**Penitella penita**

Common piddock

**Phylum:** Mollusca  
**Class:** Bivalvia, Heterodonta, Euheterodonta  
**Order:** Imparidentia, Myida  
**Family:** Pholadoidea, Pholadidae, Martesiinae

### Taxonomy

The taxonomies of both pholad species in this guide (Z. pilsbryi and *Penitella penita*) are extensive and complicated, including many synonyms and overlapping descriptions (for full list of synonymies see Kennedy 1974). *Penitella penita* was originally described as *Pholas penita* by Conrad in 1837. The current name was designated by Gabb in 1869 and the most common synonym seen today is *Pholadidea penita*. However, *Pholadidea* species differ from those in the genus *Penitella* by having a mesoplax that is divided longitudinally into two pieces, a feature not present in the latter genus (see *Penitella*, Kennedy 1974).

### Description

**Size:** Individuals to 70–95 mm in length and 50 mm in height (Turner 1955; Haderlie and Abbott 1980; Kozloff 1993). The illustrated specimen (from Coos Bay) is 40 mm long, 18 mm high (Fig. 1).

**Color:** White, inside and out (Haderlie and Abbott 1980; Kozloff 1993).

**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). Myoid bivalves are burrowers and borers, with long siphons and hinges with few teeth (Coan and Valentich-Scott 2007). Members of the Pholadidae bore into a variety of substrates, possess no pallets on siphon tips and have an anterior end that is pointed or curved with no notch (contrast to Teredinidae species, e.g. *Bankia setacea*, this guide) (see Plate 427F, 430D, Coan and Valentich-Scott 2007). While most pholad species are intertidal or subtidal, some can be found boring into wood at great depths (e.g. 7,250 meters *Xylophaga*, Kennedy 1974; Reft and Voight 2009; Voight 2009; Marshall and Spencer 2013).

**Body:**

**Color:** Foot and mantle white (Turner 1955).

**Interior:**

**Exterior:**

**Byssus:**

**Gills:**

**Shell:** Shell shape is elongate, and divided into two distinct parts (Fig. 1). Shell anterior becomes worn away from burrowing abrasion (Evans and LeMessurier 1972), the addition of new shell creates a rough and bulbous anterior (Kozloff 1993). No periostracum is present.

**Interior:** Divided into three areas by pallial lines. The pallial sinus and posterior is with a large posterior muscle scar. The anterior muscle scar and accessory are unusually dorsal and a ventral muscle scar is also present (Fig. 4). An apophysis (myophore) is a short, narrow, spoon-shaped structure of each valve, which serves as an extra muscle attachment site for powerful grinding muscles (Keen 1971) (Fig. 4). In *P. penita* it is "weakly blade-like" (Turner 1955).

**Exterior:** The shell anterior is rounded, bulbous, and with rasp-like radial and concentric striae. These heavy file-like denticulations consist of a triangular rasping section which covers less than 1/2 valve area (Fig. 1, 3) (Kozloff 1993). The posterior is wedge-shaped, with regular concentric striations only, and a truncated end. Valves gape does
Penitella penita

1. *Penitella penita* (L:40mm, W:18mm) x3: elongate shell divided into two distinct parts by umbonal-ventral sulcus; bulbous anterior with callum and rasping surface, posterior with concentric striae, truncate end; siphonoplas: heavy, brown flaps; siphons long, white, smooth.

2. Mesoplax x4.5
   a. (Dorsal view).
   b. (Ventral view).

3. (Dorsal view).

4. Interior, right valve:
   white; divided into three sections by two pallial lines; three muscle scars; apophysis: long, spoon-shaped.

5. Young (dorsal view) x3:
   no callum: foot exposed.
not extend to the middle of the shell (Penitella, Keen and Coan 1974). A callum is present in adults (but not in young (Fig. 5)) at the anterior end (Fig. 1). Umbones are not prominent and umbonal reflection (where umbones turn posterior, Fig. 1) are closely appressed for the entire length (Coan and Valentich-Scott 2007). Siphonoplax is brown, membranous, heavy, flexible flaps, and is not lined with calcareous granules (Coan and Valentich-Scott 2007).

**Hinge:** No hinge teeth or ligament present.

**Eyes:**

**Foot:** Foot atrophies in adult individuals after the callum seals the shell anterior (Haderlie and Abbott 1980).

**Siphons:** Long, white, and retractible. The tips are marked with small red spots, but not solidly, red-tipped smooth. No warts or orange chitinous patches are present. No pallets are on siphon tips (compare to Teredinidae, e.g., Bankia setacea, this guide). Inhalant siphons with six large, and several small branched cirri around aperture (Turner 1955).

**Burrow:** (for burrow shape, see Fig 1B, Evans 1968d). Burrows are pear- (Haderlie 1981b) or cone-shaped (Evans and Fisher 1966; Evans 1968d). Burrows into stiff clay, sandstone, soft rock, shale and concrete (Haderlie and Abbott 1980; Kozloff 1993), up to 15 cm below the surface (at least 3 times the shell length). Burrowing mechanism is like that of the common local pholad, Zirfaea pilsbryi (see description in this guide): The foot is sucker-like and attaches to the substrate so that the shell can rotate slowly and create a cylindrical burrow. Shell valves rock back and forth by contractions of anterior and posterior adductor muscles. Individuals rotate after each stroke, making a cylindrical burrow (Lloyd 1896; Ricketts and Calvin 1952; Haderlie and Abbott 1980). Estimated burrowing rates varied with substrate type from 50 mm/year (soft substrates) to 50 mm/12 years (hard substrates, Evans 1968b), i.e., harder rock leads to a shallower burrow (Evans 1970). In Monterey, California, Haderlie (1981a) reported boring rates of 32 mm/year (2.6 mm/month). (see also Habitat and Behavior.)

**Pholadidae-specific character**

**Mesoplax:** A small accessory plate on dorsal edge (Fig. 2) has no accessory plates (e.g., protoplax. metaplax, hypoplax) present. The mesoplax is pointed posteriorly, and truncate anteriorly, with swept back lateral wing-like projections (Turner 1955).

**Possible Misidentifications**

There are several families of burrowing clams and the Pholadidae can be distinguished by their distinctively marked body areas (Fig. 1). Members of the Teredinidae and Pholadidae can be found locally. They can be distinguished by the absence of pallets on siphon tips in the latter family as well as an anterior end that is not notched, as in the Teredinidae. The Pholadidae includes 10 species locally, within the following genera: Barnea (B. subtruncata), Chaceia (C. ovoidea), Netastoma (N. rostratum), Parapholas (P. californica), Penitella (five local species) and Zirfaea (Z. pilsbryi). The genus Zirfaea is characterized by adults that burrow into sand or mud, the absence of a callum in mature individuals, and a shell sculpture that is divided into two distinct zones (see Plates 427C, 429D, Coan and Valentich-Scott 2007). The genus Barnea, for example, also lacks a callum, but does not have these two distinct zones. All other local genera are characterized by the presence of a callum and all except Netastoma have a myophore as well. Parapholas species have shell sculpture with three distinct zones, where members of Chaceia and Pentilla have two. None of the other local burrowing clams (e.g. in the genera Hiattella, Entodesma, Barnea, Petricola, Bankia)
have distinct body areas or the bulbous, denticulated anterior of *Penitella*.

The genus closest to *Penitella*, and most likely to be confused with it, is *Zirfaea*. As mentioned above, *Penitella*’s valves are also divided into two distinct sections, but it differs in having a calcareous anterior cal- lum, or accessory plate (in the adult) as well as a posterior which gapes only at the end, not to the middle of the shell (it has no ante- rior gape) and the apophysis is narrow, not broad. No *Penitella* species have a siphon longer than its body (Evans and Fisher 1966) and all *Penitella* species have retractor siphons. There are five species of *Penitella* in our area (see Coan and Valentich-Scott 2007).

*Penitella conradi* is very small and is found in *Mytilus* or *Haliotus* (abalone) shells. It has a siphonoplax lined with coarse granu- les (*Zirfaea* has no siphonoplax) (Evans and Fisher 1966) and can bore into nephrite (Monterey, California, Wilson and Kennedy 1984). *Penitella penita* has a heavy mem- braneous siphonoplax, a calcified callum and a distinctive *mesoplax*. Its anterior ras- ping surface covers less than half the valve area (Kozloff 1974) (Fig. 1, 3). It can be up to 70 mm in length. *Penitella fitchi* also has a heavy siphonoplax, but has a callum with a gap. This is a rare species, found low in the intertidal up to 25 meters deep. *Penitella turnerae* is larger than *P. penita* (to 125 mm), and less common. It is stout, and like *Zirfaea* lacks a siphonoplax. It has a distinctive, rounded mesoplax, however, and its long, white, retractable siphons are tipped with solid red. Like *Zirfaea*, it has a strongly angled anterior ventral edge, but unlike *Zir- faea*, *P. turnerae* has a callum. *Penitella richardsoni* (=*gabbi*, Kennedy 1989) is also small (up to 75 mm) with a warty, creamy- lemon colored siphon and it is not common. It is different from the other members of this genus as its umbone reflection is not ap- pressed to the anterior end, a character also found in *C. ovoidea*. *Penitella richardsoni* differs from *C. ovoidea* by having a callum that does not gap and an more elongated shell (Coan and Valentich-Scott 2007). A new spe- cies of *Penitella, P. hopkinsi*, was described from Alaska, but it not yet reported in our area (Kennedy and Armentrout 1989). With adult specimens, it should be easy to tell *Penitella* from *Zirfaea* because the latter species has a long, non-retractable siphon and a mem- brose covering of the anterior, instead of a calcareous callum. Small shells without the callum could be young *Penitella* as well as mature *Zirfaea* and size at maturity varies greatly with environmental condition.

**Ecological Information**

**Range:** Type locality is San Diego, California (Turner 1955). Eastern Pacific distribution includes the Gulf of Alaska (e.g., Chirikof Is- land) to Pequena, Baja California. The first presence of *P. penita* in the fossil record is in the Oligocene in California (for pholad palaeo- ecology see Kennedy 1974, 1993) and fossil pholad beds can be observed at 2–15 meters above the high tide line on cliffs in Coos Bay and southward (Evans 1968d).

**Local Distribution:** Coos Bay distribution at Pigeon Point, Fossil Point, and Coos Head. Other Oregon sites include Yaquina and Ne- tarts Bays (Turner 1955).

**Habitat:** Individuals found in open coast habi- tats as well as exposed bays (Haderlie and Abbott 1980), where they bore into mud and rock and prefer northeast surfaces, where al- gae and light are reduced (similar to barnacles). The ability of *P. penita* to utilize a wide variety of substrates leads to the wide geographic distribution (Evans 1968d). Harder substrates produce individuals with heavier, less elongate shells and larger muscles (Evans and LeMessurier 1972). The substrate also affects the burrowing speed, as harder rock leads to individuals that burrow
and grow more slowly. For example, individuals in soft rock may mature (and stop burrowing) at three years, while those in harder rock may mature as late as 21 years. Such timing corresponds to burrowing speeds that are 4 (hard substrate) to 50 mm (soft substrate)/year (Haderlie and Abbott 1980). Substrate type (e.g., hard versus soft) has been shown to alter the piddock shell shape, size and hardness (Evans 1968c; Tajima and Kondo 2003). Piddock burrows have the ability, particularly when individuals are present in large numbers, of compromising the stability of shorelines throughout their lifetimes (e.g., Pholus dactylus, Barnea candida, B. parva, Pinn et al. 2005; Davidson and de Rivera 2012). The ability of *P. penita* to burrow into a variety of substrates (e.g., clay, sandstone, cement, Coan and Valentich-Scott 2007) renders it a significant species in the erosion and destruction of marine structures (e.g., jetties). For example, erosion from physical factors leads to roughly 0.5 mm substrate eroded/year while that due to erosion from *P. penita* is 12 mm/year (Fossil Point, Coos Bay, Evans 1968a).

**Salinity:** Collected at salinities of 30.

**Temperature:** Cold to temperate waters.

**Tidal Level:** Intertidal and subtidal (Evans 1967), with a broad distribution vertically, individuals are found as high as +0.6 m (Coos Bay, Evans 1968a) and as low as -91 m (Kofoid and Miller 1927).

**Associates:** Other nestling and burrowing invertebrates utilize the burrows of *Penitella penita* (e.g. polychaetes Thelepus, Halosydna, clams Hiatella, Entodesma, Zirfaea, Coos Bay, Table 2, Evans 1967).

**Abundance:** Often co-occurs with other pholads (e.g., Zirfaea pilsbryi, Penitella spp., Netastoma rostratum) (Haderlie 1979). In Oregon, *Penitella penita* accounted for up to 90% of all boring species in the low intertidal and has been called the most common and widely distributed rock boring clam in the eastern Pacific (Evans 1968d). However, in California, *P. penita* was less abundant than the congeners, *P. conradi* and *P. richardsoni* (Haderlie and Abbott 1980). Fossil records (El Rosario, Baja California) suggest densities as high as 200 individuals/m² (Ledesma-Vazquez and Johnson 1994).

**Life-History Information**

**Reproduction:** Reproductive strategies are variable among the Pholadidae (e.g., reproduction in *Barnea candida* includes hermaphroditic, dioecious, oviparous and larviparous, Evans 1970). *Penitella penita* is dioecious and oviparous. Sexual maturity is postponed until growth stops (Evans 1970), as individuals become sexually mature once callum is formed and their foot atrophies (Haderlie and Abbott 1980). Gonad morphology in mature individuals suggests gamete development in February, ripe gametes in June and spawning in July (Fossil Point, Coos Bay, Evans 1970). The development of *P. penita* has not yet been described. Boyle and Turner (1976) described the reproduction and development of the east coast pholad, *Martesia striata*. This species spawns in February and eggs are translucent white and 45–46.8 µm in diameter (33°C, Turner and Johnson 1968; 21°C, Boyle and Turner 1976).

**Larva:** Bivalve development, including members of the Pholadidae, generally proceeds from external fertilization via broadcast spawning through a ciliated trochophore stage to a veliger larva. However, in the deep water pholad genus, Xylophaga, species brood larvae until late veliger stages (Kennedy 1974; Voight 2009). 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.) Larvae of *P. penita* are free swimming with a pelagic duration of two weeks (Haderlie and Abbott 1980) with peaks in settlement occurring from August to September (Evans 1970). The development of other pholads (e.g. *Barnea truncata*, Chanley 1965; *Cyrtopleura costata*, Chanley and Andrews 1971; *Martesia striata*, Boyle and Turber 1976) proceeds as planktotrophic veliger larvae. After 24 hours, *M. striata* larvae are straight hinge veligers (68 µm in length and 59 µm in height, Boyle and Turner 1976). After eight days, they are umbo larvae (129–224 µm) and they are pediveligers by 28–32 days (224–236 µm) post fertilization. Metamorphosis in *M. striata* occurs after 48–53 days (see Table 1, Figure 1, Boyle and Turner 1976). (see also Campos and Ramorino 1990 for planktonic pholad larvae from Chile).

**Juvenile:** Average time to maturity is 33 months and metamorphosis is marked by the resorption of the foot (Evans 1968a, 1970). This species is unusual in having determinate growth where, at about three years, individuals metamorphoses into non-boring adults (about 55 mm in length). Crowding may induce early metamorphosis (Evans 1968d). Anterior end of juveniles is soft (without callum), while animal is actively burrowing. Exposed foot is circular and has developed as a suction disc (Fig. 5).

**Longevity:** Lives until substrate surrounding the burrow erodes enough to make it subject to predators. Longevity is thus dependent on erosion rate and varies with rock hardness (Haderlie and Abbott 1980). At Fossil Point, erosion process takes about six years following metamorphosis (nine years total lifespan, Evans 1970).

**Growth Rate:** Once they settle, growth proceeds at a rate of 22 growth bands/year (Haderlie and Abbott 1980). Growth occurs in two distinct phases: the first where individuals are actively boring and growing, and the second where both boring and growth stops (Evans 1970).

**Food:** A suspension feeder, *P. penita* uses long siphons and gills to filter food.

**Predators:** Flatworms *Stylochoplana, Notoplanina inquieta*, where worms enter the shell, eat the flesh, and lay eggs (Evans 1967). Additionally, interference from *Botula californiensis*, which settles on the burrow entrance may lead to the death of *P. penita* individuals (Evans 1967). Other invertebrates predators include *Ceratostoma foliatum, Roperia poulsoni* (Haderlie and Abbott 1980).

**Behavior:** Pholads are the most efficient burrowers of the seven families of rock-boring bivalves (Evans 1968a). Grinding is assisted by keeping algae out of burrow with sea water, by loosening rock grains, and by ciliary currents which flush out cavity (Keen 1971). The callum shape is determined by the contours of the burrow and, in artificial burrows, the callum can be rather square (versus pear-shaped, Haderlie 1981b).

**Bibliography**

marine invertebrates of the Pacific Northwest. A. Shanks (ed.). Oregon State University Press, Corvallis, OR.


39. VOIGHT, J. R. 2009. Diversity and reproduction of near-shore vs offshore wood-


Updated 2015

T.C. Hiebert