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A new sea star of the genus *Hippasteria* (Asteroidea: Goniasteridae) from the Aleutian Islands

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Abstract

A new species of goniasterid sea star, *Hippasteria* ***aleutica*** **sp. nov.** is described from the Aleutian Islands, and compared to *H. phrygiana* (Parelius, 1768) from the North Atlantic-Arctic, as well as its congeners from the North Pacific. Distribution is discussed and a key to the described species of *Hippasteria* in Alaskan waters is presented.

Key words: sea star, AKMAP, Alaska, *Hippasteria*, echinoderm, Valvatida

Introduction

Fisher (1911) recorded two species of *Hippasteria* Gray, 1840 from Alaskan waters, but none from the Aleutian Islands. *Hippasteria spinosa* Verrill, 1909, was recorded in the Gulf of Alaska, north and west to the Shelikof Strait, NW of Kodiak Island (although he mentions a specimen from off Saint Paul Island, in the Bering Sea, he does not include it in his range data) and *H. heathi* Fisher, 1904, was recorded from Clarence Strait in southeastern Alaska.

From 1994–2004 specimens of several *Hippasteria* spp. were taken in National Oceanic and Atmospheric Administration (NOAA)/ National Marine Fisheries Service (NMFS) survey trawl catches in the Aleutian Islands. Most were referable to known species, but one form differed markedly from the well known *Hippasteria spinosa* of the North American Pacific coast, and was very similar in appearance to the North Atlantic-Arctic *Hippasteria phrygiana* (Parelius, 1768). A comparison of the two forms demonstrated that the Aleutian form was distinct from the Atlantic species, and new to science.

In 2006–2007 during the Alaska Monitoring and Assessment Program (AKMAP) survey in the Aleutian Islands, Divers collected and photographed specimens of the new species at several Islands. The Holotype was collected the subsequent year (2008) on another dive expedition to the region. The species is herein described, and its morphology compared to other *Hippasteria* from the region. The distribution of the genus in Aleutian waters is discussed and a key to the identification is presented.

Methods

Specimens were collected during AKMAP in 2006–2007, and subsequent dives in the region in June of 2008. They were gathered using scuba and photographed *in situ* using a variety of digital cameras with underwater housings. Additional material was collected from trawl samples from 1994–2005, during NOAA/NMFS Aleutian Islands and Gulf of Alaska trawl surveys.

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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.

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); ZIAS (Zoological Institute, Academy of Sciences, Saint Petersburg, Russia); UW (University of Washington, Seattle); NMFS (National Marine Fisheries Service); and NOAA (National Oceanic and Atmospheric Administration); AB (NOAA Auke Bay Laboratory).

Genus *Hippasteria* Gray, 1840

Goniasteridae with large, swollen disk, and broad, short rays. Abactinal plates roundish, with peripheral fringe of minute spinelets or granules, and bearing a single spine, tubercle or bivalve pedicellaria. Marginal plates large, quadrate to rounded fringed with spinelets or granules and bearing one to five large spines, tubercles, or large bivalve pedicellaria. Adambulacral plates with one to three furrow and one or two subadambulacral spines.

Hippasteria aleutica sp. nov.

Figs. 1–7

Hippasteria sp. Barr & Barr, 1983: 175.

Type locality. Alaska, Aleutian Islands, Rat Island (51º49.594 N 178º27.184 E), 13 m, (AKALE07-A0031).

Type material.

Type	Deposition	Collection Location	Collection Depth, m	Collection Date	Collector & Method
Holotype	LACM 2008-030.001 1 specimen dry	Rat Island 51º49.594 N, 178º27.184 E, 13 m. AKALE07-A0031	13	June 8, 2008	R.N. Clark, scuba
Paratype	USNM 1125124 1 specimen dry	Chuginadak Is 52°48.289 N 169°42.526 W AKALE06-0010	17	June 16, 2006	H. Chenelot, scuba
Paratype	USNM E47392 1 specimen dry	Kiska Is 52°04.17 N 177°15.20 E NMFS 23-199701-199	91	July 31, 1997	R.N. Clark, trawled R/V *Dominator*
Paratype	CASIZ 180539 1 specimen dry	NW of Semisopochnoi Is 52°13.78 N 179°58.10 E NMFS 23-199701-154	64	July 27, 1997	R.N. Clark, trawled R/V *Dominator*
Paratype	UAF Inv 8140 1 specimen dry	Umak Bight/Umak Is 51°53.45 N 175°58.282 W AKALE07-0013	8	July 14, 2007	H. Chenelot, scuba
Paratype	AB11-0002 1 specimen dry	SE of Amlia Is 51°55.72 N 172°53.58 W NMFS 23-199701-88	214	July 5, 1997	R.N. Clark, trawled R/V *Dominator*

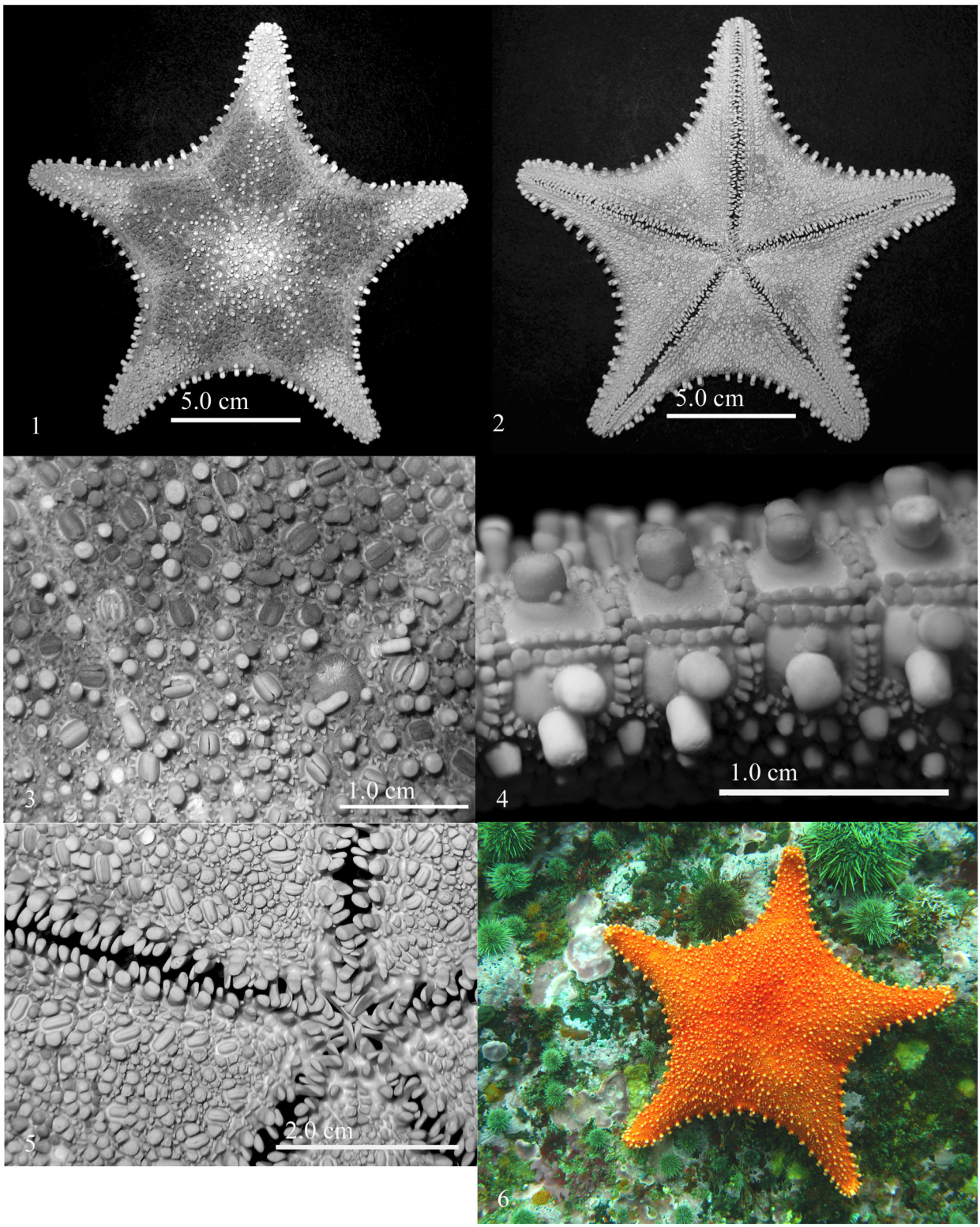
Additional material.

Deposition	Collection Location	Collection Depth, m	Collection Date	Collector & Method
LACM 1997-221.001 1 specimen dry	SSW of Buldir Is 52°16.53 N 175º58.73 E NMFS 23-199701-245	141	August 9, 1997	R.N. Clark, trawled R/V *Dominator*
R.N. Clark Coll. 2 specimens dry	S of Kiska Is 51°50.96 N 177°41.35 E NMFS 147-200401-183	118	July 23, 2004	R.N. Clark, trawled R/V *Gladiator*
R.N. Clark Coll. 2 specimens dry	N of Atka Is 52°12.71 N 174°44.64 W NMFS 23-199701-104	164	July 8, 1997	R.N. Clark, trawled R/V *Dominator*
LACM 1997-154.013 9 specimens dry	W of Tanaga Is 51°44.50 N 178º07.68 W NMFS 23-199701-137	95	July 15, 1997	R.N. Clark, trawled R/V *Dominator*
R.N. Clark Coll. 2 specimens dry	W of Tanaga Is 51º44.31 N 178º09.16 W NMFS 23-199701-132	88	July 14, 1997	R.N. Clark, trawled R/V *Dominator*
LACM 1999-183.001 2 specimens dry	S of Tigalda Is 53º59.7 N 165°05.058 W NMFS 23-199901-13	84	May 19, 1999	R.N. Clark, trawled R/V *Dominator*
R.N. Clark Coll. 1 specimen dry	Unimak Pass 54º22.83 N 165°04.05 W NMFS 23-199901-14	139	May 20, 1997	R.N. Clark, trawled R/V *Dominator*

Diagnosis. Large, broad, relatively rigid, R to 11 cm, R:r 1.7–1.8 (Figs. 1–2); disc very broad, rays short, sharply tapering; abactinal and marginal plates surrounded by pointed granules or thorns, bearing relatively short, thick, blunt, cylindrical spines; abactinal surface also profusely covered with small, bivalve to quadravalve pedicellaria (Fig. 3); adambulacral plates with two thick, blunt furrow spines, the adoral spine often more compressed than the aboral one, behind which are one or two very thick, blunt subadambulacral spines, and several bluntly pointed granules. Color in life orange to red-orange abactinally, actinal side pale yellow-cream.

Description. Large, broad, only slightly inflated, relatively rigid, R to 11 cm, R:r 1.7–1.8 (Figs. 1–2); disc very broad, rays broad at base, sharply tapering; abactinal plates small, round or oval, each bearing a single short, blunt cylindrical or inflated (sometimes nearly spherical) spine, or rather short, wide, bivalve pedicellaria (Fig. 3); plates edged with thorn-like granules. Madreporite small, irregularly ridged, located about half way between the anus and the edge of the disc. Marginal plates (Fig. 4) in regularly paired rows; plates large, nearly round to quadrate, encircled by large (usually) pointed granules or thorns, and bearing one or two relatively large, thick, blunt, cylindrical or inflated (rotund) spines. Actinal plates larger than abactinal plates, and bearing large, thick tubercles, and some smaller, often thorn-like granules; plates adjacent to adambulacral plates (Fig. 5) usually bear a single large, low, broad, bivalve pedicellaria. Adambulacral plates bearing two large, thick, blunt furrow spines, the aboral spine notably compressed, often only half as thick as the aboral spine; one or two large thick blunt subadambulacral spines and several smaller, thick, blunt, irregular tubercles. Oral plates (Fig. 5) with three large, thick, blunt, strongly compressed marginal spines, 0–2 suboral spines, and seven to ten thick, blunt granules. Color in life (Fig. 6) abactinal side bright orange, red-orange, or orange and red mottled; spine tips often paler; actinal side pale yellow-cream colored. Very rarely specimens may have some yellowish mottling abactinally.

Distribution. Aleutian Islands (Fig. 7), SSW of Buldir Island (52°16.53 N, 175º58.73 E; NMFS 23-199701-245) (*leg.* R. N. Clark, 9 August, 1997, trawled R/V *Dominator,* 141 m) to Krenitzin Islands, Unimak Pass, N of Tigalda Island (54°22.83 N, 165°04.05 W; NMFS 23-199901-14), at depths of 15–250 m.



FIGURES 1–6. *Hippasteria* ***aleutica*** **sp. nov.**, Holotype, LACM 2008-030.001. Fig. 1, Whole animal, abactinal view. Bar = 5.0 cm. Fig. 2, Whole animal, actinal view. Bar = 5.0 cm. Fig. 3, Close-up, abactinal surface. Bar = 1.0 cm. Fig. 4, Close-up, marginal plates. Bar = 1.0 cm. Fig. 5, Close-up, adambulacral-oral region. Bar = 2.0 cm. Fig. 6, Live, *in situ*, Rat Island, 13 m (image R. N. Clark). R = 9.5 cm.

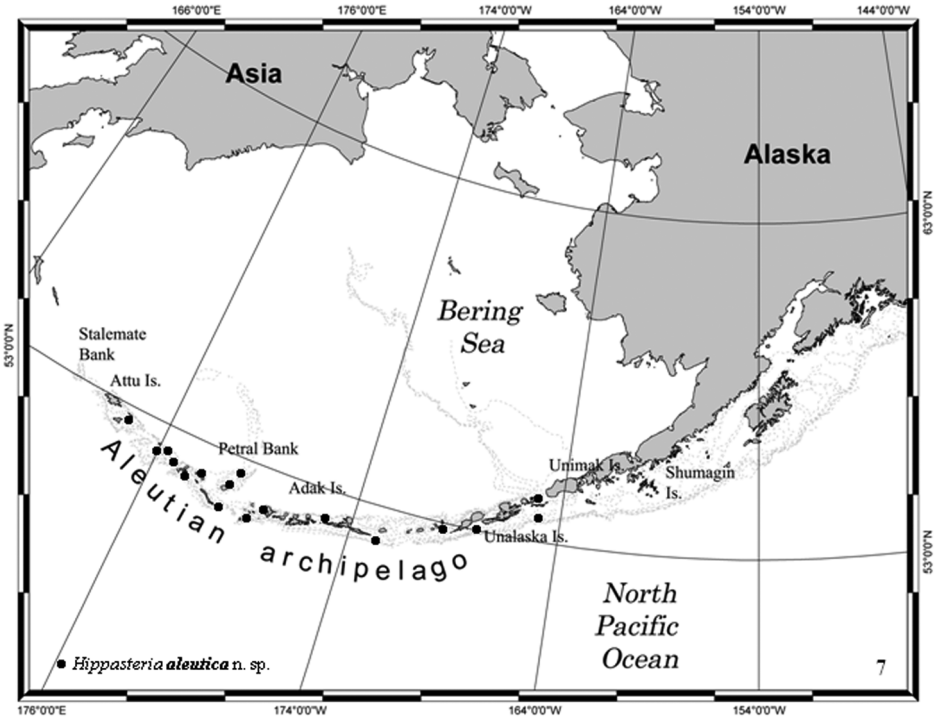


FIGURE 7. Map of Aleutian Islands showing distribution of *Hippasteria aleutica* **sp. nov.**

Habitat. Bedrock and boulders (at diving depths, < 30 m), thickly encrusted with the coralline red algae *Clathromorphum nereostratum.* In deeper depths, the species occurs on bedrock, cobble, pebble, and sand/ gravel bottoms.

Etymology. Named for its distribution in the Aleutian Islands.

Remarks. *Hippasteria aleutica* **sp. nov.** superficially resembles *H. phrygiana* (Parelius, 1768) from the Atlantic-Arctic region in general form, but is distinguished by 1) the thorn-like granules surrounding the abactinal and marginal plates, those of *H. phrygiana* are smaller, and rounded; and 2) inferomarginals typically bearing two cylindrical or barrel-shaped spines, those of *H. phrygiana* usually bear several short thick, rounded knobs. The diagnostic characteristics of *H. aleutica* are consistent even in juveniles as small as R = 5 mm (LACM 1997-154.013).

Hippasteria aleutica **sp. nov.** may be distinguished from *Hippasteria spinosa* Verrill, 1909, *Hippasteria armata* Fisher, 1911, and *Hippasteria kurilensis* Fisher, 1911, by the thick, blunt, often inflated (barrel-shaped) spines, and the low, long bivalve pedicellaria of the abactinal surface. From *Hippasteria heathi* Fisher, 1905, it is readily distinguished by 1) the lack of numerous short, stout, conical spines and tubercles on the actinal and marginal plates; 2) lack of large bivalve pedicellaria on marginal plates; and 3) color, which is uniformly white or cream in *H. heathi. Hippasteria californica* Fisher, 1905, differs in 1) having oblong, oval to elliptical marginal plates; and 2) rugose or denticulate granules surrounding the abactinal and marginal plates, and occasional small pedicellaria.

Discussion. The pointed (often thorn-like) granules of the abactinal, and marginal plates shows affinity with *Hippasteria kurilensis*, and suggest a strong kinship with the *Hippasteria spinosa* species group. Additionally, although *H. phrygiana* is apparently wide spread and variable in the Atlantic Ocean (and adjacent Arctic Ocean), and may even penetrate into the extreme southern Pacific Ocean (Mah, *et. al.*, 2010). The isolation of *H. aleutica* **sp. nov.** in the extreme northern Pacific Ocean and absence of any *Hippasteria* spp. in Arctic North America (Grainger, 1966, Bluhm, et. al. 2009) or Siberia (D'yakonov, 1950) suggests that a close (i.e. sub-specific) relationship with *H. phrygiana* is highly unlikely. Although there was no opportunity for a genetic analysis of *Hippasteria* spp. in this study, genetic samples have been taken from all nominal Alaskan species and are available for study.

The species of *Hippasteria* presently known from the Aleutian Islands are distributed as follows: *Hippasteria spinosa* is found in the SE Bering Sea, south to the vicinity of Unalaska Island, eastward into the Gulf of Alaska and southward to off California at depths of 20–600 m (Fisher, 1911). In Aleutian waters *H. spinosa* occurs west to

the vicinity of Unalaska Island. (R. N. Clark, pers. obs.). *Hippasteria kurilensis* is found throughout the Aleutian Islands (R. N. Clark, pers. obs.), and westward to the Kurile Islands (Fisher, 1911; D'yakonov, 1950) at depths of 80–600 m. *Hippasteria heathi* is found throughout the Aleutians Islands and Gulf of Alaska at depths of 250–500 m (R. N. Clark, pers. obs.). *Hippasteria californica* Fisher, 1905 occurs from southern California north to the Gulf of Alaska, north into the eastern Bering Sea (R. N. Clark, pers. obs.) and west across the Aleutian Is., to Hokkaido Island, Japan, at depths of 500–1820 m (Mah, et. al. 2010). *Hippasteria armata* is found in the Kurile Islands (Fisher, 1911; D'yakonov, 1950) Aleutian Islands (R. N. Clark, pers. obs.), Okhotsk Sea and western Bering Sea [D'yakonov, 1950 (as *Hippasteria mammilifera* D'yakonov, 1950 & *Hippasteria colossa* D'yakonov, 1950, respectively; *fide* R. N. Clark, based upon examination of type specimens), and the eastern Bering Sea at depths of 230–650 m (R. N. Clark, pers. obs.).

Key to the genus *Hippasteria* in the Aleutian Islands

1a Marginal plates oblong, oval or elliptical, bearing a single slender tapering spine at the center, often flanked on either side by short tubercles; actinal and abactinal plates often extending between marginals; abactinal and marginal plates encircled by small rugose or denticulate granules; abactinal pedicellaria numerous, relatively small, base broader than apex. . . . . *H. californica*

1b Actinal and abactinal plates not extending between marginal plates; marginal plates more or less quadrate; granules encircling abactinal and marginal plates not rugose or denticulate 2

2a Abactinal surface profusely covered with large, low, long, bivalve pedicellaria and short, blunt conical spines and tubercles; surface of marginal plates bearing 1–2 thick, blunt conical spines, variously sized conical tubercles and frequently one large, low bivalve pedicellaria. Color uniformly white or cream . . . . . *H. heathi*

2b Surface of marginal plates lacking large, low bivalve pedicellaria and/or numerous conical spines and tubercles. Color red-orange abactinally 3

3a Granules encircling abactinal and marginal plates pointed, usually with sharp apical projection; furrow spines slightly to strongly compressed (oval to flattened in cross-section) 4

3b Granules encircling abactinal and marginal plates low, smooth, rounded or oval; furrow spines cylindrical or sub-cylindrical (tapering), round in cross-section 5

4a Abactinal and marginal plates bearing rather stout, tapering spines; granules encircling plates usually broad, flattened, triangular; a few marginals usually bearing a single small pedicellaria (slightly taller than long); adambulacral plates bearing two strongly compressed furrow spines, and a single shorter, thick, blunt subadambulacral spine (or sometimes a large bivalve pedicellaria). . . . . *H. kurilensis*

4b Abactinal and marginal plates bearing short, thick, blunt cylindrical or inflated spines; abactinal surface bearing numerous bivalve pedicellaria; granules encircling abactinal plates well spaced, often quite elongated; adambulacral plates bearing two blunt, somewhat compressed spines; adoral spine often reduced, much shorter, and only half as thick as aboral spine, and a single short, thick, blunt subadambulacral spine and some thick, blunt, flattened tubercles . . . . . *H. aleutica* **sp. nov.**

5a Abactinal and marginal plates bearing 1–2 short, stout, tapering spines or tubercles; abactinal surface profusely covered with relatively small, bivalve pedicellaria; several marginal plates typically bearing a single bivalve pedicellaria; adambulacrals bearing 1–2 thick, blunt tapering, cylindrical furrow spines and one or two similar but shorter subadambulacral spines . . . . . *H. armata*

5b Abactinal and marginal plates bearing slender, tapering spines (up to 5 on some marginals); encircling granules small (often spaced), smooth; marginal plates very rarely (if ever) bearing any pedicellaria; adambulacral plates with typically two relatively long, tapering furrow spines and a single similar subadambulacral spine . . . . . *H. spinosa*

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