

SPECIES FACT SHEET

Species Common Name: Pacific walker
Species Scientific Name: *Pomatiopsis californica* (Pilsbry, 1899)
Phylum: Mollusca
Class: Gastropoda
Order: Mesogastropoda
Superfamily: Rissosoidea
Family: Pomatiopsidae
Subfamily: Pomatiopsinae

Taxonomic Note:

This species has been synonymized with *P. chacei* by Taylor (1981) and other authors; however, the two species are recognized as distinct by more recent treatments, including Turgeon *et al.* 1998, the currently accepted authority on mollusk nomenclature. The basis of separation of these two species appears to be mostly based on shell color (Burch 1982 and Frest and Johannes 1999). Frest and Johannes (1999) do describe *P. chacei* as “more slender (than *P. californica*), with microscopic spiral striations, most visible on the last whorl”.

Conservation Status:

Global Status (2000): G1
National Status (2000): N1
State Status: Oregon: S1, California: S1
(NatureServe 2015)

Technical Description:

Pomatiopsis is a genus of very small, semi-aquatic freshwater snails in the family Pomatiopsidae. The Pomatiopsidae family is composed of freshwater (and a few marine) species characterized by the following features: shell coiled; shell with raised spire; shell dextral; shell without teeth on parietal wall; operculum and gills present; operculum multispiral or paucispiral, outer margins not concentric; adults less than 7 mm; males possessing verge (penis) behind right tentacle; head-foot region divided on each side by longitudinal groove; eyes in prominent swellings on the outer bases of the tentacles; amphibious or terrestrial; crawls with step-like movement (Brown 2001). Two genera in this family occur in North America, the saltwater genus *Cecina* (1 species) and the freshwater genus *Pomatiopsis* (4 species) (Kameda & Kato 2011). Members of the *Pomatiopsis* genus are described as having the shell elongate and the spire (of about six whorls) much exceeding the length of the aperture (Tyron 1862).

The Pacific Walker has a shell moderately high, conical, and perforate, with 6-7 deeply and evenly convex whorls; length 4 mm, aperture thin, definitely adnate; shell rather thin with chestnut brown color (Frest & Johannes 2000).

Life History:

Very little is known about the reproduction, oviposition, growth, life span, dispersal, or feeding habits of *P. californica*. However, the biology of this species is probably similar to that of *P. cincinnatiensis* and *P. lapidaria* from eastern North America, both of which are relatively common and well-studied [largely on account of their relatedness to *Oncomelania* and other Pomatiopsidae genera known to serve as intermediate hosts of schistosomes (parasitic flatworms) in Asia] (Schalie & Dundee 1955). As such, the following paragraphs report primarily on the life history of *P. cincinnatiensis* and *P. lapidaria*.

Similar to most of its aquatic relatives, the *Pomatiopsis* genus exhibits separate sexes with both male and female individuals. The male-female sex ratio seen in wild populations of *P. lapidaria* is reported to be roughly 1 to 3 (Dundee 1957). *Pomatiopsis* females are oviparous (producing eggs that hatch outside the body). The reproductive period of this genus appears to occur twice per year; *P. cincinnatiensis* copulates in spring and again in fall, with fewer mating pairs seen throughout the warm (summer) season. Similarly, *P. lapidaria* begins mating and egg laying soon after it becomes active in the spring, and copulating pairs are seen from March to early July and again from September to October (Dundee 1957). In *P. lapidaria*, males appear to contain mature sperm during all seasons of the year, whereas females seem to have mature ova only during the warm seasons. Mating in *P. lapidaria* occurs during the day and at night, and may last from 2 to 10 hours. Copulating pairs of this species have been documented on flat mud surfaces, rough slopes, fallen vegetation, and similar habitats, but never in water (Dundee 1957).

Eggs of *P. lapidaria* and *P. cincinnatiensis* are laid singly (rarely paired) on the soil surface or partially buried in soil (Dundee 1957; Schalie & Walter 1957). The soil where eggs are laid is generally damp and/or near to water. Moisture levels and density of vegetation appear to be important variables in egg distribution in these species (Dundee 1957; Schalie & Walter 1957). The oviposition process of *P. cincinnatiensis* is described by van der Schalie & Walter (1957) in great detail, including the following steps: searching for an acceptable site using probing action of the proboscis and foot; digging a groove in the soil; depositing the egg; and leaving the egg. The egg is initially clean and transparent, but the outer egg membrane is very adhesive so that a dirty film quickly forms and a husk of particles tightly adheres to it, rendering it very difficult to detect in its environment (van der Schalie & Walter 1957). The number of eggs laid by *Pomatiopsis* females is not well known; in captivity, *P. lapidaria* females have been found to lay twenty-six to forty-two eggs. Eggs of this species are laid from mid-March to mid-May, and again in late August. The egg incubation period of *P. lapidaria* and *P. cincinnatiensis* ranges from four to seven weeks in laboratory conditions at temperatures of 60 to 65 degrees F° (van der Schalie & Walter 1957; Dundee 1957). In the hatching process, the young snail rasps a hole through both the egg coat and its sand husk and then crawls out of the egg (Dundee 1957).

Newly hatched *P. lapidaria* exhibit a growth rate of about 0.1 mm per week in the laboratory and about 0.19 to 0.20 mm per week in nature (Dundee 1957). *Pomatiopsis cincinnatiensis* exhibits a faster growth rate of 0.25 mm per week under laboratory conditions (van der Schalie & Dundee 1955). In *P. cincinnatiensis* populations, large numbers of young are found in August, and some later through early fall. In *P. lapidaria* populations, some young are present throughout the year except for late July and August (Dundee 1957). Limited mark-recapture studies of *P. lapidaria* have revealed a life span of at least 2.5 years, although more observations are necessary to establish the actual life span of *P. lapidaria* (Dundee 1957).

The dietary preferences of *Pomatiopsis* are not well-reported. In general, freshwater snails in the Rissoidea superfamily graze on algae, diatoms, and/or detritus, and certain members of the Pomatiopsidae family are known to feed on the biofilm of algae that develops on the surface of stones in aquatic habitats (Attwood & Upatham 2012). In captivity, *P. cincinnatiensis* has been successfully reared on plain filter paper and on filter paper with “vegetal fragments from the habitat”, both of which were ingested with mud (van der Schalie & Walter 1957). *Pomatiopsis lapidaria* has been reared in captivity on ground rat food pellets (Dundee 1957). Efforts to rear *P. californica* in captivity have been unsuccessful (Davis 1967).

The dispersal behavior of *P. lapidaria* has been examined by Dundee (1957). In this study, movement of *P. lapidaria* colonies was restricted to periodic, short-distance shifts that were correlated with changes in moisture content of the habitat. Mark-recapture studies revealed that individuals apparently do not voluntarily move more than about six feet throughout their entire life span. Establishment of new *P. lapidaria* colonies appears to be by passive dispersal events; for example, new colonies may become established at different points along a stream bank where individuals were deposited during floods. It is noted, however, that since the snails have highly specific habitat requirements, most dispersal events are likely unsuccessful. Overall, *P. lapidaria* usually exists in small and highly localized colonies that show little tendency to spread unless the animals find the right habitat requirements (Dundee 1957).

Dundee (1957) also reports on the aestivation and hibernation patterns of *P. lapidaria*. In Michigan, there are two major dormant periods in the yearly cycle of this species, one during the cold months (November through February) and another during the hot and dry summer weather (last week of June through July). Neither period is continuous, and the snails may become temporarily active during a typical dormant period if a few days of rain occur. During winter hibernation, the snails are found lying beneath fallen vegetation, in crevices, and under objects with their opercula well inserted into the apertures of their shells. During the summer aestivation, the snails are similarly inactive, but are typically found lying on the surface of the ground (Dundee 1957).

While the collection records for *P. californica* do not present a complete picture of seasonal or annual patterns for this species, it is likely that patterns of aestivation follow those of other species in our region. As such, this species is likely inactive during periods of prolonged cold temperatures, or during hot dry periods. Since this species' habitat is relatively temperate, it is likely that it is active for much of the year. However, following the recommendations of Duncan (2003) and only looking for this species when other, more common snails are active and abundant in similar habitat is likely the best practice.

Range, Distribution, and Abundance:

The Pacific Walker is a central to southern Oregon coastal and northwest California coastal endemic with very limited range. The historic range includes the narrow coastal fog belt of the Pacific Coast, from the central Oregon coast to northern San Mateo County in California. The taxon *Pomatiopsis chacei* has been used as a synonym for this species in northern California (Taylor 1981; Frest & Johannes 2000 – see taxonomic note above).

In 1998, specimens resembling this taxon were noted by Frest from several sites in Lincoln and Tillamook Counties, all within half a mile of the coast. There is a possibility of more widespread occurrence; but searches in more interior drainages, specifically in its narrow habitat, as well as the limited nature of that habitat, suggest that the taxon will continue to be very rare and confined to the coast with very limited potential range. It is quite sporadic and scarce (Frest and Johannes 2000).

There are four known locations of this species from the central to southern Oregon coast (Johannes pers. com; Frest and Johannes 2000). One site is in the East Fork Millicoma River subwatershed in the Coos sub-basin in northern Coos County, approximately six miles from Coos Bay District BLM land, Umpqua Resource Area. The second site is near the Pacific Coast in Lane County on the Waldport Ranger District of the Siuslaw National Forest, in the Cape Creek subwatershed of the Alsea River subbasin (Duncan, N. 2008). A third location is on the south side of the Coquille River, along the Bandon – Coquille HWY, six miles east of Bandon in the Lampa Creek-Coquille River subwatershed in the Coquille sub-basin (ANSP n.d. Unknown Date). This location is not on Federal Land, but is approximately six miles from Coos Bay District BLM land, in the Umpqua Resource Area. The fourth location for this species is along Twomile Creek about 5 miles south of Bandon, OR and one mile east of HWY 101 in the Twomile Creek-Frontal Pacific Ocean subwatershed within the Sixes sub-basin. This site is not on Federal property, but approximately 2 miles from Coos Bay District BLM land, in the Myrtlewood Resource Area (Johannes pers. com.).

Forest Service/BLM lands:

Both the Forest Service and BLM have listed the Pacific Walker as a Sensitive Species in Oregon.

The Pacific Walker has been documented on one National Forest in Oregon (SIU). Because of proximity of Federal lands to known presence points, within this species' range, and the abundance of suitable, unsurveyed habitat, it is suspected to potentially occur on one additional National Forest (RRS) and two BLM Districts (CB and SA) in Oregon.

Habitat Associations:

The Pacific Walker is a riparian associate semi-aquatic snail with very specialized habitat. Frest and Johannes (2000) state that this species is characteristically found among wet leaf litter and vegetation, beside flowing or standing water in shaded situations where humidity remains high, and Davis (1967) states that this species lives on shallow mud banks and marshy seepages leading into shallow streams. However, all known records from Oregon with associated habitat descriptions are from springs and seeps. Although there are few records in Oregon, all associated springs appear to be in forested habitats. Habitat descriptions included with records of this species are as follows: very shallow spring flowing down gentle slope, spring seep with mud-cobble substrate, cobble substrate; much modified muddy spring run, and spring seep with mud-cobble substrate. Plant associations include *Rorippa* sp., *Mimulus* sp., horsetails (*Equisitum* sp.), *Lysichitum* sp. and grasses (Johannes pers com.).

Threats:

Habitat loss and alteration is the primary threat to the Pacific walker. Any activity or natural event that has the possibility to alter springs and seeps, including affects to water quantity (e.g. from groundwater withdrawal) and water quality (e.g. dissolved oxygen, temperature, sedimentation, pollution), as well as activities that alter the terrestrial habitat surrounding the springs where this species occurs can be considered a threat to this species (Johnson et al. 2013). Activities that have the potential to create disturbance include, but are not limited to, urbanization and associated coastal modification, grazing, timber harvest, diversion and ditching of springs and seeps, highway and road construction, and natural and prescribed fire (Frest & Johannes 2000; Jordan & Black 2012).

Conservation Considerations:

Inventory:

- Because this species is known from only four sites in Oregon, further documentation of its range and habitat is critical to advance our understanding of its habitat requirements in order to inform management activities.

Management:

- Protect all new and known sites from practices that would adversely affect any aspect of this species' life cycle, including timber harvest, cattle-

grazing, road construction, building construction, groundwater withdrawal and other hydrologic modifications.

Other Considerations:

- Because the springs with which this species is associated with in Oregon are within forests, management of the surrounding forests are likely important to the immediate and long-term survival of this species.
- Research suggests that in order to reduce microclimate extremes and protect gastropods, partial cuts should be favored over clearcuts, aggregated (group) retention over dispersed retention or thinning, and larger group retention over smaller group retention. In particular, harvesting with large group retention helps to maintain pre-harvest boreal gastropod assemblages and will likely conserve boreal gastropod species if used as a tool for biodiversity management (Jordan & Black 2012).
- Other members of the Pomatiopsidae family are known to be highly sensitive to silting; *e.g.*, *Neotricula aperta* grazes on the algal epilithon covering stones and therefore cannot survive in areas where sediment is depositing and preventing the growth of the algae upon which it feeds (Attwood & Upatham 2012).
- Numerous studies have found negative and long-lasting responses of gastropods to fire, including population extirpation and reductions in abundance and species richness (Jordan & Black 2012 and references therein). Small burns surrounded by unburned plots have been most successful at maintaining gastropod community structure. Although there is little information comparing gastropod responses to differences in burn severity and frequency, it is presumed that a fire regime involving low-intensity burns at infrequent fire-return intervals (>5 years) would best maintain gastropod communities (Jordan & Black 2012).

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Date: March 2015

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Date: March 2015

Final Edits by: Rob Huff, Interagency Sensitive and Special Status Species Program, FS/BLM

Date: May 2015

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Date: 30 September 2009

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January 2010

ATTACHMENTS:**(1) References****(2) List of pertinent or knowledgeable contacts****(3) Maps of Species Distribution****(4) Photographs of Species****(5) Aquatic Gastropod Survey Protocol, including specifics for this species****ATTACHMENT 1: References**

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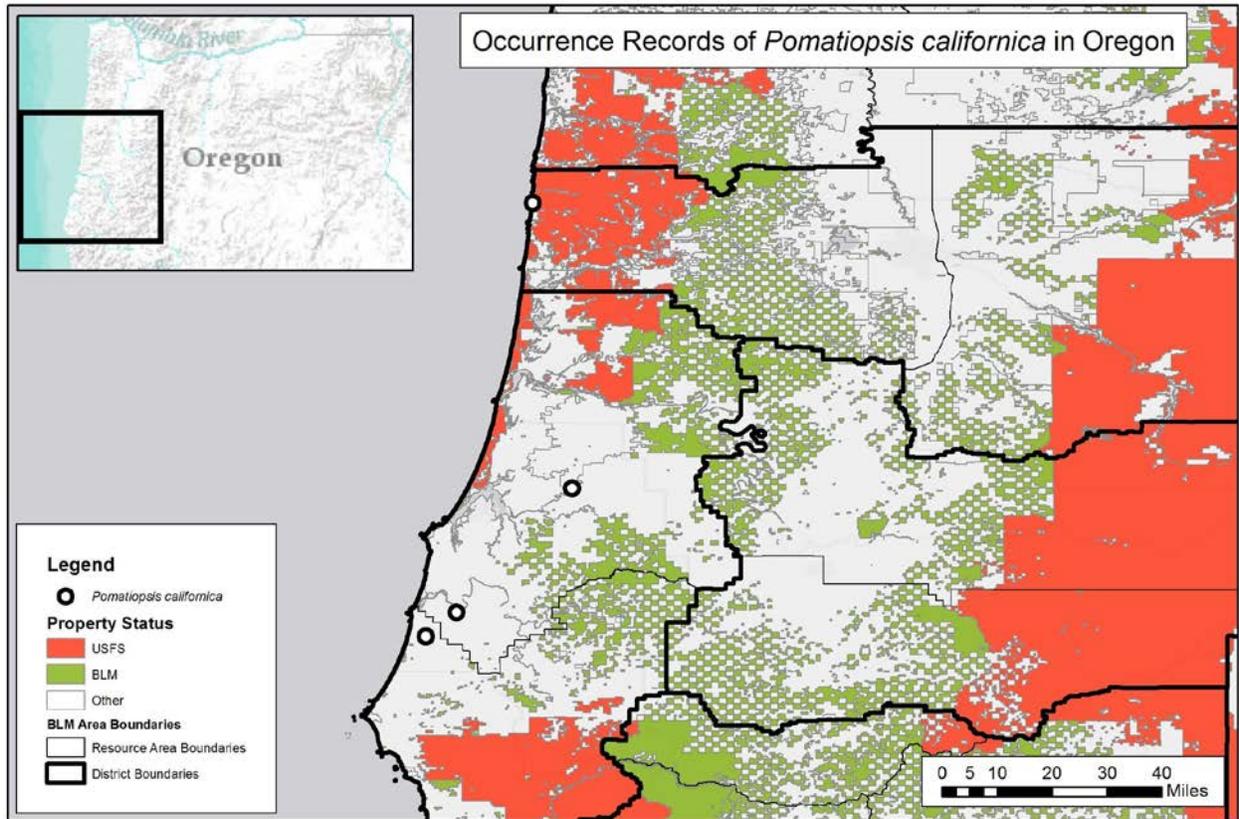
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ATTACHMENT 2: List of pertinent or knowledgeable contacts

Ed Johannes, Deixis Consultants
 Tom Burke, retired biologist, consultant

ATTACHMENT 3: Maps of Species Distribution



Map of occurrence records of the Pacific Walker (*Pomatiopsis californica*) in Oregon. The Xerces Society (2014).



Range map for *Pomatiopsis californica*. The Xerces Society (2014).

ATTACHMENT 4: Photographs of Species



Figure 1: Photographs of *Pomatiopsis californica* from The Academy of Natural Sciences, Philadelphia. Available from <http://clade.ansp.org/malacology/collections/index.html>. ANSP states that photos in this collection "may be used free of charge for purposes of research or non-commercial publication".

ATTACHMENT 5: Aquatic Gastropod Survey Protocol, including specifics for this species

Survey Protocol

Taxonomic group:

Aquatic Gastropoda

Please refer to the following documents for detailed mollusk survey methodology:

1. General collection and monitoring methods for both aquatic and terrestrial mollusks (pages 64-71):

Frest, T.J. and E.J. Johannes. 1995. Interior Columbia Basin mollusk species of special concern. Final report: Interior Columbia Basin Ecosystem Management Project, Walla Walla, WA. Contract #43-0E00-4-9112. 274 pp. plus appendices.

2. Standard survey methodology that can be used by field personnel to determine presence/absence of aquatic mollusk species in a given waterbody, and to document species locations and habitats in a consistent format:

Duncan, N. 2008. Survey Protocol for Aquatic Mollusk Species: Preliminary Inventory and Presence/Absence Sampling. Version 3.1. Portland, OR. Interagency Special Status/Sensitive Species Program. U.S. Department of Interior, Bureau of Land Management,

Oregon/Washington and U.S. Department of Agriculture, Forest Service, Region 6. 52 pp. [Available at: <http://www.fs.fed.us/r6/sfnpw/issssp/species-index/fauna-invertebrates.shtml>].

3. Pre-disturbance surveys for terrestrial mollusk species, the objective of which is to establish whether a specific mollusk is present in proposed project areas with a reasonable level of confidence, and to document known sites discovered during surveys:

Duncan, N., Burke, T., Dowlan, S. and P. Hohenlohe. 2003. Survey protocol for survey and manage terrestrial mollusk species from the Northwest Forest Plan. Version 3.0. U.S. Department of Interior, Bureau of Land Management, Oregon/Washington and U.S. Department of Agriculture, Forest Service, Region 6, U.S. Fish and Wildlife Service. 70 pp. [Available on ISSSSP intranet site].

Species-specific Survey Details:

Pomatiopsis californica

Recent survey efforts along the Oregon coast in suitable habitat did not detect this species (Jepsen et al. 2011). At present, only a small fraction of the potential habitat for *P. californica* in Oregon has been surveyed (Jepsen *et al.* 2011). Further surveys for this species are recommended at additional springs and seeps in a narrow region along the southern Oregon coast in Lincoln, Lane, Douglas, Coos and Curry counties (Johannes 2009, *pers. comm.*, Jepsen *et al.* 2011).

Habitat: Species in the *Pomatiopsis* genus are generally amphibious, living in both wet areas and habitats with drier conditions (Kameda & Kato 2011). Davis (1979) describes the genus as occurring in humid habitats, including marshy ground, the mud of streams, periodically flooded soil (*e.g.*, *P. californica* and *P. lapidaria*), and trickling water (*e.g.*, *P. binneyi*). The habitat for *P. californica* is described as among wet leaf litter and vegetation, beside flowing or standing water in shaded situations where humidity remains high (Frest and Johannes 2000) and near shallow mud banks and marshy seepages leading into shallow streams (Davis 1967).

Like many terrestrial and amphibious snails, the microhabitat preferences and activity levels of *Pomatiopsis* species are strongly affected by moisture levels. For example, *P. lapidaria* snails tend to remain hidden under the leaves on bright days but expose themselves on dull days or in shaded habitat, provided the habitat is well-saturated with moisture (*reviewed in* Dundee 1957). When habitats become too dry, amphibious snails are known to resist desiccation by crawling into crevices and wet litter (Kameda & Kato 2011).

When: Based on the activity patterns of other *Pomatiopsis* species, spring and fall surveys in wet or humid weather conditions are probably the most promising times for survey although this species may remain active for much of the year.

How: The following survey approach was used by Jepsen *et al.* (2011) for similar species:

Once survey sites and areas with key habitat features were identified, surveyors drove to the sites and stopped when a key habitat feature, such as a spring, seep, marsh, or small creek was spotted. Surveyors looked for gastropods on the undersides of rocks, dead wood and at the base of vegetation in areas with persistent high humidity. If surveyors spent 10-20 minutes at a site without finding any gastropods, then they left the site to search for a new location. GPS locations were noted with a hand held unit. When mollusks were observed, shells and live specimens were collected in vials with 70% ethanol and sent to an expert for identification.

Identification of this species is based on external shell morphology and other characters outlined and illustrated in (Brown 2001) and in this fact sheet. This species is very similar to other species within the genus [*P. binneyi* and *P. chacei* (most similar to the latter) with which it co-occurs - see Frest and Johannes (1999) for descriptions and Burch (1982) for diagrams, and the taxonomic note at the beginning of this document]. Frest and Johannes (1999) describe *P. chacei* as “more slender (than *P. californica*), with microscopic spiral striations, most visible on the last whorl”. This species is also very similar to the introduced New Zealand mud snail, *Potamopyrgus antipodarum*. The major difference is in habitat; while the New Zealand mud snail is aquatic, the Pacific walker is found in semi-aquatic environments. See Table 1 for more details. If identified specimens are needed for comparison the California Academy of Sciences holds specimens of *P. californica*. **Expert identification of this species is recommended.**

Table 1: Comparison of identification characteristics for *Pomatiopsis californica* and *Potamopyrgus antipodarum* with differences highlighted in **Bold**.

Character	<i>Pomatiopsis californica</i>	<i>Potamopyrgus antipodarum</i>
Size	4 mm	Average 5 mm
Operculum	Yes	Yes- thin and corneous with an off-center nucleus from which paucispiral markings (with few coils) radiate.

Aperture	aperture thin, definitely adnate	Oval; its height is less than the height of the spire
shell shape	Moderately high conical	elongated
shell features	Shell rather thin	Some morphs exhibit periostracal ornamentation such as spines for anti-predator defense
coiling direction	Dextral	Dextral
Whorls	6-7 deeply and evenly convex whorls	7-8 whorls with deep grooves between whorls
Color	Chestnut brown	Varies from gray to dark brown to light brown
Gilled	Yes	Yes
Key to family	<p>Order Prosobranchia; Family Pomatiopsidae; Genus Pomatiopsis (key to family only):</p> <p>Shell coiled; Shell with raised spire; Shell dextral; Shell without teeth on parietal wall, operculum and gills present; Operculum multispiral or paucispiral, outer margins not concentric; Adults less than 7 mm; Males possess verge (penis) behind right tentacle; Spire high, head-foot region divided on each side by longitudinal groove; eyes in prominent swellings on the outer bases of the tentacles; amphibious or terrestrial; crawls with steplike movement.... (Brown 2001)</p>	<p>Order Neotaenioglossa; Family Hydrobiidae; Genus Potamopyrgus (key to family only):</p> <p>Shell coiled; Shell with raised spire; Shell dextral; Shell without teeth on parietal wall, operculum present or absent; Spire longer; Shell stronger; operculum and gills present; Operculum multispiral or paucispiral, outer margins not concentric; Adults less than 7 mm; Males possess verge (penis) behind right tentacle; Shell length variable; head-foot region not divided; eyes at same location (as Pomatiopsidae) but not on prominent swellings; totally aquatic.... (Brown 2001)</p>
Habitat	Semi-aquatic ; among wet leaf litter and vegetation beside flowing or standing water and near shallow mud banks and marshy seepages leading into shallow streams.	Aquatic; found in disturbed watersheds (tolerates siltation & high nutrients that allow filamentous green algae growth); prefers littoral zones in lakes or slow streams with

		<p>silt and organic matter substrates, but tolerates high flow environments where it can burrow into the sediment; occupies fresh and brackish water.</p>
<p>Photos</p>	 <p>The Academy of Natural Sciences, Philadelphia. Available from http://clade.ansp.org/malacology/collections/index.html. ANSP states that photos in this collection "may be used free of charge for purposes of research or non-commercial publication".</p>	 <p>Scale bar is 5 mm. Photos from Dmitry P. Filippenko & Mikhail O. Son; http://seagrant.wisc.edu/Home/Topics/InvasiveSpecies/Details.aspx?PostID=656 Used with permission; Creative Commons (CC-BY) license.</p>