimen	S of Tanaga Island 51°37.36 N, 178°26.46 W; NMFS 23-199701-135	163 m	14 July, 1997	R. N. Clark, trawled, R/V <i>Dominator</i>
Paratype	LACM 2007-120.001, 1 specimen, dry	Rat Island 51°49.59 N, 178°16.67 E; AKALE07-A0031	14 m	1 July, 2007	H. Chenelot, scuba
Paratype	UAF 8139, 1 specimen, dry	Little Sitkin Island 51°58.20 N, 178°27.18 E; AKALE07-0045	11 m	1 July, 2007	R. N. Clark, scuba

Reproduction. Like many *Pteraster* spp., *P. willsi* sp. nov. broods its young in the nidamental chamber until they are developed enough to break through the supradorsal membrane, crawl away and fend for themselves (R = 4–5 mm) (Fig. 20) (LACM 2007-118.002). This has been observed in many specimens, including several Paratypes (LACM 2007-118-002, LACM 1997-222.001, CASIZ 184727).

Remark. *Pteraster willsi* sp. nov. is similar to *P. militaris*, but differs in 1) smaller size and firmer, more rigid supradorsal membrane which lacks the convolutions, 2) large, trigonal suboral spines, and 3) fewer adambulacral spines, 3–4 compared to 6–9 in *P. militaris*. The two species are frequently found together in the same habitat.

A Paratype specimen from station AKALE07-0017 (LACM 2007-118.002) was apparently feeding on the (scavenged?) chela of the small lithode crab *Dermaturus mandtii* Brandt.

Key to the shallow water (< 20 m) species of *Pteraster* in the Aleutian Islands.

- 1a Rays eight to eleven; body firm, relatively rigid; color in life yellow to orange with brown markings. *Pteraster octaster*
- 1b Rays normally five 2
- 2b Actinolateral membrane wide, extending to near or beyond ray edge 3
- 2a Actinolateral membrane narrow, only about half of ray width 4

- 3a Surface finely papillose; suboral spine trigonal; color in life uniformly white to orange *Pteraster willsi* sp. nov.
 3b Supradorsal membrane wrinkled or convoluted; suboral spine cylindrical color in life gray or pale tan to orange.
 *Pteraster militaris*
 4a Surface firm, relatively rigid, reticulated; actinolateral membrane narrow, extending only about half way to edge of rays; suboral spine cylindrical; color pattern in life tessellated. *Pteraster tessellatus*

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