UF IFAS Extension UNIVERSITY of FLORIDA

EENY-729

Salvinia Weevil *Cyrtobagous salviniae* (Calder & Sands) (Insecta: Coleoptera: Curculionidae)[1]

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Introduction

The salvinia weevil, *Cyrtobagous salviniae* (Calder & Sands) (Figure 1), is a subaquatic (underwater) herbivorous insect native to Brazil (Calder and Sands 1985). This insect feeds on the invasive aquatic plants *Salvinia molesta* D.S. Mitchell and *Salvinia minima* (Baker). This insect is an effective classical biological control agent used in several countries to control the invasive giant salvinia, *Salvinia molesta*. Feeding by *Cyrtobagous salviniae* larvae and adults kills its invasive host plants and restores recreational, agricultural, and ecosystem functions in aquatic systems. In the United states, the insect has been credited for controlling *Salvinia minima* in Florida (Jacono et al. 2001) and causing the decline of *Salvinia molesta* in Texas and Louisiana (Tipping et al. 2008).

Distribution

Cyrtobagous salviniae is native to southern Brazil. However, it now occurs in at least 17 other countries, including Australia, Papua New Guinea, Sri Lanka, South Africa, and the United States (Winston et al. 2014). The insect was deliberately introduced into these countries as a classical biological control agent of the invasive aquatic weed, *Salvinia molesta* (Room et al. 1981; Cilliers 1991; Tipping et al. 2008; Russell et al. 2017). In the United States, *Cyrtobagous salviniae* was introduced into Texas and Louisiana from Brazil in a project that began in 1999 for management of *Salvinia molesta.* Florida has an established adventive populationof *Cyrtobagous salviniae*, whichwas probably introduced in the 1960s or earlier (Kissinger 1966). It is now present in more than 77% of the Florida's waterbodies, resulting in the control of *Salvinia minima* (Jacono et al. 2001).

Figure 1. Adult *Cyrtobagous salviniae* (Calder & Sands) on its aquatic host plant, *Salvinia molesta* (D. S. Mitch).
Credits: Katherine Parys, USDA-ARS, Bugwood.org

1. This document is EENY-729, one of a series of the Entomology and Nematology Department, UF/IFAS Extension. Original publication date April 2019. Visit the EDIS website at https://edis.ifas.ufl.edu for the currently supported version of this publication. This document is also available on the Featured Creatures website at http://entomology.ifas.ufl.edu/creatures.

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Description

Adult and immature life stages of this beetle can be found on *Salvinia molesta* or *Salvinia minima* above and below the water surface. Interestingly, these insects can breathe underwater through an air bubble (called a plastron) that they create and attach to the underside of their body (Forno et al. 1983; Russell et al. 2016).

Eggs

The eggs of *Cyrtobagous salviniae* are deposited singly on the leaves or rhizomes (belowground or sub-surface stems) of *Salvinia molesta* or *Salvinia minima.* Eggs are elliptical, milky white, and measure 0.5 by 0.2 mm (Figure 2).

Figure 2. Egg of *Cyrtobagous salviniae* (Calder & Sands).
Credits: Alana Russell, LSU AgCenter

Larvae

The larvae of *Cyrtobagous salviniae* undergo five instars, or developmental stages. Larvae progress in size from a 1 mm long first instar to a 2.6 mm long fifth instar. Their color is milky white with a distinct hardened, dark brown head capsule (Figure 3). Early instars feed on new leaf buds of *Salvinia molesta* or *Salvinia minima*, while later instars bore into the rhizome and feed internally on new rhizomes. Mature larvae develop into a resting pupal stage, during which they transform into adult beetles.

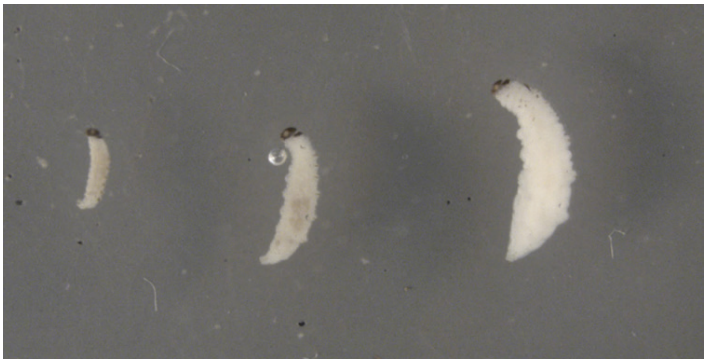

Figure 3. Larvae of *Cyrtobagous salviniae* (Calder & Sands) at fifth, third, and first instar.
Credits: Alana Russell, LSU AgCenter

Pupae

The pupae of *Cyrtobagous salviniae* measure 2 mm by 2.6 mm and remain within an enclosed cocoon made with *Salvinia molesta* or *Salvinia minima* roots. They pupate underwater within rhizomes of *Salvinia molesta* or *Salvinia minima*.

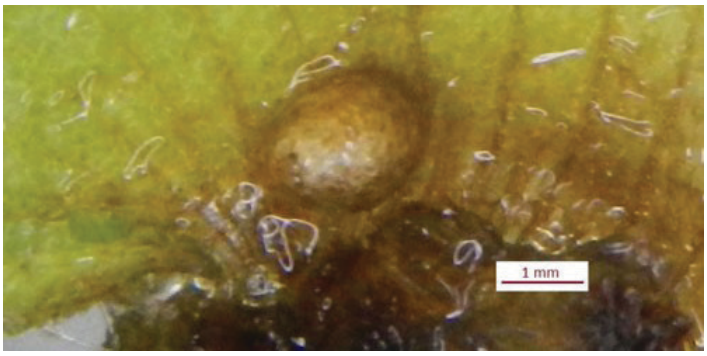

Figure 4. Pupa of *Cyrtobagous salviniae* (Calder & Sands).
Credits: Alana Russell, LSU AgCenter

Adult

The adults of *Cyrtobagous salviniae* measure 2 to 3.5 mm long and are brown during the first five days following emergence before turning shiny black for the remainder of their life. Similar to other weevil species, they have hardened forewings (called elytra) and membranous hindwings used for flight, along with a long snout on their head (Figure 5). The antennae and chewing mouthparts are located at the apex of the rostrum (snout) as shown in Figure 5.

Figure 5. Adult of *Cyrtobagous salviniae* (Calder & Sands).
Credits: Alana Russell, LSU AgCenter

Life Cycle and Biology

Cyrtobagous salviniae is a multivoltine species; it has multiple generations per year. The insect undergoes complete metamorphosis with four distinct developmental stages: eggs, larvae, pupae, and adults. The developmental time from egg to adult takes approximately 45 days but may vary depending on temperature and food quality. Adult females oviposit (deposit eggs) in small fissures or crevices that they cut into the new growth of *Salvinia molesta* or

Salvinia minima. After approximately 10 days, a larva will emerge from the egg and feed for approximately 23 days before developing into a pupa. Pupal development takes 10 to 15 days, after which an adult beetle will eclose (emerge) to begin feeding and reproducing. Newly emerged females begin laying eggs approximately five days after emerging from the pupa. A single female can deposit one egg every two to five days for at least 60 days (Eisenberg et al. 2018). Both larval and adult stages feed on plant material. Neonates (newly emerged larvae) feed on the roots within their first to fourth days and move to new leaf buds within five to nine days after hatching (Sands et al. 1983). After feeding on external plant buds and roots, the larva will tunnel into the rhizomes and feed internally (Sands et al. 1983, Julien et al. 1987). Tunneling into the rhizomes is essential for the larval stage to complete development (Sands et al. 1983, Julien et al. 1987). Adults feed on roots, buds, and young leaves that enclose the buds (Julien et al. 1987). Nitrogen-rich host plants promote larval development and increased egg production (Sands et al. 1986).

Host

Field studies in Brazil found that *Cyrtobagous salviniae* only feeds on plants from the genus *Salvinia*, commonly called floating ferns. These plants consist of rhizomes that run horizontally below the water surface and produce leaves in whorls or spiral patterns of three. In the United States, *Cyrtobagous salviniae* feeds exclusively on two invasive floating fern species, *Salvinia molesta* and *Salvinia minima*. These two species are the only members of the genus *Salvinia* in North America (Jacono et al. 2001, Russell et al. 2016). *Salvinia molesta*, native to southeastern Brazil, is the primary host of *Cyrtobagous salviniae* and a major target of weed biological control programs around the world.

In the United States, *Salvinia molesta* was first observed in South Carolina in 1995, followed by Louisiana in 1998, and several other states by 1999 (Center for Agriculture and Bioscience International 2018). The plant is now well established in Louisiana and Texas (Tipping et al. 2008). As of 2019, *Salvinia molesta* is on the Federal Noxious Weed List, in an effort to increase awareness and reduce the spread of noxious weeds. Additionally, the second species, *Salvinia minima,* was introduced to North America in late 1920s and has been reported to occur in Florida, Texas, and Louisiana. Because of the early introduction and pressure caused by *Cyrtobagous salviniae, Salvinia minima* is not considered a problem in Florida, and the impacts in Texas and Louisiana are not well documented (Jacono et al. 2001).

Economic Importance

Salvinia molesta is considered the most invasive *Salvinia* species and a serious threat to tropical and subtropical aquatic ecosystems worldwide (Douglas-Oliver 1993). *Salvinia molesta* spreads from fragments of leaves and roots via water currents and on contaminated equipment such as boats and vehicles. It has been found forming dense mats on water surfaces that can thicken up to 1 m deep (Thomas and Room 1986). Beginning in the 1940s, human activities have spread *Salvinia molesta* to various tropical and subtropical regions of Africa, Asia, Australia, and United States (Figure 6, Thomas and Room 1986). The plant now occurs in more than 30 countries.

Figure 6. Worldwide distribution of *Salvinia molesta* D. S. Mitchell, the primary host plant of *Cyrtobagous salviniae* (Calder & Sands). Red dots represent areas where the plant is considered invasive and the green dot is in its native range.
Credits: Center for Agriculture and Bioscience International, 2018. (Available online at: https://www.cabi.org/isc/datasheet/48447)

Cyrtobagous salviniae is an important classical biological control agent of *Salvinia molesta* worldwide. *Salvinia molesta* is considered a major destructive aquatic weed in waterbodies characterized by slow-moving fresh water. Dense stands of *Salvinia molesta* not only disrupt recreational activities like boating and fishing, but also displace native flora, clog irrigation systems, and deplete dissolved oxygen in water bodies, causing hypoxic conditions that kill aquatic wildlife (Horner 2002; Russell et al. 2017). Feeding damage by *Cyrtobagous salviniae* suppresses the growth of *Salvinia molesta*. Larval feeding in particular is the most damaging because it destroys the vascular tissue and interrupts the translocation of nutrients, causing the plant to decay, lose buoyancy, and sink to the bottom of water bodies (Julien et al. 2002; Russell et al. 2016).

Because of the insect's effect on *Salvinia molesta*, it has been introduced as a biological control agent in multiple countries around the world with the intent of controlling the invasive plant. For example, *Cyrtobagous salviniae* successfully eliminated a *Salvinia molesta* infestation within 15

months after being released into Lake Moondarra, Australia in 1980. Introduction of *Cyrtobagous salviniae* to at least 17 other countries has achieved similar levels of control within 36 months (Julien et al. 2009; Julien et al. 2012). In the US, evaluation of the impact of this insect in Texas and Louisiana revealed that it has the capacity to reduce the surface coverage of *Salvinia molesta* by more than 99% (Tipping et al. 2008).

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