Siliqua patula

The flat razor clam

Phylum: Mollusca

Class: Bivalvia, Heterodonta, Euheterodonta

Order: Imparidentia, Adapedonta

Family: Solenoidea, Pharidae, Siliquinae

Taxonomy: The familial designation of this species has changed frequently over time. Previously in the Solenidae, current intertidal guides include *S. patula* in the Pharidae (e.g., Coan and Valentich-Scott 2007). The superfamily Solenacea includes infaunal soft bottom dwelling bivalves and contains the two families: Solenidae and Pharidae (= Cultellidae, von Cosel 1993) (Remacha-Trivino and Anadon 2006). In 1788, Dixon described *S. patula* from specimens collected in Alaska (see **Range**) and Conrad described the same species, under the name *Solen nuttallii* from specimens collected in the Columbia River in 1838 (Weymouth et al. 1926). These names were later synonymized, thus known synonyms for *Siliqua patula* include *Solen nuttallii*, *Solecurtus nuttallii*. Occasionally, researchers also indicate a subspecific epithet (e.g., *Siliqua siliqua patula*) or variations (e.g., *Siliqua patula* var. *nuttallii*, based on rib morphology, see **Possible Misidentifications**) (Oldroyd 1924).

Description

Size: Individuals up to 190 mm (Haderlie and Abbott 1980; Coan and Valentich-Scott 2007), with average size adults over 40 mm (Coan and Carlton 1975).

Color: Periostracum is smooth, brown, shiny, and lacquer-like (Ricketts and Calvin 1952). The shell exterior is white, obscurely rayed, with faint violet coloration and the interior is also white, but tinged with violet and pink (Haderlie and Abbott 1980).

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). Solenid and pharid bivalves are burrowers and some species are quite fast (e.g., *Siliqua patula*, see description in this guide). They have shells that are longer than wide and often razor-like at the opening edge (see Plate 397G, Coan and Valentich-Scott 2007).

Body: (see Plate 29 Ricketts and Calvin 1952; Fig 259 Kozloff 1993).

Color:

Interior: (see Fig 5, Pohlo 1963).

Exterior:

Byssus:

Gills:

Shell: The shell in *S. patula* is thin and with sharp (i.e., razor-like) edges and a thin profile (Fig. 4). Thin, long, fragile shell (Ricketts and Calvin 1952), with gapes at both ends (Haderlie and Abbott 1980). Shell smooth inside and out (Dixon 1789), elongate, rather cylindrical and the length is about 2.5 times the width.

Interior: Prominent internal vertical rib extending from beak to margin (Haderlie and Abbott 1980).

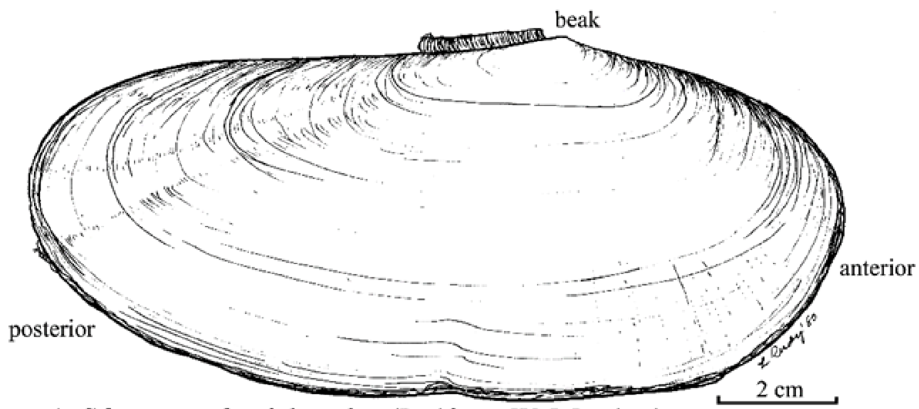
Exterior: Both valves are similar and gape at both ends. The beaks are subcentral and toward anterior end, and the posterior end is round.

Hinge: The hinge ligament is completely external, and not seated on a nymph (Fig. 2). The left valve is with four cardinal teeth, while the right valve is with two (Fig. 2). A vertical or radial rib projects downward and anteriorly from hinge in both valves (*Siliqua,* Keen and Coan 1974) (Fig. 2).

Eyes:

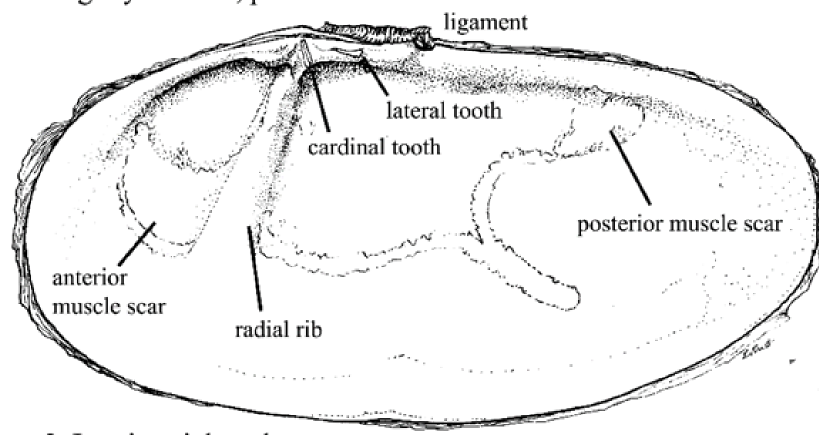
Foot: The foot in *S. patula* projects to a length

Siliqua patula

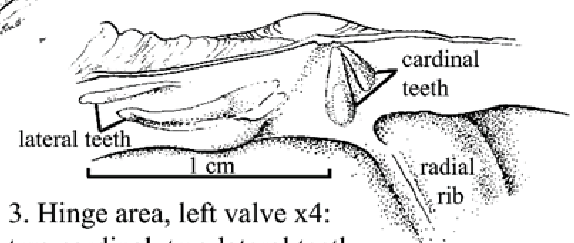


1. *Siliqua patula*, right valve (L: 13cm, W:5.5cm) x1:
length 2.5x width; shell cylindrical, shiny, brown; beaks subcentral, slightly anterior; posterior rounded.

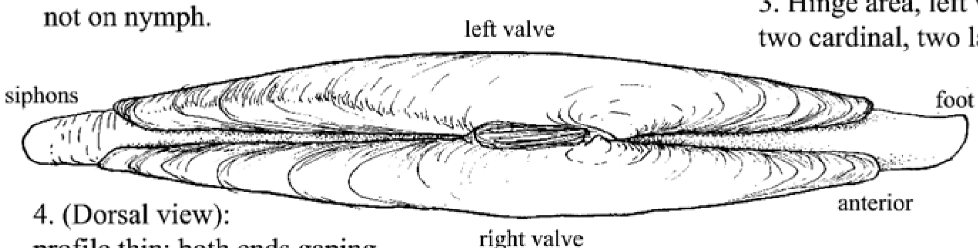
1a. *Malacobdella grossa* x2:
actural size 2.5 cm, commensal nemertean (Smith & Carlton, 1975).



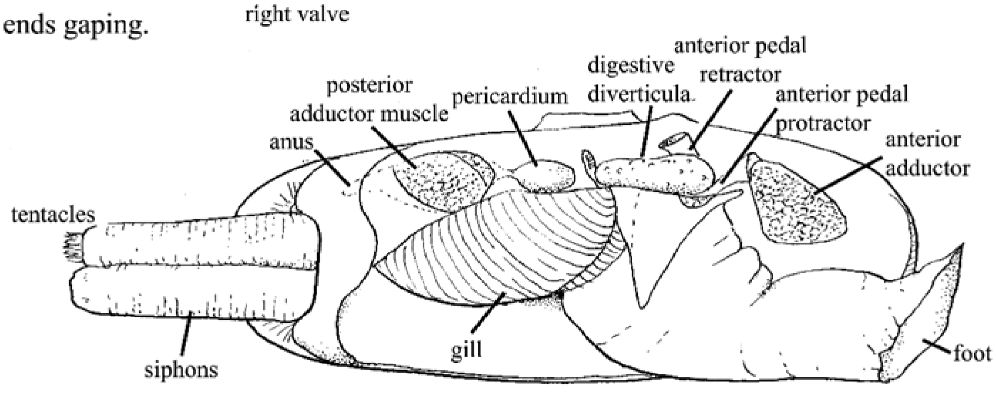
2. Interior, right valve:
one cardinal tooth, one lateral tooth; prominent radial rib; ligament external, not on nymph.



3. Hinge area, left valve x4:
two cardinal, two lateral teeth.



4. (Dorsal view):
profile thin; both ends gaping.



5. Dissection, right valve removed
(Pohlo, 1963).

Hiebert, T.C. 2015. *Siliqua patula. 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.

that is one half the total shell length and has a muscular flap (Haderlie and Abbott 1980). It aids in digging by anchoring within the sediment and contracting such that the body is pulled downward (Ricketts and Calvin 1952) (see **Burrow** and **Behavior**).

Siphons: Siphons are short and fused at the tips, except at the very end (Haderlie and Abbott 1980) (Fig. 4). The exhalant and inhalant openings are ringed by tentacles.

Burrow: A fast burrower, *S. patula* uses its **foot** to anchor and muscular contractions to pull body downward. Individuals can completely bury itself within seven seconds (Ricketts and Calvin 1952) and the burrowing speed allows them to avoid the reach of many clam diggers. Burrowing behavior leaves a slight dimple in the sand at the surface (not unlike a thumb imprint). There is no permanent burrow, unlike the similar species *Solen sicarius* (see description in this guide) (Haderlie and Abbott 1980). Individuals orient vertically within the sediment (see Fig 3, Pohlo 1963; Haderlie and Abbott 1980).

Possible Misidentifications

Solenidae and Pharidae are two razor clam families represented locally and pharid genera were recently placed in the former family (see previous editions of this guide). They are both characterized by cylindrical shells that are about 2.5 times as long as high and gape at both ends. They have no dorsal margin ears (compare to Pectinidae, see Plate 394E, Coan and Valentich-Scott 2007), a hinge with ligament that is entirely external and dorsal, equally shaped adductor muscle scars (compare to *Mytilus trossulus*, this guide), and shells that do not have prominent radial sculpturing (Coan and Valentich-Scott 2007). The difference between the two families is that members of the Pharidae have one shell valve with two cardinal teeth and the other with four, while the Solenidae have a single cardinal tooth on each shell valve (Coan and Valentich-Scott 2007). Other local razor-shaped clams besides the Solenidae such as the Mytiiidae include some genera (e.g. *Adula*) which are also long and cylindrical. *Adula* (see *A. californiensis*, this guide) are usually a boring species, however, having hairy posterodorsal slopes, a very small anterior adductor scar, and no hinge teeth (Coan and Valentich-Scott 2007). Hiatellidae, including the geoduck, *Panopea generosa* have large, quadrate, gaping bivalves, without hinge teeth, and with nearly equal adductor muscle scars (Keen and Coan 1974).

Four species are reported locally in the Pharidae. *Siliqua patula* has an internal rib that slopes anteriorly, a wide and tapering posterior end. *Siliqua lucida* is smaller than *S. patula* (< 55 mm in length) and has an internal rib that is vertical and narrow and a posterior end that is truncate. It has been suggested that *S. lucida* are simply young *S. patula* individuals (Hertlein 1961), but this is not yet known. *Siliqua lucida* lives in protected bay sands and has concentric brown bands on its exterior. Although variations in *S. patula* have been synonymized, occasionally readers will find references to *S. patula* var. *nuttallii*, which is more oval shape, with purple beaks and four hinge teeth in the left valve, not two (Oldroyd 1924). *Ensis myrae* and *Siliqua altra* are offshore species and *E. myrae* is has a shell that is long and thin.

Only two species, in the genus *Solen*, are reported locally in the Solenidae, they have an almost straight dorsal margin, a terminal beak, and one cardinal tooth in each valve (Keen 1971). *Solen rostiformis* (= *S. rosaceus,* but see Pohlo 1963; von Cosel 1992) has a thin shell that tapers and a periostracum that is lighter than *S. sicarius*; it is light olive green to brown in color. *Solen rostiformis* is a pink shelled clam and its siphons are annulated (and it can regenerate them when disturbed, Pohlo 1963). It lives in sandier situations than does *S. sicarius* (Coan and Carlton 1975). *Solen sicarius*, on the other hand, has a thick shell, a blunt posterior ('the blunt razor shell') and a dark brown periostracum. *Solen sicarius* is found occasionally in permanent burrows in mud or muddy sand (Kozloff 1974) and is the species most likely to be confused with *Siliqua patula*. It lacks an interior vertical rib and multiple hinge teeth, and is four times as long as wide, not 2.5 times, as in *S. patula* (Keen and Coan 1974). Furthermore, the profile in *S. patula* is much more oval, and not as cylindrical as in *Solen sicarius.*

One long, cylindrical bivalve of the family Solecurtidae, *Tagelus californianus*, the jackknife clam, could be confused with *Siliqua patula*. It too has nearly central beaks, is about 2.5 times as long as wide, and gapes at both ends. It never has the internal strengthening rib of *S. patula*, however, and its ligament is seated on a nymph or projection (as in *Protothaca staminea*, see plate). *Tagelus californianus* is gray, has no lateral teeth, and has short siphons (Coan and Carlton 1975). It is found below Humboldt Bay, California, in mudflats.

Ecological Information

Range: *Siliqua patula* was described from individuals collected near Coal Harbor, Cook Inlet, Alaska (Weymouth et al. 1926). Known range includes Aleutian Islands to Pismo Beach, California, but individuals are uncommon in California (Weymouth et al. 1931).

Local Distribution: Coos Bay distribution at Pt. Adams spit near the mouth of the bay and usually on open coast. This species is more common in coastal regions with long stretches of wide sandy beaches (e.g., Seaside, OR, Connolly 1995).

Habitat: Flat, open beaches with fine, clean sand in strong surf zone with aeration (Anonymous 1968; Haderlie and Abbott 1980). This niche is occupied further south by the Pismo clam, *Trivela stultorum* (Ricketts and Calvin 1971).

Salinity: Collected at salinities of 30 or more, in full strength seawater.

Temperature: Lives in cold to temperate waters.

Tidal Level: Low intertidal to shallow subtidal (Haderlie and Abbott 1980), about - 0.3 meters and lower (Kozloff 1993).

Associates: Known associates include the olive snail, *Olivella biplicata*, caprellid amphipods, and polychaetes (e.g., *Ophelia*). The commensal nemertean, *Malacobdella grossa,* occurs in up to 80% of the clams (Fig. 1a) (Ricketts and Calvin 1952; Haderlie and Abbott 1980). These nemerteans are found attached to the clam's gills with their posterior sucker and they feed on planktonic organisms in the water that is passed over the gill surface; there is believed to be no harmful effect (Ricketts and Calvin 1952; Kozloff 1991).

Abundance: Populations can be very abundant in certain locals, but they move and fluctuate, which may be due to sand movement from storms and surf. Densest groups occur near mean low water (Anonymous 1968). Up to 10,123 clams/m^2 were reported in British Columbia, Canada (see Table 6, Bourne and Quayle).

Life-History Information

Reproduction: Separate sexes with broadcast spawning and external fertilization. Females produce 6–10 million eggs. In Washington, all individuals spawn suddenly and simultaneously near the end of May or early June, when water temperatures rise (e.g., 13˚C, Fraser 1936; Ricketts and Calvin 1952; Haderlie and Abbott 1980). However, spawning is not sudden or simultaneous in Alaska or British Columbia, Canada, where spawning occurs from July to August (Ricketts and Calvin 1952; Bourne and Quayle 1970; Breese and Robinson 1981, Lassuy and Simons 1989. Sperm morphology appears to characterize many veneroid taxa (see Fig. 2, Healy 1995).

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. 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.) Swimming larval duration is up to eight weeks (Ricketts and Calvin 1952; Haderlie and Abbott 1980). Larvae of *Siliqua patula* are free swimming, but they often stay close to sediment surface (Haderlie and Abbott 1980). After metamorphosis, individuals are the size of wheat grain or smaller and reach to 1.5 cm by end of the "growing season" in December (Washington, Anonymous 1968).

Juvenile: Juveniles have an oval shell outline until they are about 2.5 mm in length (Pohlo 1963). Individuals are with central beak, but not elongate (see Fig. 6, Pohlo 1963). Eighty-six percent of third year clams (approximately 10 cm in length) are sexually mature or maturing (Queen Charlotte Island, Fraser 1936). In British Columbia, clams reached 90 mm by about 1.5–3 years old (Bourne and Quayle 1970).

Longevity: 12 (Washington) to 19 years of age (Alaska) (Ricketts and Calvin 1952; Haderlie and Abbott 1980); little growth is seen after 15 years (Alaska, Haderlie and Abbott 1980). The largest individuals in California were nine years old (Haderlie and Abbott 1980). Mortality is high among young individuals (reaching up to 99%), with greatest losses after major storms (Anonymous 1968).

Growth Rate: Growth can be measured by annual shell rings; growing seasons show as wide brown areas between rings. Growth proceeds as follows: 20 mm in first year, 130 mm after 5 years, and 160 mm after 13 years (Haderlie and Abbott 1980). Individuals reach 11.5 cm in length by approximately 3.5 years (Washington). Washington and California (e.g., Pismo) individuals grow rapidly, but do not reach as large a size or live as long as they do in Alaska (Chignik Bay, Weymouth et al. 1926; Ricketts and Calvin 1952). Growth rates tend to slow after 10 cm sizes are reached (Weymouth and McMillin 1931). Winter shell lengths were measured in Long Beach, British Columbia, Canada and were 37mm, 91mm, 112.5 mm, 123 mm, and 131mm in years 1–5, respectively (Bourne and Quayle 1970).

Food: A filter feeder of planktonic diatoms. *Siliqua patula* concentrates phytoplankton and, at the same time, concentrates some species that are associated with harmful algal blooms (e.g., *Pseudo-nitzschia*). Toxins (domioc acid) within their tissues can be dangerous if ingested by humans (Horner et al. 1997; Dortch et al. 1997; Kumar et al. 2009; Chadsey et al. 2012).

Predators: *Siliqua patula* is probably the most highly prized food mollusk in the northwest, thus this species has been extensively harvested both recreationally and commercially. Unrestricted in 1925, harvesting severely harmed populations (Weymouth and McMillin 1931) and lead to a downward trend. In 1976, Oregon total harvest was 2,211,000 clams (Link 1977). Additional predators include seagulls, ducks, perch, crab, and fish (e.g. Starry flounder) (Anonymous 1968; Haderlie and Abbott 1980). Interestingly, DNA sequence data revealed that razor clam species in the commercially harvested genus *Ensis* are often mislabeled as congeneric cryptic species with sympatric distributions (Esperina et al. 2009; Vierna et al. 2013).

Behavior: *Siliqua patula* is known for its quick, efficient digging (see **Burrow**). Individuals move especially rapidly in the second or "slosh" layer of sand (Anonymous 1968). Digging is accomplished by the ability of the anchor-shaped foot to change shape. Extraordinary muscle capacity and the displacement of body fluids are responsible for this (Pohlo 1963; Kozloff 1993). Digging is vertical, and is sometimes angled toward the sea with very little horizontal movement. Individuals 3 to 8 cms in length bury themselves within 7 and 27 seconds, respectively (Pohlo 1963).

Bibliography

1. ADAMS, N. G., M. LESOING, and V. L. TRAINER. 2000. Environmental conditions associated with domoic acid in razor clams on the Washington coast. Journal of Shellfish Research. 19:1007-1015.
2. ANONYMOUS. 1968. Invertebrate fisheries, p. 35-49. Department of Fish and Wildlife, Oregon State University, Corvallis, OR.
3. BISHOP, J. A. 2000. A record size for the razor clam *Siliqua patula*. Festivus. 32:77-78.
4. BOURNE, N. 1979. Razor clam, *Siliqua patula* Dixon, breeding and recruitment at Masset, British Columbia. Proceedings of the National Shellfisheries Association. 69:21-29.
5. BOURNE, N., and D. B. QUAYLE. 1970. Breeding and growth of razor clams in British Columbia. Technical Report of the Fisheries Research Board of Canada. No. 232:1-42.
6. BREESE, W. P., and A. ROBINSON. 1981. Razor clams, *Silqua patula* (Dixon): gonadal development, induced spawning and larval rearing. Aquaculture. 22:27-33.
7. BRINK, L. A. 2001. Mollusca: Bivalvia, p. 129-149. *In:* Identification guide to larval marine invertebrates of the Pacific Northwest. A. Shanks (ed.). Oregon State University Press, Corvallis, OR.
8. CHADSEY, M., V. L. TRAINER, and T. M. LESCHINE. 2012. Cooperation of science and management for harmful algal blooms: domoic acid and the Washington coast razor clam fishery. Coastal Management. 40:33-54.
9. COAN, E. V., and P. VALENTICH-SCOTT. 2007. Bivalvia, p. 807-859. *In:* The Light and Smith manual: intertidal invertebrates from central California to Oregon. J. T. Carlton (ed.). University of California Press, Berkeley, CA.
10. CONNOLLY, T. J. 1995. Archaeological evidence for a former bay at Seaside, Oregon. Quaternary Research. 43:362-369.
11. DIXON, G. 1789. A voyage around the world. George Goulding, London.
12. DORTCH, Q., R. ROBICHAUX, S. POOL, D. MILSTED, G. MIRE, N. N. RABALAIS, T. M. SONIAT, G. A. FRYXELL, R. E. TURNER, and M. L. PARSONS. 1997. Abundance and vertical flux of *Pseudo-nitzschia* in the northern Gulf of Mexico. Marine Ecology Progress Series. 146:249-264.
13. DRUM, A. S., T. L. SIEBENS, E. A. CRECELIUS, and R. A. ELSTON. 1993. Domoic acid in the Pacific razor clam, *Silqua*

patula (Dixon, 1789). Journal of Shellfish Research. 12:443-450.

14. ELSTON, R. A., and M. G. PEACOCK. 1984. A Rickettsiales-like infection in the Pacific razor clam, *Silqua patula*. Journal of Invertebrate Pathology. 44:84-96.
15. ESPINEIRA, M., J. M. VIEITES, and F. J. SANTACLARA. 2009. Development of a method for the genetic identification of commercial bivalve species based on mitochondrial 18S rRNA sequences. Journal of Agricultural and Food Chemistry. 57:495-502.
16. HADERLIE, E. C., and D. P. ABBOTT. 1980. Bivalvia: the clams and allies, p. 355-410. *In:* Intertidal invertebrates of California. R. H. Morris, D. P. Abbott, and E. C. Haderlie (eds.). Stanford University Press, California.
17. HEALY, J. M. 1995. Comparative spermatozoal ultrastructure and its taxonomic and phylogenetic significance in the bivalve order Veneroida. Memoires du Museum National d'Histoire Naturelle. 166:155-166.
18. HERTLEIN, L. G. 1961. A new species of *Siliqua* (Pelecypoda) from western North America. Bulletin of the Southern California Academy of Sciences. 60:12-19.
19. HIRSCHHORN, G. 1962. Growth and mortality rates of the razor clam (*Siliqua patula*) on Clatsop Beaches, Oregon. Contributions Oregon Fish Commission. No. 27:1-55.
20. HORNER, R. A., D. L. GARRISON, and F. G. PLUMLEY. 1997. Harmful algal blooms and red tide problems on the US west coast. Limnology and Oceanography. 42:1076-1088.
21. HORNER, R. A., and J. R. POSTEL. 1993. Toxic diatoms in western Washington waters (US west coast). Hydrobiologia. 269:197-205.
22. KABAT, A. R., and D. O'FOIGHIL. 1987. Phylum Mollusca, Class Bivalvia, p. 309-353. *In:* Reproduction and development of marine invertebrates of the northern Pacific Coast. M. F. Strathmann (ed.). University of Washington Press, Seattle, WA.
23. KEEN, A. M. 1971. Sea shells of tropical west America: marine mollusks from Baja California to Peru. Stanford University Press, Stanford, CA.
24. KEEN, A. M., and E. COAN. 1974. Marine molluscan genera of western North America: an illustrated key. Stanford University Press, Stanford, CA.
25. KOZLOFF, E. N. 1993. Seashore life of the northern Pacific coast: an illustrated guide to northern California, Oregon, Washington, and British Columbia. University of Washington Press, Seattle.
26. KUMAR, K. P., S. P. KUMAR, and G. A. NAIR. 2009. Risk assessment of the amnesic shellfish poison, domoic acid, on animals and humans. Journal of Environmental Biology. 30:319-325.
27. LASSUY, D. R., and D. SIMONS. 1989. Species profiles, life histories and environmental requirements of coastal fish and invertebrates: Pacific Northwest. Pacific razor clam. US Fish and Wildlife Service Biological Report. 82:I-VI, 1-16.
28. LECLAIR, L. L., and S. R. PHELPS. 1994. Genetic characteristics and relationships of five razor clam (*Silqua patula,* Dixon) populations along the Pacific coast of North America. Journal of Shellfish Research. 13:207-216.
29. MCLACHLAN, A., J. E. DUGAN, O. DEFEO, A. D. ANSELL, D. M. HUBBARD, E. JARAMILLO, and P. E. PENCHASZADEH. 1996. Beach clam fisheries. Oceanography and Marine Biology. 34:163-232.
30. OLDROYD, I. S. 1924. Marine shells of Puget Sound and vicinity. University of Washington Press, Seattle.
31. POHLO, R. H. 1963. Morphology and mode of burrowing in *Siliqua patula* and *Solen rosaceus* (Mollusca: Bivalvia). Veli-

ger. 6:98-104.
32. RICKETTS, E. F., and J. CALVIN. 1952. Between Pacific tides : an account of the habits and habitats of some five hundred of the common, conspicuous seashore invertebrates of the Pacific Coast between Sitka, Alaska, and Northern Mexico. Stanford : Stanford University Press, Stanford.
33. TAYLOR, C. C. 1959. Temperature and growth: the Pacific razor clam. Journal du Conseil. 25:93-101.
34. VIERNA, J., J. CUPERUS, A. MARTINEZ-LAGE, J. M. JANSEN, A. PERINA, H. VAN PELT, and A. M. GONZALEZ-TIZON. 2014. Species delimitation and DNA barcoding of Atlantic *Ensis* (Bivalvia, Pharidae). Zoologica Scripta. 43:161-171.
35. VON COSEL, R. 1992. *Solen rosaceus*: three species. Veliger. 35:366-380.
36. WEKELL, J. C., E. J. GAUGLITZ, JR., H. J. BARNETT, C. L. HATFIELD, D. SIMONS, and D. AYRES. 1994. Occurrence of domoic acid in Washington State razor clams (Siliqua patula) during 1991-1993. Natural Toxins. 2:197-205.
37. WEYMOUTH, F. W., and H. C. MCMILLIN. 1931. The relative growth and mortality of the Pacific razor clam (*Siliqua patula* Dixon), and their bearing on the commercial Fishery. Bulletin, Fishery Bulletin. 46:543-567.
38. WEYMOUTH, F. W., H. C. MCMILLIN, and H. B. HOLMES. 1926. Growth and age at maturity of the Pacific razor clam, *Siliqua patula* (Dixon). Fishery Bulletin. 41:201-236.
39. WEYMOUTH, F. W., H. C. MCMILLIN, and W. A. RICH. 1931. Latitude and relative growth in the razor clam *Siliqua patula*. Journal of Experimental Biology. 8:228-249.

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