HISTORY AND ECOLOGY IN NORTH AMERICA

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Rhizaspidiotus donacis
Arundo armored scale

Rhizaspidiotus donacis is a biological control agent approved in North America for release against giant reed.

CLASSIFICATION

RANKING	SCIENTIFIC NAME	COMMON NAME
Kingdom	Animalia	Animals
Phylum	Arthropoda	Arthropods
Class	Insecta	Insects
Order	Hemiptera	True bugs
Family	Diaspididae	Armored scales
Genus	*Rhizaspidiotus*	
Species	*Rhizaspidiotus donacis* (Leonardi)	Arundo armored scale

DESCRIPTION

Crawlers are orange, ¼–½ mm long (**Fig. 1a**), and become covered with a waxy whitecap scale while feeding. A brown waxy secretion is added to the periphery of this whitecap and serves as the scale covering of the immobile second instars (**Fig. 1b**). Short-lived adult males are winged, orangish-brown, and just over ½ mm long. Male scales when developing are oyster-shaped (**Fig. 1c**), about 0.5–1.0 mm long, and often found attached to larger female scales. Adult females are more round (**Fig. 1d**), covered by the brown and white scale, and expand their bodies up to 2 mm in diameter while developing the next generation of crawlers.

LIFE CYCLE

There are two immature stages or instars of *R. donacis* prior to the adult stage. Mobile crawlers (first instar) emerge from the body of the adult female in winter or early spring. They disperse up to a few feet (1 m) and settle on giant reed leaf collars at the bases of side shoots and rhizomes. Once settled, they become immobile, begin feeding on giant reed tissue with their piercing/sucking mouthparts, and secrete a waxy whitecap covering. The first instars then secrete a brown waxy covering around the edges of the whitecap (**Fig. 1b**) and molt to the immobile second instar. Male pupation occurs beneath their oyster-shaped brown scale coverings (**Fig. 1c**). Adult males are winged and mobile while adult females are immobile and remain beneath the waxy scale cover. Adult males find and mate with females, and then die after only 2–3 days. Females continue to develop beneath their scale covering, more than doubling their body size as they develop crawler embryos and continue feeding. The full female life cycle requires 5–6 months. There may be one or, possibly, two overlapping generations per year, depending on site conditions.

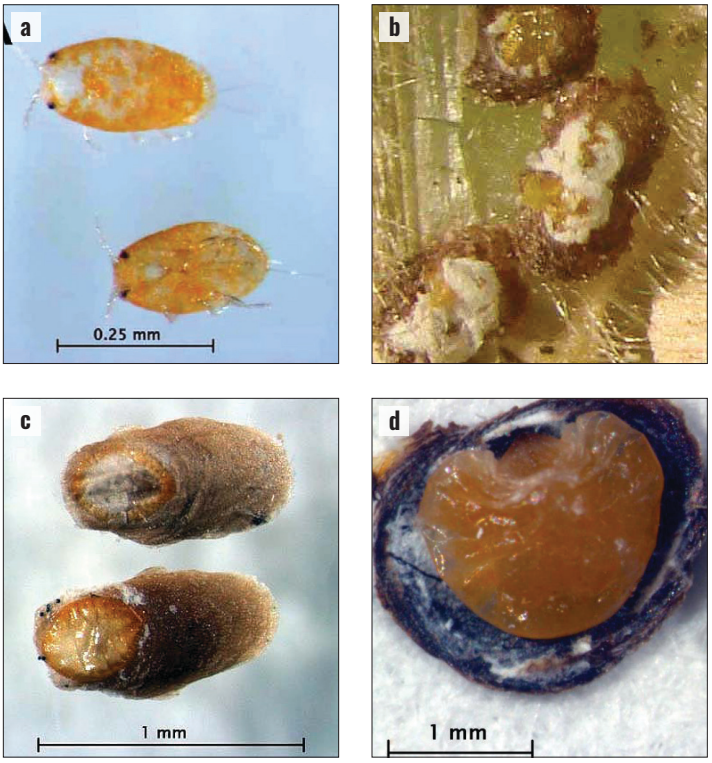

Figure 1. *Rhizaspidiotus donacis* (a) crawlers; (b) brown and white scales of second instars; (c) second-instar males with scale covering; (d) adult female beneath opened scale (a,c,d: Moran and Goolsby 2010, reprinted by permission from Oxford University Press; b: Patrick Moran, USDA-ARS)

DAMAGE

Heavy scale infestation of side shoot bases leads to a 'witches broom' symptom (**Fig. 2c**). In release plots, scale infestations combined with heavy galling by the arundo wasp (*Tetramesa romana*, see next section) reduce live biomass of giant reed by about 50% compared to plots with only the wasp.

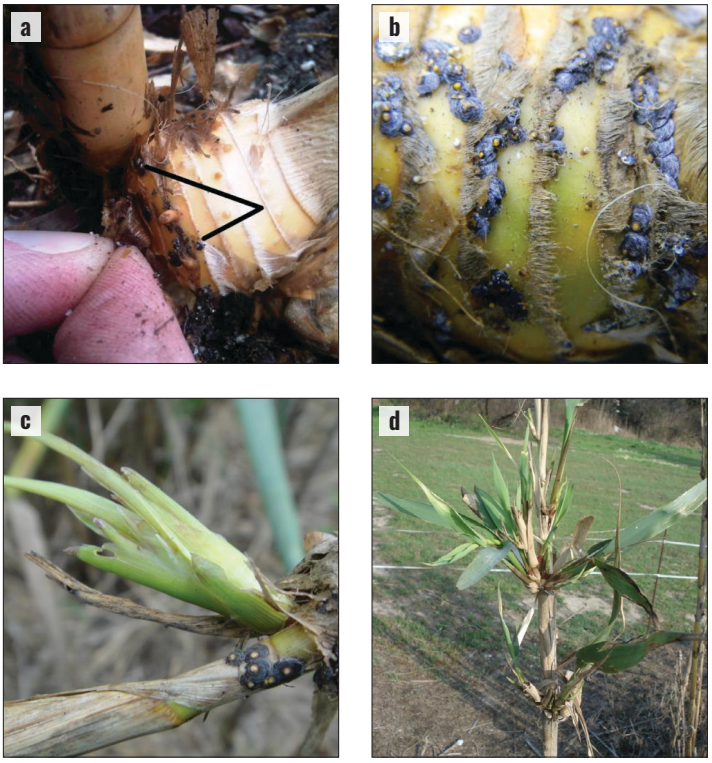

Figure 2. *Rhizaspidiotus donacis* (a) scattered scales on rhizome; (b) dense scale infestation on rhizome; (c) scales attacking lateral shoots causing (d) 'witches broom' growth deformity (a: Patrick Moran, USDA-ARS; b–d: John Goolsby, USDA-ARS)

FIELD IDENTIFICATION

Establishment can be confirmed by examining rhizomes for females (**Fig 2a,b**) or by examining leaf collars/ligules for 'whitecaps' indicative of newly-settled scales (**Fig. 1a**) or 2nd-instar male scale covers (**Fig. 1c**), which persist even after the adult male has emerged. Over time, dense populations can develop on rhizomes (**Fig. 2a,b**) and on the bases of lateral shoots (**Fig. 2c**), causing a distorted 'witches broom' growth from lateral nodes (**Fig. 2d**).

Only one other biocontrol agent has thus far established on giant reed in North America, *Tetramesa romana*. This species is easily differentiated from *R. donacis* because *T. romana* is a wasp (**Fig. 4d,e**), and its larvae (**Fig. 4b**) feed internally in galls devloping within giant reed stems.

PREFERRED HABITAT

The arundo scale does especially well at sites where giant reed has extensive lateral branching. Because galls of the biocontrol agent *Tetramesa romana* cause the proliferation of side shoots, the scale does well in conjunction with *T. romana*. In its native range, the arundo scale tends to be most abundant at sites with well-drained sandy or rocky soil.

HISTORY AND CURRENT STATUS

Rhizaspidiotus donacis is native to Mediterranean Europe. Scales originally sourced from France and Spain were repeatedly released on giant reed in Texas, USA beginning in 2010, California in 2013, and Coahuila, Mexico beginning in 2011. The scale has since successfully established at all three locations (**Fig. 3**). This species is causing significant reductions to side stem recruitment and biomass along the Rio Grande between the USA and Mexico. However, it is a poor disperser, so the large impacts are currently restricted to the physical release sites.

Figure 3. *Rhizaspidiotus donacis* reported distribution on giant reed in the USA. Also established in Coahuila, Mexico (Winston et al. 2021)

NONTARGET EFFECTS

In greenhouse tests in California, the arundo scale was able to develop on common reed (*Phragmites australis*) from crawler to adult in low numbers (50–100-fold less than on giant reed) in 10–50% of plants tested. However, field surveys in Texas and in the native range did not find the arundo scale on any plant outside the genus *Arundo*.

Tetramesa romana
Arundo wasp

Tetramesa romana is a biological control agent approved in North America for release against giant reed.

CLASSIFICATION

RANKING	SCIENTIFIC NAME	COMMON NAME
Kingdom	Animalia	Animals
Phylum	Arthropoda	Arthropods
Class	Insecta	Insects
Order	Hymenoptera	Bees, wasps, ants, sawflies
Family	Eurytomidae	Eurytomid wasps
Genus	*Tetramesa*	
Species	*Tetramesa romana* (Walker)	Arundo wasp

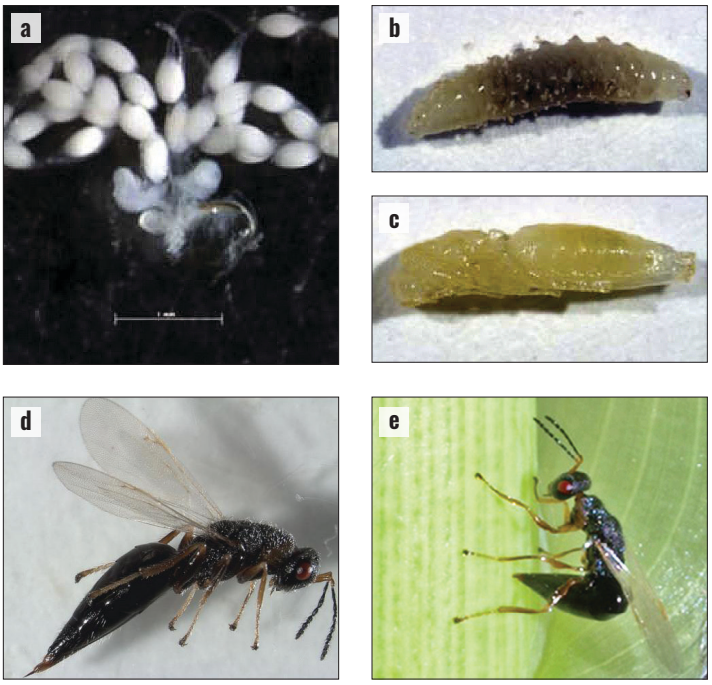

Figure 4. *Tetramesa romana* (a) ovaries dissected from newly emerged female showing numerous eggs with stalk-like pedicels (bar = 1 mm); (b) third-instar larva; (c) pupa; (d) adult; (e) adult female ovipositing eggs (a–d: Moran and Goolsby 2009 with permission from Elsevier; e: John Goolsby, USDA-ARS)

DESCRIPTION

Eggs are tiny, milky-white, and have stalk-like pedicels (**Fig. 4a**). Larvae are creamy-white but partially translucent (**Fig. 4b**) and are typically 4 mm long by the third instar. Pupae are 5 mm long and are creamy-white initially (**Fig. 4c**) but eventually turn dark. Adults are <7 mm long (not including antennae) with black, tapering bodies and brown legs (**Fig. 4d,e**). Antennae are long and brown to black, and the wings are transparent with pale yellow veins.

LIFE CYCLE

Adults lay eggs inside giant reed stems near shoot tips (**Fig. 5a**). Numerous eggs are often laid individually within the same stem. This species of wasp is able to lay eggs without fertilization, so there are very few males. Oviposition induces the formation of a gall around the deposited egg, and hatching larvae feed on gall tissue through three instars. Pupation occurs within galls. Adults chew a small, round exit hole to emerge from the gall (**Fig. 5b**). There may be up to five generations per year, depending on site conditions. In warm climates, wasp populations may be active year-round. In colder climates, pupae overwinter within galls, and adults emerge the following spring.

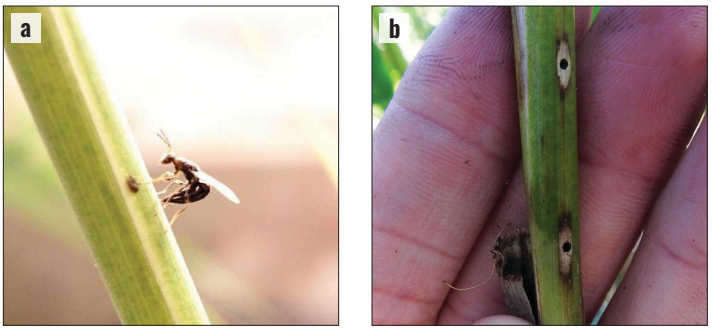

Figure 5. *Tetramesa romana* (a) female ovipositing in giant reed stem; (b) adult exit holes (a: John Goolsby, USDA-ARS; b: Sam Kieschnick, iNaturalist.org CC BY-4.0)

DAMAGE

Galling likely disrupts movement of metabolites in the stem and weakens stem structure, increasing risk of breakage (**Fig. 6a**), especially where multiple larvae feed within stems, which can lead to distortion, breakage, and death of young main shoots (**Fig. 6b**) and death of side shoots (**Fig. 6c**). High wasp populations significantly reduce live giant reed stem density, height, and biomass (**Fig. 6d**).

FIELD IDENTIFICATION

Eggs laid in stems are not immediately visible under field conditions, and adults may be difficult to see due to their small size. Consequently, observing adult exit holes (**Fig. 5b, 6c**) is the most reliable means for confirming the presence of this wasp.

Only one other biocontrol agent has thus far established on giant reed in North America, *Rhizaspidiotus donacis*. This species is easily differentiated from *T. romana* because *R. donacis* is an armored scale insect. Its immobile instars, immature males, and adult females are covered in characteristic brown and white waxy coverings (**Fig. 2b,c**).

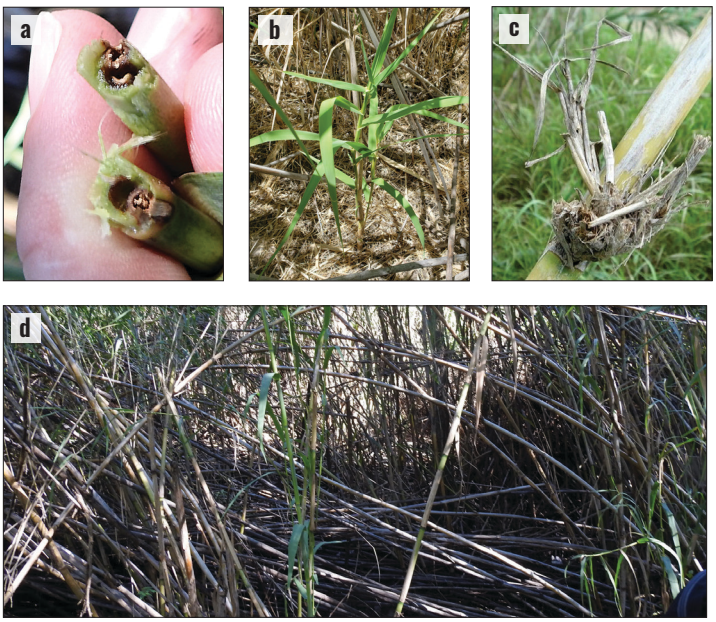

Figure 6. Damage caused by *Tetramesa romana* galling (a) dead tissue around gall; (b) distorted, galled main shoot; (c) dead galled side shoot; (d) stems damaged or outright destroyed by heavy *T. romana* attack (a,d: Sam Kieschnick, iNaturalist.org CC BY-4.0; b: Patrick Moran, USDA-ARS; c: John Goolsby, USDA-ARS)

These can often be observed in large colonies on giant reed rhizomes and at the bases of lateral shoots (**Fig. 2a–c**). Scale feeding at lateral nodes also causes a characteristic 'witches broom' growth deformity (**Fig. 2d**).

PREFERRED HABITAT

This wasp does well at a variety of giant reed sites, provided there are sufficient annual heat units for efficient development. The wasp can go into diapause (hibernation) during drought conditions. It does not appear to have the ability to survive prolonged freezing conditions found at the northern edge of giant reed's invasive range.

HISTORY AND CURRENT STATUS

Tetramesa romana is native to the Mediterranean. Several unique genotypes were intentionally introduced from Spain and France in order to better match the different invaded climates and different genetic clones of giant reed in North America. These were released in Texas, USA and Coahuila and Tamaulipas, Mexico beginning in 2009 and in northern California, USA and Morelos, Mexico beginning in 2010. Adventive populations of *T. romana*, different than the intentional genotypes, were discovered in southern California and Texas prior to 2007 and were subsequently not differentiated in the literature. The wasp established in both California and Texas (**Fig. 7**), and populations are high across a broad area where there are sufficient annual heat units for optimal development. The overall impact of this wasp is moderate. It significantly reduces live stem density, height, and biomass (by about 20 percent after five years, and up to 54% seven years after release), and this has resulted in a corresponding increase of native plant regeneration. However, attacked shoots that survive galling when young are still able to grow, and rhizomes are able to produce new shoots.

Figure 7. *Tetramesa romana* reported distribution on giant reed in the USA. Also established in Coahuila, Tamaulipas, and Morelos, Mexico (Winston et al. 2021)

NONTARGET EFFECTS

None reported. Field surveys found no evidence of galling by this wasp on common reed or other native or introduced grasses in the Lower Rio Grande Basin of Texas.

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SUGGESTED CITATION

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