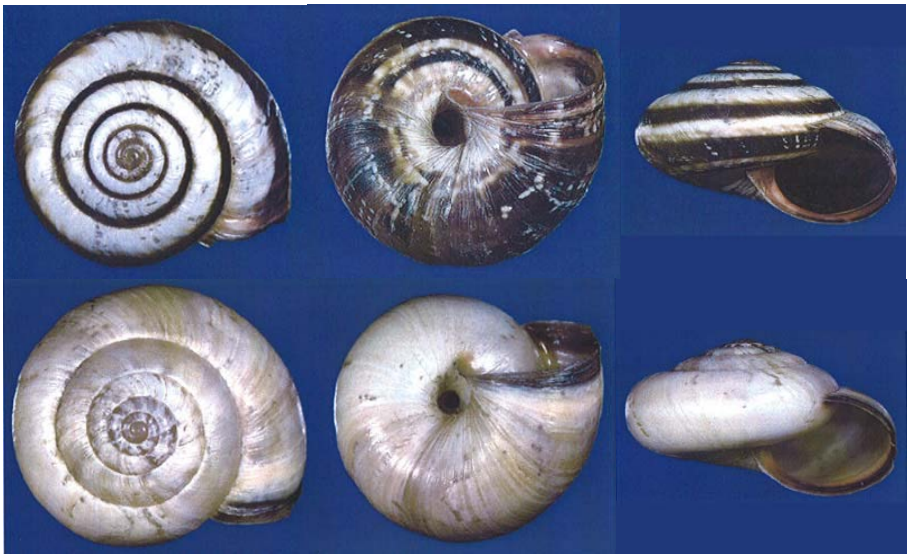
Cernuella spp.*

*Information for specific species within the genus is included when known and relevant. Other species may occur in the genus and are still reportable at the genus level.



Figures 1-6. *Cernuella virgata* collected from Port of Tacoma, WA (P. Marquez).

Scientific Name

Cernuella virgata da Costa, 1778

Synonyms:

Cernuella virgata
Cernuella virgatus,
Cernuella variabilis,
Cernuella virgata ssp. *variegata*,
Helicella maritima (Draparnaud),
Helicella variabilis (Draparnaud),
Helicella virgata (da Costa),
Helix virgata

Figure 7. Banding of *Cernuella virgata* (Image courtesy of Tenby Museum).

Common Name

Maritime gardensnail, Mediterranean snail, Mediterranean white snail, striped snail, vineyard snail, white snail

Type of Pest

Mollusk

Taxonomic Position

Class: Gastropoda, **Order:** Stylommatophora (Eupulmonata), **Family:** Hygromiidae (Helicidae)

Reason for Inclusion in Manual

CAPS Target: AHP Prioritized Pest List – 2003 – 2011 (as *Cernuella* spp.)

Pest Description

Cernuella virgata

Eggs: Eggs are 1.5 mm (approx. $^{1}/_{16}$ in) (Heller, 2001).

Adults: The maritime garden snail is relatively small and is characterized by prominent spiral banding on the shell (Figs. 1 to 8). The shell of *C. virgata* is globose-depressed and white or yellowish-white in color with dark-brown bands or spots. Snail size is 6 to 19 mm (approx. $^{1}/_{4}$ to $^{3}/_{4}$ in) high x 8 to 25 mm (approx. $^{5}/_{16}$ to 1 in) wide. Shell size and banding patterns are reported to vary widely geographically throughout Southeastern Australia (Baker, 1988). Size has been demonstrated as inversely proportional to population density (Baker, 1988). *Cernuella virgata* is considered polymorphic; banded and unbanded (more common) morphs have been found throughout Australia. Relative frequencies of each morph are likely correlated with site-specific factors such as predator pressure (Baker, 1988).

Figure 8. Image of shell illustrating polymorphic shell colors compared to Figure 1 (Image courtesy of James D. Young, USDA APHIS PPQ, Bugwood.org).


Figure 9. *Cernuella virgata* collected from Port of Tacoma, WA (P. Marquez).

Shell description: Maximum dimension is usually about 10 mm (approx. $^{3}/_{8}$ in) in diameter, but can be up to 25 mm (approx. 1 in). Shell is solid, globular helicoid, with a convex spire of 5 to 7 whorls that are somewhat convex, producing moderate sutures. Whorl outline is quite rounded. Shell sculpture consists primarily of faint axial growth lines that may be somewhat accentuated if the shell was broken during growth; no axial or spiral ribbing, is present, nor is there evidence of spiral striation.

Shell aperture rounded, with a thickened apertural rib just inside the lip (in adult specimens only). Apertural lip may be darkened brown to bright red, the apertural rib may be white to red. Juvenile and immature shells lack any apertural coloration. Umbilicus moderately large and deep; in some populations the apertural lip may flare when fully adult, partially obscuring the umbilicus. Color is highly variable, from white or cream, with or without dark or light brown spiral banding.

This species is polymorphic with regard to shell-banding patterns. The color can be completely white to having multiple dark bands (Baker, 2002). Other descriptions of this

species can be found in Kerney and Cameron (1979), Gittenberger (1993), and Burke (2013).

Biology and Ecology

Cernuella spp. are semelparous (mating only once before they die) (Heller, 2001). *Cernuella* spp. have the potential to produce 60 eggs per clutch and up to 40 clutches per year (White-McLean, 2011).

Snails in this family spend much of their time in a dormant state. This usually occurs daily during the winter, lasting for a few hours at a time. During the summer when conditions are dry, aestivation can last for days to weeks (Pomeroy, 1968). This allows the species to endure long periods of warmth, light, and dryness (Godan, 1983). Estivation usually occurs in conspicuous positions, often in direct sunlight and high heights (up to 11 m (36 ft) from the ground). When aestivating, they can be found on grass stems, tree trunks, posts, or other places. In South Australia temperatures usually limit activity to no more than a few hours at a time (Pomeroy, 1968).

Cernuella virgata

This species is hermaphroditic and obligate outcrosser (cannot fertilize itself) (reviewed in USDA, 2006). *Cernuella virgata* adults mate after late summer or early fall rains and can lay 100 to 200 eggs. Eggs are laid in leaf litter or below the soil surface (reviewed in USDA, 2010), typically 1 to 2 cm (approx. $^{3}/_{8}$ to $^{13}/_{16}$ in) below the soil surface. Snails can produce multiple clutches in a season (reviewed in USDA, 2006). Fecundity levels decrease as the population levels increase (reviewed in USDA, 2010).

Eggs hatch in autumn and winter. This species can develop rapidly during wet winters and may reach maturity before their first spring (reviewed in USDA, 2006). In Australia, heavy rainfall during autumn seems to be a good indicator of higher than average spring populations of *C. virgata* (Baker, 2008).

These snails are usually gregarious and can be seen congregating on items they have climbed (Pomeroy, 1968). Population levels can average 200 snails/m^2; during wet years, this level can jump to 400 snails/m^2 (reviewed in USDA, 2006). This species has been observed to self-regulate population levels. When the population increases to a certain point, the number of young produced and the growth rate and life span of adults all decreases (reviewed in Godan, 1983). Population growth can also be limited by the lack of high quality food (Speiser, 2001).

In Australia, this species has a two year life cycle in pasture-cereal rotations and an annual life cycle in permanent pastures (reviewed in USDA, 2010). “In Europe, *C. virgata* can be found in a range of habitats ranging from lowlands to high tablelands; woodlands, ditches, pastures and irrigated crops (Baker, 1988; Schall, 2006)” (USDA, 2006). This species can be found in moderately dry and open calcareous sites, dunes, grassland, and hedgerows (Kerney and Cameron, 1979).

For more on biology and ecology, see Pomeroy (1969) and Baker (1988; 1991).

Damage

Visual signs of *Cernuella* spp. can include chewing or rasping damage to plants, presence of eggs, juveniles and adults, empty snail shells, mucus and slime trails, ribbon like feces.

Cernuella virgata

Cernuella virgata is found atop plants during summertime and may also be found feeding on new growth earlier in the season. These snails aestivate on plant heads and stalks (Fig. 10), which contaminate crops and clog machinery. Areas previously infested with snails can prevent re-establishment of site as pastureland, as livestock often reject slime contaminated hay and forage (Baker, 2002). Feeding damage occurs in winter and spring when populations are high (Carne-Cavagnaro et al., 2006).

Figure 10. Multiple *C. virgata* on tree trunk. Photo courtesy of L. Poggiani, HU www.lavalledelmetauro.itU

Godan (1983) lists this species as a pest of fodder plants (sainfoin, lucern, clover). It will eat young plants and leaves.

Pest Importance

Cernuella spp. are considered pests of small grains and seeding production. This species can damage seedling crops (wheat, barley, peas, oil seeds) as well as ornamental plants (Biosecurity New Zealand, 2005).

Cernuella virgata

In southern Australia, there are four introduced snail species that cause damage to grain crops and pastures: *Cernuella virgata*, *Cochlicella acuta*, *Cochlicella barbara*, and *Theba pisana* (Baker, 2002). This species, in association with the other three, can become a contaminant of small grains due to large amounts of them aggregating on crops. Significant economic losses can occur to farmers due to this aggregation behavior which causes damage to the crop and damage to machinery during harvest (White-McLean, 2011). Contaminated grain can be cleaned mechanically, but this is costly and difficult (Baker, 2002). *Cernuella virgata* also causes damage to canola seedlings in Australia. It “may cause direct feeding damage to canola in early winter, just as they [pest snails including *C. virgata*] attack pastures and other crops in southern Australia (Baker 1986, 1989)” (Gu et al., 2007).

Large numbers of snails can also cause an increase in moisture content which can lead to secondary infestation by fungal pathogens. This can in turn lead to the production of toxins in the grain. Grains contaminated with toxins are unmarketable and cannot be used for human or animal consumption. Shipments of grains contaminated with this species have previously been rejected by other countries (White-McLean, 2011). Baker (2002) states that contaminated material “has damaged Australia's international reputation as a supplier of good-quality grain and poses a serious threat to the

marketing of future exports". USDA (2006) states that *Cernuella virgata* has the potential to cause trade issues between the United States and Canada.

Cernuella virgata can also cause loss of wheat, barley, and oilseed rape seedlings during crop establishment (Baker, 2002).

There do not seem to be many records of this species being a pest outside of Australia. This may be because the populations are controlled by natural enemies.

Cernuella neglecta
Cernuella neglecta is considered a pest in Belgium (reviewed in Godan, 1983).

Known Food Sources*

This species feeds on organic matter and decaying plants. It can also feed on a variety of crop and pasture plants (USDA, 2006). Godan (1983) lists this species as a pest of fodder plants (leaves and young plants of clover, lucern, and sainfoin).

Brassica napis (rape), *Cynara cardunculus* (wild artichoke), *Hordeum vulgare* (barley), *Marrubium vulgare* (horehound), *Medicago sativa* (alfalfa), *Phaseolus* spp. (beans), *Pisum sativum* (pea), *Reseda lutea* (cut-leaf mignonette), *Rapistrum rugosum* (turnip weed), *Triticum* spp. (wheat), and *Trifolium* spp. (clover) (Schall, 2006).

During the summer, this species can be found on robust weeds including *Marrubium vulgare* (horehound), *Reseda lutea* (cutleaf mignonette), and *Rapistrum rugosum* (turnip weed) (Baker, 2002).

*Terrestrial mollusks do not show host specificity and can feed on multiple crops as well as other materials, like decaying organic matter.

Pathogen or Associated Organisms Vectored

Human and Animal Pathogens
This species can vector protostrongylid nematodes (small lungworms) (Cabaret, 1988).

Cernuella spp. are known to vector *Aelurostrongylus abstrusus* (cat lungworm), *Brachylaima cribbi* (intestinal fluke)* and *Dicrocoelium dendriticum* (lancet fluke) (Baker, 1986; López et al., 2005). They can also transmit *Cystocaulus ocreatus*, *Muellerius capillaris*, and *Neostrongylus linearis* to livestock.

Cernuella virgata
Cernuella virgata is an intermediate host of *Davainea proglottina*, which can infect chickens (Godan, 1983). *Cernuella virgata* is also implicated in protostrongylid transmission affecting livestock (reviewed in USDA, 2010).

*This parasite can infect humans (Butcher et al., 2002).

Note: While most cases of human infections result from consumption of raw or partially cooked snail meat, government inspectors, officers and field surveyors are at-risk due to the handling of live snail, samples, and potential exposure to mucus secretions. ***Wear gloves when handling mollusks and wash hands thoroughly after any mollusk survey or inspection activities.***

Plant Pathogens
Unknown.

Known Distribution

Distribution lists may not be all inclusive.

Cernuella virgata
This species is predominantly found in the Mediterranean Basin.

Africa: Morocco, Tunisia; **Asia:** Turkey; **Europe:** Albania, Andorra, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, France, Gibraltar, Greece, Ireland, Italy, Macedonia, Malta, Netherlands, Portugal, Romania, Spain, Ukraine, and United Kingdom; **Oceania:** Australia (Lahmar et al., 1990; Örstan et al., 2005; USDA, 2006; USDA, 2010; Bank, 2011).

Pathway

Cernuella cisalpina
Cernuella cisalpina has previously been found on imported military shipping containers (Mack, n.d.). It has also been intercepted on tile shipments from Italy (Tang, 2004).

Cernuella virgata
This species was previously introduced into South Australia from Europe in the beginning of the 20th century. It has also been introduced into other countries, including Turkey (Örstan et al., 2005).

This species cannot move long distances on its own; however, it can be spread as a hitchhiker pest. Cowie et al. (2009) state that hygromiids (including *C. virgata*) are prone to being imported into the United States in association with tiles from southern Europe. An interception in New Zealand occurred in 2005 on an imported boat from Australia (Biosecurity New Zealand, 2005).

This species has been intercepted at U.S. ports of entry over 550 times. Many of the interceptions occur on non-host material, including tiles (250), containers (119), ceramic tiles (27), marble/marble tiles (17), and machinery (11). Approximately 39 interceptions occurred on a variety of plant material including citrus (6), *Pittosporum* sp. (4), and *Viburnum* sp. Most interceptions occurred on general cargo (475), permit cargo (45) and baggage (23) (AQAS, 2013, queried July 15, 2013).

This species has also previously been intercepted in soil (Godan, 1983).

Potential Distribution within the United States

Cernuella virgata

This species can be found in coastal habitats and is widespread in countries bordering the Mediterranean. It is also found throughout temperate regions of Australia (Baker, 1986).

According to White-McLean (2011) this species is currently present in North Carolina. However, USDA (2010) states that this species was found in North Carolina in 2000 but was eradicated by 2001.

This species detected in Washington in 2005 and 2006 (NAPIS, 2007; USDA, 2010). This population became an active eradication target in 2007 (USDA, 2010). There is also a report of this species in California (Hardy, 2004); however, USDA (2006) states that this report is erroneous and likely another exotic snail, *Theba pissana*. Burke (2013) lists *Cernuella virgata* as present in the Pacific Northwest.

Cernuella virgata can endure warm, sunny, and dry areas over relatively long periods meaning it has the potential of being widely distributed (Godan, 1983).

Survey

CAPS-Approved Method*:

Visual. See the Introduction to the mollusk manual for specific information on visual surveys.

Notes: Negative data for the genera *Cernuella*, *Cochlicella*, and *Monacha* can be entered at the genus level if no individuals of that genus are found in the sample and if the sampling method used will capture individuals of that genus if they are present in the environment from which that sample was taken. All species of these genera are exotic and not native to the U.S. All positives, regardless of genus, must be reported at the species level; no positive entries at the genus level are allowed.

Survey Site Selection

New introductions of terrestrial mollusks will likely be related to commerce and human-assisted movement. The habitat and land-use type of each survey site may be variable, ranging from agricultural land, to residential or industrial features. When planning the survey route for a particular site, examine the following microhabitats:

- Near heavily vegetated areas, especially gardens and fields where plants have been damaged by feeding;
- Under rocks, asphalt or cement pieces that are in loose contact with the ground surface;
- Discarded wooden boards and planks, fallen trees, logs, and branches;
- Damp leaf litter (not wet or soggy), compost piles, and rubbish heaps;
- Under flower pots, planters, rubber mats, tires, and other items in contact with the soil; and

- Standing rock walls, cement pilings, broken concrete, and grave markers.

Trap Placement
Trapping ***cannot*** be used alone but can be used to supplement visual surveying. Trapping for terrestrial mollusks is not species-specific and will attract non-target species, including non-mollusks. Platform or baiting traps can be used to supplement visual inspection. Trap placement can occur in the same areas that visual surveys occur.

Time of year to survey
Most species of terrestrial mollusks are active during nocturnal hours, when environmental conditions are cool and wet. Some species may also be active during daylight, especially during overcast and rainy days in the spring and fall. If possible, plan surveys during spring and fall, during the early morning, and on overcast days. Many slugs and snails have diurnal patterns of activity, so early morning and evening hours may be the best time to carry out a survey (Pearce and Örstan, 2006).

*For the most up-to-date methods for survey and identification, see Approved Methods on the CAPS Resource and Collaboration Site, at http://caps.ceris.purdue.edu/.

Key Diagnostics/Identification

CAPS-Approved Method*:
Morphological: Confirmation requires a morphological identification. All specimens should be submitted to Patrick Marquez. He is able to identify (even immature specimens) to the species level for this genus.

A key to the genera in Hygromiidae (including *Cernuella virgata*) in the Pacific Northwest is found in Burke (2013).

A key to terrestrial mollusks (including *Cernuella* spp.) is found here: http://idtools.org/id/mollusc/index.php.

*For the most up-to-date methods for survey and identification, see Approved Methods on the CAPS Resource and Collaboration Site, at http://caps.ceris.purdue.edu/.

Easily Confused Species

Cernuella virgata closely resembles the white Italian snail (*Theba pisana*) in appearance and pest status. *Cernuella virgata* can be differentiated from *T. pisana* by more pronounced spiral banding. Also, the umbilicus (hole about which the shell spirals) appears as a circular hole rather than being partially obscured as in the white Italian snail (CABI, 2007).

Kerney and Cameron (1979) state that this species is also similar to *Helicella bolenensis*, *Cernuella neglecta* and *Cernuella aginnica*, none of which are known to occur in the United States. A shell description of *Cernuella neglecta* and *Cernuella aginnica* can be found in Kerney and Cameron (1979). *Helicella bolenensis* “usually

lacks bands, is yellowish-white with stronger, more regular growthridges" while the last two "are more depressed and have larger umbilici" (Kerney and Cameron, 1979).

Burke (2013) states that *C. virgata* is similar to *Candidula intersecta*. "Both are recognized by their rather globose shells, the thickened rides around the inside of their apertures, and spiral banding". *Cernuella virgata* is usually larger; "its whorls increase more rapidly and its growth-wrinkles are finer and less consistent" (Burke, 2013).

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