
Adula californiensis

A gammarid amphipod

Phylum: Mollusca

Class: Bivalvia, Heterodonta, Euheterodonta

Order: Imparidentia, Adapedonta

Family: Hiatelloidea, Hiatellidae

Taxonomy: This species was originally described under the name *Modiola californiensis* by Philippi in 1847, but was transferred to the genus *Adula* in 1857 by Adams and Adams. Additional, but uncommon, synonyms include *Adula stylina* (Huber 2010). Dall (1921) and Rocque (1953) have included *Adula* in the genus *Botula*, but Soot-Ryen (1955) differentiated the two genera. Ockelmann and Dinesen (2009) found these two genera to be distantly related, and suggested evidence for a well-defined genus *Adula* within the Mytilinae (Ockelmann and Dinesen 2009).

Description

Size: Individuals up to 40 mm in length and 10 mm in height.

Color: Shell exterior brown to black (Mytilidae, Coan and Valentich-Scott 2007), interior white, sub-nacreous, with posterior edge that is tinged with blue. Worn beaks, anteriorly, show white, and periostracum is thin, brown, and lacquer-like (Fig. 1). No chalky incrustations on shell (*Adula*, Coan and Valentich-Scott 2007).

General Morphology: Bivalve mollusks are bilaterally symmetrical with two lateral valves or **shells** that are hinged dorsally and surround a mantle, head, **foot** and viscera (see Plate 393B, Coan and Valentich-Scott 2007). Mytilids have cylindrical shells and two adductor muscles, with associated scars that are unequal in size (see Plate 395, Coan and Valentich-Scott 2007). Mytilids often use byssal threads to maintain contact with the substratum (Kozloff 1993).

Body: (see plate 17, Kozloff 1993)

Color:

Interior:

Exterior:

Byssus: Hairy threads which attach mussel to substrate, appear on *Adula* as a large hairy posterior patch encrusted with mud and debris (Fig. 1).

Gills:

Shell: (see Plate 403C, Coan and Valentich-Scott 2007) Valves are deep and subequal, cylindrical, do not taper, and are thin and fragile. Dorsal and ventral margins are parallel for at least half of their length (Keep and Longstreth 1935). Umbones extend one quarter of the way from anterior end (i.e. subterminal), are not prominent, and extend higher than posterior end (Packard 1918). Shell elongate and tapers posteriorly. The posterior and anterior ends are of equal thickness (Coan and Valentich-Scott 2007).

Interior: Muscle scars very unequal in size (Mytilidae, Coan and Valentich-Scott 2007), although faint crenulations appear on the dorsal anterior margin (Fig. 2). Hinge is about one quarter of the way from anterior end.

Exterior: Surface with some radial sculpture, particularly at the anterior end, but no patches of vertical file-like striations (Fig. 1). Shells are often eroded near the beaks, anteriorly (Haderlie and Abbott 1980).

Hinge:

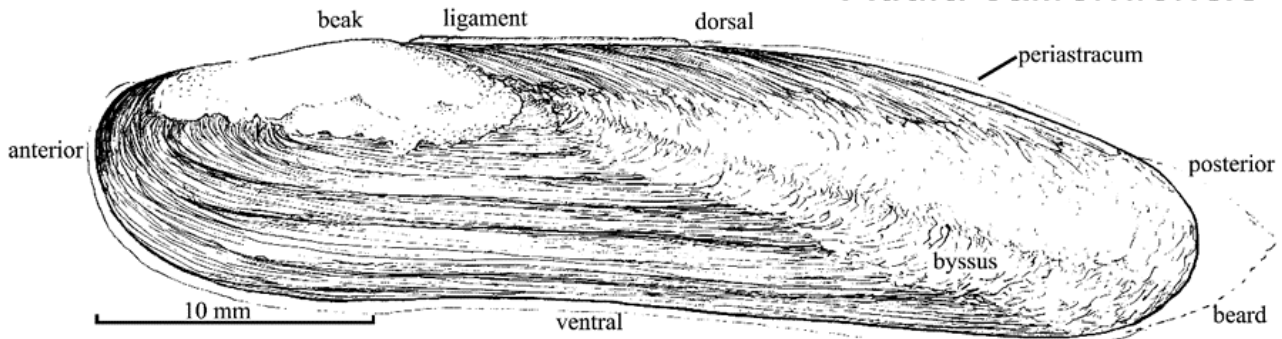
Eyes:

Foot:

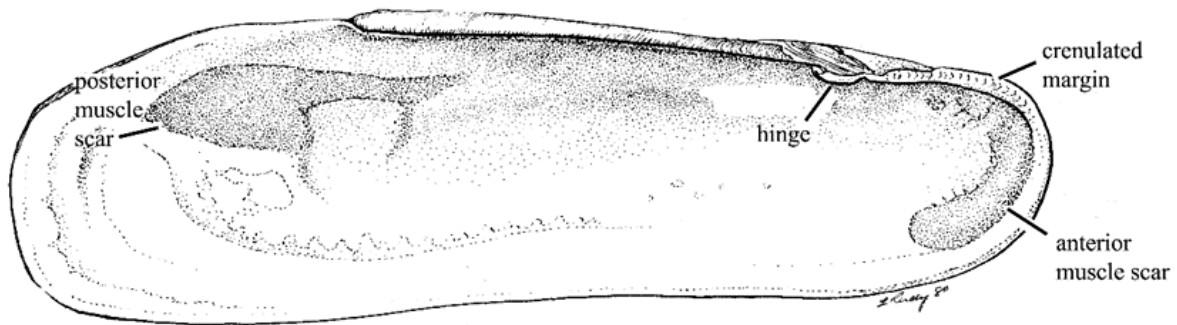
Siphons: White and fused almost to end. The incurrent siphon is with feathery oak leaf-shaped tentacles, in the illustrated specimen (Fig. 4).

Burrow:

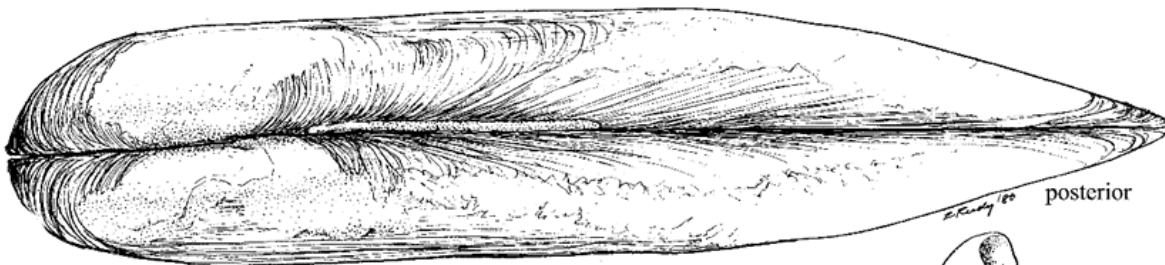
Adula californiensis



1. *Adula californiensis* x4.5: cylindrical shells, valves subequal; dorsal and ventral margins roughly parallel; smooth periostracum; posterior slope hairy; worn beaks 1/4 of way from rounded anterior; ligament external; radial sculpture.

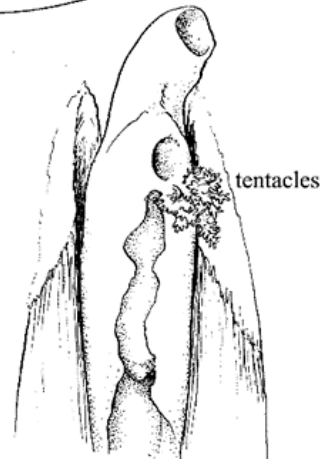


2. Left valve, interior: posterior muscle scar much larger than anterior scar; color white; sub-nacreous, posterior tinged with blue; anterior margin slightly crenulate; hinge without teeth.



3. (Dorsal view): posterior pointed; beaks not prominent.

4. Siphons: white, fused almost to ends; incurrent siphon with oak-leaf like tentacles.



Possible Misidentifications

The family Mytilidae is characterized by two adductor muscles and associated scars that are unequal in size; the anterior scars are smaller and near the shell beak (see Plate 395, Coan and Valentich-Scott 2007). Members of this family have cylindrical shells that are dark brown or black that sometimes taper anteriorly, and the two shell valves are of similar morphology. They lack both a chondrophore (e.g., compare to *Mya arenaria*, this guide) and dorsal margin ears, and the shell is not cemented to the substratum (Coan and Valentich-Scott 2007). There are nearly 20 local species in the family Mytilidae comprising the genera *Septifer* (*S. bifurcatus*), *Lithophaga* (*L. plumula*), *Geukensia* (*G. demissa*), *Musculista* (*M. senhousia*), *Modiolus* (six species) and *Mytilus* (one to four species). Other genera are possibly present in the area, but are not included in current keys including *Crenella* (*C. decussata*), *Gregariella* (*G. coarctata*), *Solamen* (*S. columbianum*) (Coan and Valentich-Scott 2007).

Genera included in the current key can be differentiated as follows: *Mytilus* species (see *M. trossulus*, this guide) have shells that with beaks at the terminal portion of the anterior end and lack internal septa, while *Septifer* species possess an internal septum at their anterior end. All other genera have shells with beaks that are anterior, but not terminal. Of those, *Lithophaga plumula* individuals are with cylindrical shells and a posterodorsal slope that is rough and with chalky encrustations, while *Adula* species have a posterodorsal slope without chalky encrustations and, instead, have a thick mat and are sometimes covered with mud or debris. The genera *Geukensia*, *Modiolus*, and *Musculista* have shells that are not cylindrical, *G. demissa* shells have prominent ribs externally and are dark brown or black in color. *Modiolus* and *Musculista*

species have shells without external ribbing and members of the former genus have periostracial hairs while *Musculista* do not.

The genus closest to *Adula* is *Lithophaga* (the “date shell”), a boring mussel with cylindrical shell and roughly parallel margins. It lacks the hairy posterior of *Adula*, and bores in hard rock and it has peculiar feather-like wrinkling on the posterior of the shell. There are three local species of *Adula* including *A. gruneri*, *A. diegensis*, and *A. californiensis*. *Adula gruneri* (= *A. falcata*, *Lithodomus falcatus*, Ockelmann and Dinesen 2009) and *A. californiensis* both bore into shale, while *A. diegensis* is free-living. *Adula gruneri* can be recognized from the other two by the presence of persiostracum that is with irregular striae. *Adula californiensis* and *A. diegensis* can also be differentiated as the former species has an elongate shell, while *A. diegensis* has a stout shell. *Adula diegensis* also has a dorsal margin that flares and sparse periostracal mat on the posterior slope, neither are present in *A. californiensis*. *Adula diegensis* is a small species (< 19 mm in length) that occurs as far north as San Francisco, California, on mudflats and pilings with other mussels (e.g., see *Mytilus trossulus*, this guide). It is polished and dark blue interiorly. *Adula gruneri*, the hooked pea-pod shell, bores deep into hard rock as well as into clay. It has wrinkled periostracum, not a smooth one, as well as vertical striae to assist in boring. Its shell is more angular and proportionally longer than the more cylindrical than *A. californiensis*, and tapers posteriorly. The beaks in *A. gruneri* are situated at about the anterior eighth of the shell length, and are strongly involute (closely wound). Its northern limit is probably Coos Bay and is known from southern Oregon to Baja California, as is *A. diegensis* (Kozloff 1993). *Adula gruneri* is the largest of the three *Adula* species, at up to 80 mm in length, while *A. diegensis* is generally smaller (~20 mm) than *A. californiensis* (Kozloff 1993).

(For in depth differentiation between *Adula* species, see Ockelmann and Dinesen 2009.)

Ecological Information

Range: Type region in northwestern Pacific (Bernard 1983). Known range includes Vancouver Island, British Columbia, Canada, Alaska, and San Diego, California (Kozloff 1993).

Local Distribution: Local distribution at sites in Coos Bay and Pigeon Point, also Yaquina and Boiler Bays (see Fig. 1, Lough and Gonor 1971).

Habitat: Burrows into soft, muddy shale or is, occasionally, free-living (Coan and Valentich-Scott 2007). In Coos Bay, they can be found in in old pholad (fam. Pholadidae) burrows. Distribution is limited by appropriate burrowing substrate (Lough and Gonor 1971).

Salinity: Collected at salinities of 30, usually in the lower reaches of the bay where salinity is relatively high and constant. Estuarine and marine habitats (Lough and Gonor 1971).

Temperature: Individuals occur in temperate waters.

Tidal Level: Intertidal to sublittoral (Coan and Valentich-Scott 2007). Individuals collected from up to 10 meter depths (Newport, OR, Lough and Gonor 1971).

Associates: Associates include the terebelid polychaete *Thelepus*, the pholad *Penitella*, and the brachyuran crab, *Cancer oregonensis*. In addition, *A. californiensis* hosts several ciliated protozoans including *Raabella* (= *Hypocomides*) *botulae*, *R. parva* and *Insignicoma venusta* (Coan and Valentich-Scott 2007).

Abundance: not common

Life-History Information

Reproduction: Dioecious, and free-spawning. Individuals are ripe from June to October (Oregon, Kozloff 1974; Lough and

Gonor 1971). Oocytes are 70–80 μm in diameter and are pink to orange in color and yolky (Lough and Gonor 1971). For sperm morphology of members of the Mytilidae, including the conger, *A. falcatooides*, see Kafanov and Drozdov 1998.

Larva: Bivalve development generally proceeds from external fertilization via broadcast spawning through a ciliated trochophore stage to a veliger larva. Bivalve veligers are characterized by a ciliated velum that is used for swimming, feeding and respiration. The veliger larva is also found in many gastropod larvae, but the larvae in the two groups can be recognized by shell morphology (i.e., snail-like versus clam-like). In bivalves, the initial shelled-larva is called a D-stage or straight-hinge veliger due to the “D” shaped shell. This initial shell is called a prodissoconch I and is followed by a prodissoconch II, or shell that is subsequently added to the initial shell zone. Finally, shell secreted following metamorphosis is simply referred to as the dissoconch (see Fig. 2, Brink 2001). Once the larva develops a foot, usually just before metamorphosis and loss of the velum, it is called a pediveliger (see Fig. 1, Kabat and O’Foighil 1987; Brink 2001). (For generalized life cycle see Fig. 1, Brink 2001). Development in *A. californiensis* was described by Lough and Gonor (see Fig. 2, 1971) and proceeds with polar lobe formation within the first hour, which is resorbed by 1.5 hours, first and second cleavages at 1.5 and 2.5 hours post fertilization, respectively, trochophore larvae develop at 15 hours, the shell gland forms at at 31 hours, and a bivalve shell, that surrounds individuals entirely, is complete at 72 hours (at 15°C, Lough and Gonor 1971). Veliger larvae are free-swimming (Brink 2001) and are relatively tolerant of low salinity but not high temperatures (Kabat and O’Foighil 1987). While trochophore larvae tend to swim in all directions, veligers swim vertically and not horizontally (Lough and Gonor 1971;

Haderlie and Abbott 1980). Settlement and metamorphosis occur after three days. Larval size is approximately 108 μm at 3 days, 117 μm at 15 days and 119 μm at 25 days post fertilization (Lough and Gonor 1971). Development increases with temperature and slows with decreasing salinity, with lowest salinity for development 26.3 (Lough and Gonor 1971). Young larvae (3 days old) are more sensitive to a reduction in salinity than older larvae (15 days old or more), but the opposite trend is seen for temperature tolerance (older larvae have a narrower temperature tolerance) (Lough and Gonor 1973a, b). Ideal temperature and salinity for development is 10–15°C and salinity 31–33 (Lough and Gonor 1973a).

Juvenile: Juveniles morphology flares posteriorly rather than being cylindrical (i.e. modioliform).

Longevity:

Growth Rate:

Food: A suspension feeder. For feeding mechanisms and concentration of particles using currents produced by cilia in the congener, *A. gruneri*, see Fankboner 1971.

Predators:

Behavior: This species is probably more of a nestler than a burrower.

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