

Predatory Gall Midge (Unofficial Common Name), *Feltiella acarisuga* (Vallot) (Insecta: Diptera: Cecidomyiidae)¹

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Introduction

The predatory gall midge, *Feltiella acarisuga* (Vallot), is one of the most effective and widespread natural enemies of spider mites (Tetranychidae) (Gagné 1995). Because of their flying and prey-detecting capabilities, and high feeding potential, it is considered an important natural enemy of the [twospotted spider mite](#), *Tetranychus urticae* Koch, in a number of cropping systems (Opit et al. 1997; Refaei and Mohamed 2013). It is also known to feed on other pest mites, including brown almond mite, *Bryobia rubrioculus* Scheuten; carmine spider mite, *Tetranychus cinnabarinus* Boisduval; and European red mite, *Panonychus ulmi* Koch. *Feltiella acarisuga* could be particularly useful for integrated pest management of spider mites that attack greenhouse crops (Gillespie et al. 1998).

Synonymy

Cecidomyia acarisuga
Mycodiplosis minuta
Therodiplosis persicae
Therodiplosis beglarovi
Arthrocnodax rutherfordi
Feltiella tetranychii
Feltiella davisii
Feltiella americana

Feltiella ithacae

Feltiella quadrata (Gagné 1995)

Distribution

The genus *Feltiella* is virtually cosmopolitan and contains 10 species: *Feltiella acarisuga* (worldwide, except for the Neotropical Region), *Feltiella pini* (Felt) (North and Central America, West Indies, Australia), *Feltiella curtistylus* Gagné (Brazil), *Feltiella occidentalis* (Felt) (US—California; Japan—Honshu), *Feltiella acarivora* (Zehnter) (Indonesia—Java; Australia), *Feltiella insularis* (Felt) (US—Illinois, New Jersey, Florida; West Indies, Colombia, Argentina), *Feltiella reducta* Felt (US—New York), *Feltiella ligulata* Gagné (Cape Verde Island), *Feltiella kanchanjungaensis* (India—West Bengal) and *Feltiella tetranychii* (Germany) (Gagné 1995, 2010). *Feltiella acarisuga* is the most widely distributed species in the genus and is listed from the US, Canada, Finland, Germany, United Kingdom, Switzerland, Italy, Morocco, Greece, Israel, India, Sri Lanka, Taiwan, Japan, and New Zealand. It is the only species of *Feltiella* found throughout most of Europe and Asia.

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Description

Egg

The glossy, translucent, oblong eggs are deposited individually near prey mites on leaves. They are 0.1 x 0.25 mm in size (Koppert 1997). The eggs hatch ~ 2.5 days after oviposition, and the larvae immediately begin to feed (Mo and Liu 2007).

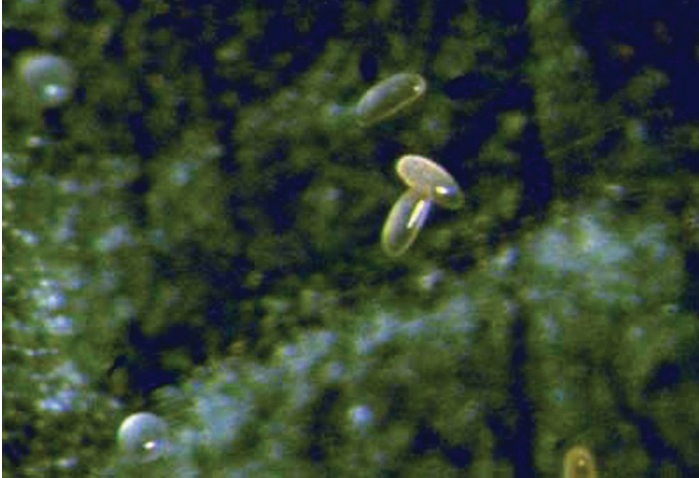


Figure 1. Eggs of the predatory gall-midge, *Feltiella acarisuga* (Vallot).
Credits: David R. Gillespie, Agassiz

Larva

The orange-brown larvae vary in length from 0.2 to 2 mm during their four developmental instars (Koppert 1997). They forage for mites on leaves and feed for four to six days, depending on temperature, relative humidity and the abundance of prey mites (Gillespie and Raworth 1999). They feed exclusively on all developmental stages of several species of spider mites. *Feltiella acarisuga* larvae occur in populations as large as 160 per cm² of eggplant leaf.



Figure 2. Larva of the predatory gall-midge, *Feltiella acarisuga* (Vallot).
Credits: Lance S. Osborne, UF/IFAS

Pupa

The fluffy white, 1 to 1.5 mm long pupa requires four to six days to complete development and produce an adult (Koppert 1997). Pupation occurs mainly on the underside of a leaf next to a vein.

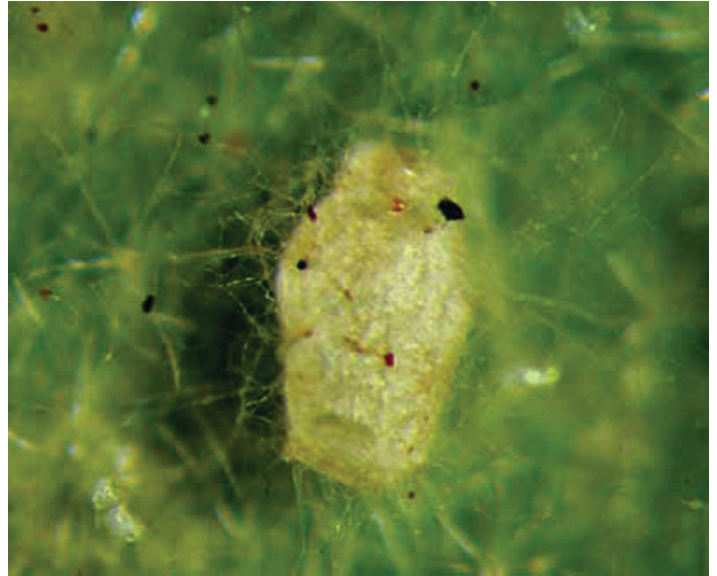


Figure 3. Pupa of the predatory gall-midge, *Feltiella acarisuga* (Vallot).
Credits: Lance S. Osborne, UF/IFAS

Adult

The adult *Feltiella acarisuga* is a delicate, pink-brown fly about 2 mm in length with long legs (Koppert 1997). Adults live for about 12–14 days, and on average, a single female lays about 33 eggs in its life span at the rate of 3.2 eggs/oviposition day. Males have a shorter life span than females (Mo and Liu 2007). The sex ratio is about 1:1. Adult *Feltiella acarisuga* are not predaceous but drink water and nectar.



Figure 4. Adult of the predatory gall-midge, *Feltiella acarisuga* (Vallot).
Credits: David R. Gillespie, Agassiz

Life Cycle

In climates without extremely dry or cold seasons, every stage of *Feltiella acarisuga* is present year-round. *Feltiella* spp. apparently develop from egg to egg in 26 to 33 days, averaging around 29 days (Sharaf 1984). *Feltiella acarisuga* developmental time may range between two to four weeks (Gillespie et al. 1998; Mo and Liu 2007; Refaei and Mohamed 2013) depending upon the temperature and/or relative humidity. Reproduction and development occur at 15°C–25°C. Eggs and larvae do not survive above 30°C or below 30% relative humidity. At least 50% relative humidity is required for a normal rate of development. The optimum temperature and relative humidity combination is about 20°C and 90% relative humidity. However, with an abundance of prey, the level of predation remains constant over the developmental range of temperature and relative humidity (Gillespie et al. 1998). If prey populations are sub-optimal, larvae can survive by pupating at a smaller size. Larvae also can survive for several days without prey.

Effectiveness

Feltiella acarisuga can be used to manage spider mite populations in a variety of greenhouse and field crops, especially when incorporated into a bio-intensive IPM program. In eggplant, for example, *Feltiella acarisuga* has appeared naturally and reduced spider mite numbers by more than 40% (Sharaf 1984). Each midge larva can consume an average of at least 15 adult mites, 30 mixed developmental stages, or 80 eggs per day. In a recent laboratory study, Xiao et al. (2012) reported *Feltiella acarisuga* had higher predation capacity than two phytoseiid predators *Neoseiulus californicus* (McGregor) and *Amblyseius swirskii* (Athias-Henriot) on *Tetranychus urticae* eggs. The maximum daily predation observed by a second instar larval *Feltiella acarisuga* was 50 eggs/day, compared to 25.6 eggs/day and 15.1 eggs/day consumed by a female *Neoseiulus californicus* and a female *Amblyseius swirskii*, respectively. In a related study, modified corn banker plant system using *Oligonychus pratensis* (Banks) as a surrogate host for dispersal and predation potential of *Feltiella acarisuga* against *Tetranychus urticae* on beans was evaluated (Xiao et al. 2011). The system showed promising results, where within two weeks period, *Feltiella acarisuga* was found to fly at least 7.0 m far from the corn-banker plants in search of new prey and successfully established on the bean plants infested with *Tetranychus urticae*. More than 176 *Feltiella acarisuga* larvae per bean leaf were recorded after dispersal from the corn plant and were effective in suppressing *Tetranychus urticae* populations.

Weekly releases of 1000 individuals per ha have been extremely effective for controlling spider mites on tomato, pepper, and cucumber (Gillespie et al. 1998). In addition, *Feltiella acarisuga* (sold as *Therodiplosis persicae*) is being used to manage spider mites on strawberries and various ornamental crops. It is recommended that 200 to 1000 individuals per ha be released weekly as a trial rate for growers. The weekly release rate is approximately doubled for heavy infestations, 2,500 adults per ha for six successive weeks (Biobest 1999). It is highly advised that *Feltiella acarisuga* be released in combination with the predaceous mite, *Phytoseiulus persimilis*, a well-established natural enemy used to control spider mites. *Feltiella acarisuga* is more mobile as an adult than is the predatory mite and, once established, eats at least five times as many spider mites (Biobest 1999). However, *Phytoseiulus persimilis* should not be released where *Feltiella acarisuga* is becoming established because they are known to eat midge eggs if prey is limited (Gillespie 1998). *Feltiella acarisuga* has also been found to be active in cool and dark weather during spring and autumn seasons. Thus, it can be used for spider mite control in strawberry and other crops that requires low temperature for production (Biobest 1999).

Commercial Availability and Use

Feltiella acarisuga pupae are commercially available from several producers and suppliers of natural enemies (<http://www.anbp.org/>). Pupae are shipped on leaves or an inert substance in various containers, such as 1-liter pots. Pots are placed in the crop on the ground at the beginning of rows and their lids are pierced to release the adult midges. It is best if the midges are released near concentrations of spider mites. To establish, *Feltiella acarisuga* requires fairly large prey populations (Gillespie and Raworth 1999). The pots should be stored in the dark for no more than two days at 10 to 15°C (Koppert 1997). Adults should be released from containers every 24 hours, late at night or early in the morning because of the cooler and more humid conditions. The RH should be kept above 80%, if possible (Gillespie and Raworth 1999).

It is essential to avoid non-target side effects of chemical pesticides, such as Thiodan, Diazinon, and Kelthane; however, most fungicides are safe to use with *Feltiella acarisuga* (Gillespie and Raworth 1999). Sulfur products used as dusts or sprays do not cause mortality in larvae but females avoid laying eggs on treated plants. Among commonly used insecticides in horticultural and field production, foliar application of azadiractin, flonicamid, pyriproxifen and spinosad, and drench applications of imidacloprid are reported to have no toxic effect on *Feltiella*

acarisuga population (mortality <25%), whereas pymetrozine and buprofezin had no to moderate impact (mortality <50%) (Biobest 2012). Abamectin, bifenazate, bifenthrin, cyfluthrin, chlorfenapyr, esfenvalerate, permethrin and spiromesifen were found to be toxic (mortality >75%) against this predator. Another concern is parasitization of *Feltiella acarisuga* larvae by *Aphanogmus floridanus*, potentially a very abundant parasitoid during warmer months. However, if necessary, releases can be timed to avoid the parasitoid because unlike the parasitoid *Feltiella acarisuga* does not diapause during the cooler months. *Feltiella acarisuga* parasitized by *Aphanogmus floridanus* have pupal cases with characteristic round emergence holes.

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