Pisaster brevispinus

The pink, short-spined sea star

Phylum: Echinodermata, Asterozoa

Class: Asteroidea

Order: Forcipulatacea, Forcipulatida

Family: Asteriidae

Taxonomy: The genus *Pisaster* includes three Pacific coast sea star species, including *Pisaster brevispinus*. One can find many historic synonyms for *P. brevispinus*, including *P. papulosus* and *P. paucispinus*. Furthermore, two subspecies were erected for *P. brevispinus* in 1930 (Fisher) but the morphological and genetic status of these subspecies is currently unknown. Before being assigned to the genus *Pisaster,* this species belonged to the, currently accepted, genus *Asterias* (synonyms *A. brevipsina*, *A. papulosa*).

Description

Size: One of the largest asteroids worldwide and typically 320 mm in diameter (Hyman 1955; Feder 1980; Mah 2007; see http://echinoblog.blogspot.com/2008/06/giant-pink-monsters-among-us-enter.html), with largest reported size 900 mm (Mah and Blake 2012). The illustrated specimen (from Coos Bay) is 190 mm in diameter.

Color: Oregon specimens always pink, although some keys indicate gray-green or maroon-purple mottling (see Plate 25, Kozloff 1993).

General Morphology: Sea stars (Asteroidea) are conspicuous members of the intertidal and subtidal. Their bodies are composed of a **central disc** from which arms or **rays** extend. The star-shaped body can be divided into an **oral** (or ventral) side where the mouth is located and **aboral** (or dorsal) side.

Body: Body is firm, not weak and flabby.

Rays: Five, unless damaged. Each ray is tapering and most broad where they join the central disc, but not broad enough to give webbed appearance (as in *Patiria* spp.).

Central Disc: Large, raised, but not set off from arms or distinctly disc-like as in Ophiuroidea (brittle stars). Contains (conspicuous) madreporite (Figs. 1, 3) and (less conspicuous) anus.

Aboral Surface: Aboral surface rough and spiny in texture and pink in color.

Spines: Short ("brevi", shorter than other *Pisaster* species, Feder 1980), spines do not usually form reticulated pattern or crescentic arcs and there is at least one straight row of spines down each arm (Fig. 1). Spines occur singly or in small groups of two and three (up to five) and are separated by areas of soft tissue (Fig. 3). Large spines are often shaped like onion domes. The spines in the center of the disc do not form a distinct star (Fig. 1).

Madreporite: The madreporite, which filters water into the interior stone canal, is raised, with channels, and is a conspicuous plate on the central disc (Fig. 1).

Pedicellariae: Stalked or sessile appendages with pincers, used for removing invaders. Pedicellariae are bird beak-like and two-jawed in *Pisaster* species. Very small pedicellariae cluster around spines (Fig. 3) and no large sessile pedicellariae are visible. Used in deterring predators (e.g. *Solaster dawsoni*, Van Veldhuizen and Oakes 1981).

Anus: Inconspicuous and near center of aboral surface.

Oral Surface: Oral surface ochre in color and consists of hard, textured surface from extension of aboral surface and ambulacral grooves running the length of each arm and converging at the mouth. Grooves are fleshy

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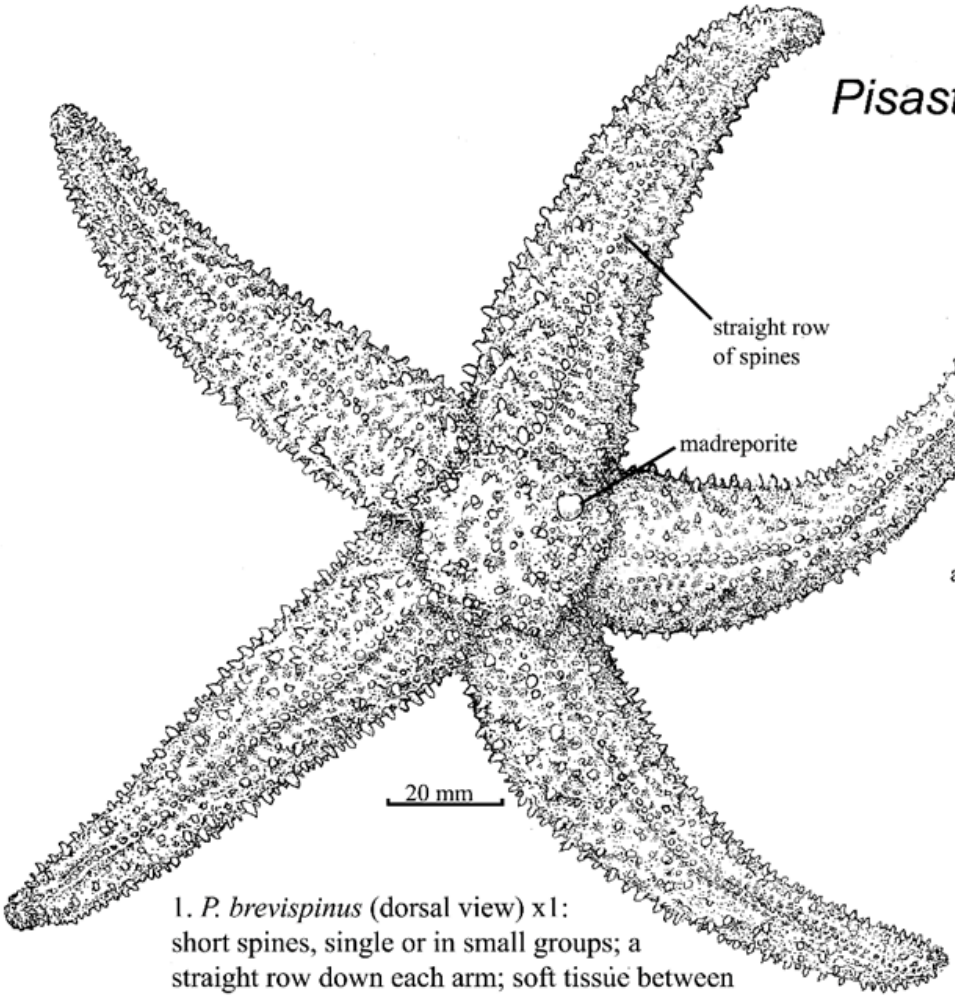
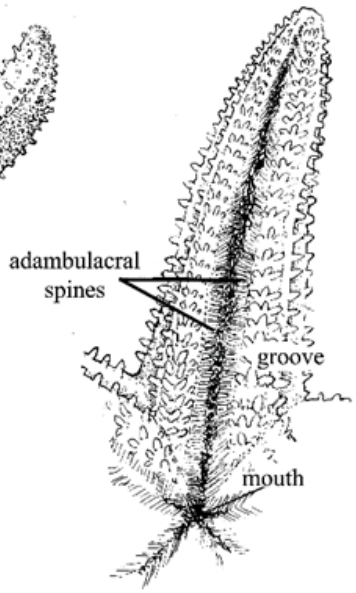
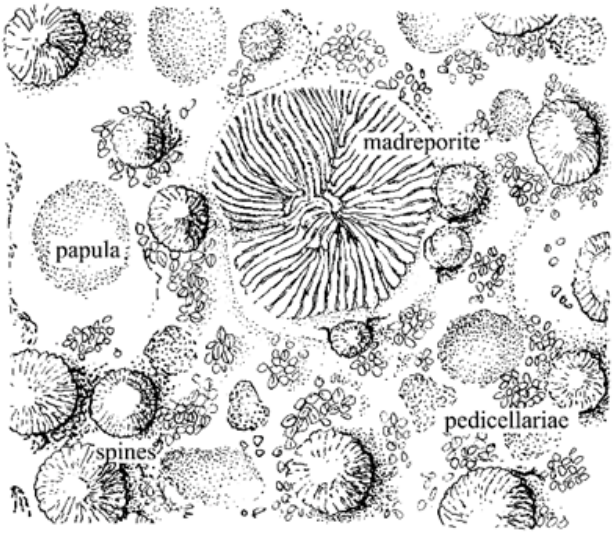


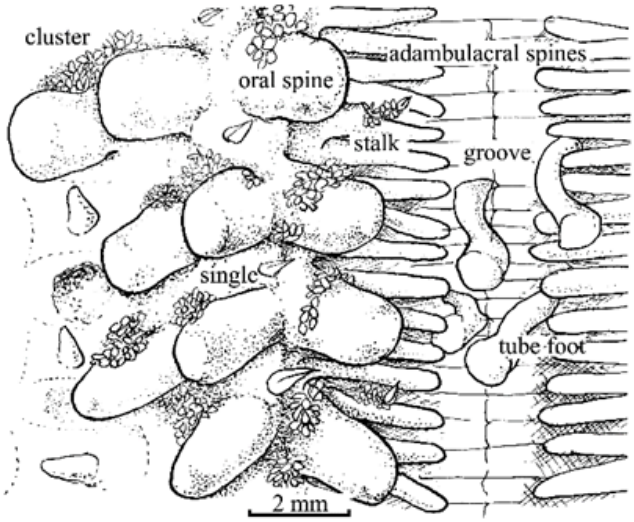
1. *P. brevispinus* (dorsal view) x1: short spines, single or in small groups; a straight row down each arm; soft tissue between spines; pink color; five tapering arms; large raised central disc.



2. One ray (ventral view) x1: adambulacral groove with tube feet.



3. Dorsal spines, madreporite x8: spines short, some "onion domed" or in small groups; rounded madreporite; pedicellariae small, clustered; dark papulae.



4. Ventral spines, groove x8: oral spines blunt, eliptical; adambulacral spines along groove; pedicellariae clustered, single or stalked.

Hiebert, T.C. and K. Meyer. 2015. *Pisaster brevispinus. In:* Oregon Estuarine Invertebrates: Rudys' Illustrated Guide to Common Species, 3rd ed. T.C. Hiebert, B.A. Butler and A.L. Shanks (eds.). University of Oregon Libraries and Oregon Institute of Marine Biology, Charleston, OR.

in texture due to thepresence of tube feet.

Spines: Four rows of flattened (elliptical) blunt spines with small clustered pedicellariae at their bases and one row of long thin spine-like adambulacral spines (Fig. 4). A few clusters of pedicellariae occur at the bases of these spines, but there are no pedicellariae on the spines (Fisher 1930; Hyman 1955).

Mouth: Large and at center of ventral surface (Fig. 2).

Pedicellariae: Two types of pedicellariae on the oral surface: (1) Small and clustered around bases of oral spines, and (2) large stalked pedicellariae on bases of adambulacral spines (Fig. 4).

Tube Feet: Used in locomotion and part of vascular system. Present on the ventral side in four rows that are staggered down each ambulacral groove (Fig. 4).

Ambulacral Grooves: Grooves are long furrows on oral surface of arms, which contain tube feet and are lined with adambulacral spines (Fig. 4).

Possible Misidentifications

Among the large five-armed sea stars, *Pisaster* species are noted for their thick arms, low papillate dorsal spines and pedicellariae. *Pisaster brevispinus* is readily identifiable by its pink coloration, its seemingly soft appearance, and its unusual (for sea stars) occurrence on soft substrates. Two other Asteriidae species share these characteristics, but can be differentiated as follows: (1) *Evasterias troschelii* is slender like *P. brevispinus*, but is generally orange-red or blue-gray (in Coos Bay), not pink. Its clusters of oral pedicellariae are on the adambulacral spines, not just at their bases as in *P. brevispinus* (Fig. 4). Like *P. brevispinus*, *E. troschelii* is subtidal (Ricketts and Calvin 1971; Mah 2007) and its preferred range is in Puget Sound, Washington, although it is known to northern California. (2) *Orthasterias koehleri* has large, sharp dorsal spines, each surrounded by a distinct ring of large pedicellariae. These spines are arranged in distinct radial rows and *O. koehleri* is often red with yellow mottling (Mah 2007).

Two other species of *Pisaster* can be found locally: (1) *Pisaster ochraceus* is a common coastal sea star, and is only present in lower reaches of high salinity estuarine systems. It is red, brown, or ochre (juveniles are gray), never pink. It inhabits only hard substrates (e.g. rocks, pilings), not soft sand. The dorsal spines on *P. ochraceus* form reticulated patterns and the straight line(s) of spines down each arm that are typical of *P. brevispinus* are absent from *P. ochraceus*. (2) *Pisaster giganteus* is bluish gray, with blunt, clubbed dorsal spines, each surrounded by a ring of blue flesh around which is a ring of pedicellariae. *Pisaster giganteus* is a low intertidal sea star, and usually found further south than Oregon. In spite of its name, it is smaller than *P. brevispinus* when fully grown (Mah 2007).

Sea stars are extremely variable intraspecifically. Fisher describes two forms of *P. brevispinus* (with status currently unknown): (1) *P. b. brevispinus*, from Puget Sound, Washington to Crescent City, California with an abundance of aboral spines (Fisher 1930). These spines are in large groups, up to 10 and can form radial bands; (2) *Pisaster brevispinus pacispinus* has few spines, standing singly or in groups of two and three. The spines are usually stout with subconical acorn-shaped with grooved tips. Papillae (respiratory surfaces) are numerous and conspicuous in this form (Fig. 3).

Ecological Information

Range: Type locality is San Francisco Bay, California (Ahearn 1995). Sitka, Alaska, to Santa Barbara, California (Fisher 1930).

Local Distribution: Typically offshore and on sand bottoms and also found in channel bottoms of large estuaries, like Coos Bay.
Habitat: Only in quietest waters and also on wharf pilings and rocks. Cannot tolerate exposure to air or to low salinities for extended periods (Ricketts and Calvin 1971).
Salinity: Collected at salinities around 30.
Temperature: Cold to temperate. Does not tolerate aerial exposure as well as *P. ochraceus* (Feder 1980).
Tidal Level: Present in low intertidal, but most common subtidally from 0.5–100 m (Feder 1980).
Associates: On low pilings, associates include the congener, *P. ochraceus*, as well as the anemone *Metridium*, and tunicates, mussels and barnacles. Several incidences of sudden sea star die off have occurred since 1972, but the most recent to the northwest coast of North America began in June 2013 and is called sea star wasting disease. Affected individuals have ectodermal lesions and tissue decay that eventually leads to death (within 2–3 days). The water-vascular system loses the ability to maintain hydrostatic pressure and individuals often look flaccid when infected. Increased temperature further heightens infection intensities (Bates et al. 2009). The current die off of sea stars is the most significant due to its widespread geographic range and large number of species infected (Hewson et al. 2014). Recently, researchers determined this disease is most likely associated with a family of single stranded DNA viruses (densovirus, *Parvoviridae*) and is now called sea star-associated densovirus (SSaDV). Incidentally, this same virus was detected in museum specimens and, thus, may have been present on the Pacific coast and undetected since those specimens were collected in 1942. Although the specific pathogen is not known in certainty, SSaDV is currently the most likely candidate (Hewson et al. 2014).
Abundance: Occasional and not as common as *P. ochraceus* (Feder 1980).

Life-History Information

Reproduction: Forcipulate asteroids primarily have separate sexes and free-swimming planktonic larvae (Fisher 1930; Chia et al. 1987). *Pisaster* species do not brood their eggs or young as do some Asteriidae, e.g. *Leptasterias* (Sutton 1975). Many species can be induced to spawn and are routinely used in developmental research (e.g. *P. ochraceus*). One pair of gonads is present in each arm and, when spawning, sea stars lift and suspend their body with their arms and gametes are released through gonopores on the aboral surface (Chia et al. 1987). Ten gonads are like feathery tufts, two in each ray, and occur next to the central disc in *P. brevispinus*. The spawning period is from March to August (San Juan Islands, Washington, Chia et al. 1987) and April in Monterey, California (Feder 1980; Miller 2001). Reproductive cycle much like that of *P. ochraceus* where development proceeds as follows (12˚C): 2 cells at 5hr, 4 cells at 6hr, 8 cells at 7hr, hatching at 29–32 hr, gastrula at 44–63 hr, planktotrophic bipinnaria larva at 5d post fertilization (Chia et al. 1987).
Larva: Embryos develop into planktotrophic larvae called bipinnariae (Chia et al. 1987; Miller 2001). Bipinnaria larvae are easily recognizable in the plankton (Fig. 26.1, 26.2, Chia et al. 1987), they are large, fleshy and uniformly ciliated with a distinct, continuous ciliated band that is used for feeding and swimming. They have a large mouth, esophagus, intestine and anus. They can have many long arms, increasing in number with age and can become long and floppy (Fig. 3, Miller 2001). The juvenile sea star develops from the left posterior portion of the larval body. Late stage bipinnaria develop three

arms (called brachiolar arms) and a central adhesive disc, anteriorly. Larvae at this stage are called brachiolaria (see Fig. 4, Miller 2001) and they use these arm to attach to substratum at metamorphosis.

Juvenile:

Longevity:

Growth Rate:

Food: Feeds on a variety of invertebrates including clams, snails, mussels, barnacles sand dollars as well as scavenging dead or dying fish or squid. The stomach of individuals can be extended up to 8 cm to digest prey externally (Feder 1980). Can apparently sense and dig out clams (e.g. *Saxidomus, Protothaca*) from gravel (Smith 1961; Feder 1980) and includes more clams in its diet than does *P. ochraceus* (Mauzey et al. 1968). *Pisaster brevispinus* can also extend tube feed into the sediment to considerable depths (roughly equal to arm length, up to 20 cm, Van Veldhuizen and Phillips 1978; Feder 1980; see http://echinoblog.blogspot.com/2008/06/giant-pink-monsters-among-us-enter.html) to seek out prey. Sand dollars escape by quickly burying themselves when *P. brevispinus* appears (MacGinitie and MacGinitie 1949).

Predators: Sea otters (McCleneghan and Ames 1976) and other sea stars (e.g. *Solaster dawsoni*, Van Veldhuizen and Oakes 1981), although their large size usually reduces predation.

Behavior: *Pisaster brevispinus* and, the sunflower star, *Pycnopodia helianthoides* are known to compete and fight for food (Wobber 1975; Feder 1980). A significant escape response was observed for *P. brevispinus* from both *P. helianthoides* and *S. dawsoni* (Van Veldhuizen and Oakes 1981).

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Updated 2015

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Hiebert, T.C. and K. Meyer. 2015. *Pisaster brevispinus. In:* Oregon Estuarine Invertebrates: Rudys' Illustrated Guide to Common Species, 3rd ed. T.C. Hiebert, B.A. Butler and A.L. Shanks (eds.). University of Oregon Libraries and Oregon Institute of Marine Biology, Charleston, OR.