EENY-768

https://doi.org/10.32473/edis-IN1333-2021

Sophia or Transvena Parasitic Wasp (suggested common name) *Encarsia sophia* Girault and Dodd (Insecta: Hymenoptera: Aphelinidae)[1]

Erich N. Schoeller, Vivek Kumar, Cindy L. McKenzie, and Lance S. Osborne[2]

The Featured Creatures collection provides in-depth profiles of insects, nematodes, arachnids and other organisms relevant to Florida. These profiles are intended for the use of interested laypersons with some knowledge of biology as well as academic audiences.

Introduction

Encarsia sophia Girault and Dodd (Hymenoptera: Aphelinidae) (Figure 1) is a small parasitic wasp used to control multiple whitefly pests including *Trialeurodes vaporarium* Westwood (greenhouse whitefly), *Bemisia tabaci* Gennadius (silverleaf whitefly), and *T. variabilis* Quaintance (papaya whitefly) (Figure 2). Because *E. sophia* possesses high reproductive capacity and is a prolific host-feeder, it is considered one of the most important biological control agents of whiteflies around the globe. The host-feeding capacity of *Encarsia sophia* on *Bemisia tabaci* is higher than *Encarsia formosa* Gahan and *Eretmocerus melanoscutus* Zolnerowich and Rose, two other important whitefly parasitoids, and it can kill nearly 3 times the number of whiteflies than either of these parasitoids by preying on the pest (Zang and Liu 2008).

Figure 1. An adult female *Encarsia sophia* parasitizing a whitefly nymph.
Credits: Jack K. Clark, UC IPM

Figure 2. Papaya whitefly *Trialeurodes variabilis* nymphs parasitized by *Encarsia sophia*.
Credits: Jack K. Clark, UC IPM

1. This document is EENY-768, one of a series of the Entomology and Nematology Department, UF/IFAS Extension. Original publication date June 2021. 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://entnemdept.ufl.edu/creatures/.

2. Erich N. Schoeller, Entomology and Nematology Department; Vivek Kumar, Entomology and Nematology Department; Cindy L. McKenzie, United States Horticulture Research laboratory, ARS-USDA; and Lance S. Osborne, Entomology and Nematology Department; UF/IFAS Extension, Gainesville, FL 32611.

Synonymy

Synonyms for *Encarsia sophia* include the following (GBIF 2017; FE 2017):

- *Coccophagus Sophia* Girault & Dodd, 1915
- *Prospaltella transvena* Timberlake, 1926
- *Encarsia transvena* Timberlake, 1926
- *Encarsia sublutea* Silvestri, 1931
- *Prospaltella sophia* Compere, 1931
- *Prospaltella sublutea* Silvestri 1931
- *Prospaltella flava* Shafee, 1937
- *Encarsia bemisiae* Ishii, 1938
- *Prospaltella bemisiae* Ishii, 1938
- *Encarsia flava* Shafee, 1973
- *Encarsia bemisiae* De Santis, 1981
- *Encarsia shafeei* Hayat, 1986

Among different synonyms, *Encarsia transvena* is the most utilizedname in the literature.

Distribution

Encarsia sophia has a cosmopolitan distribution in the Old World and is considered an introduced species to the New World (Heraty and Polaszek 2000; Polaszek et al. 1992). Globally, it has been reported from Afghanistan, Algeria, Argentina, Australia, Burundi, Canary Islands, Cape Verde, China, Dominican Republic, Egypt, Ethiopia, French Polynesia, Guadeloupe, Honduras, India, Indonesia, Iran, Israel, Italy, Ivory Coast, Japan, Kenya, Malawi, Malaysia, Martinique, Mexico, Morocco, Niger, Pakistan, Philippines, Russia, Sierra Leone, Somalia, Spain, Sri Lanka, Taiwan, Thailand, Tunisia, Turkey, United States of America, and Zimbabwe (UCD 2017).

Description

Encarsia sophia is a complex of distinct cryptic species, and their performance against different whitefly species can vary depending upon the origin of the wasp population (Giordini and Baldanza 2004). *Encarsia sophia* is a solitary, arrhenotokous (unfertilized eggs develop into males) species, where males develop as secondary ectoparasites of female larvae. The sex ratio of *E. sophia* is heavily biased toward females (Gerling 1983), and both male and female are golden-yellow in color with two large black compound eyes on either side of the head. The most reliable sign of the parasitized whitefly nymph is the change in color of their "skin" (turns black) (Figure 3).

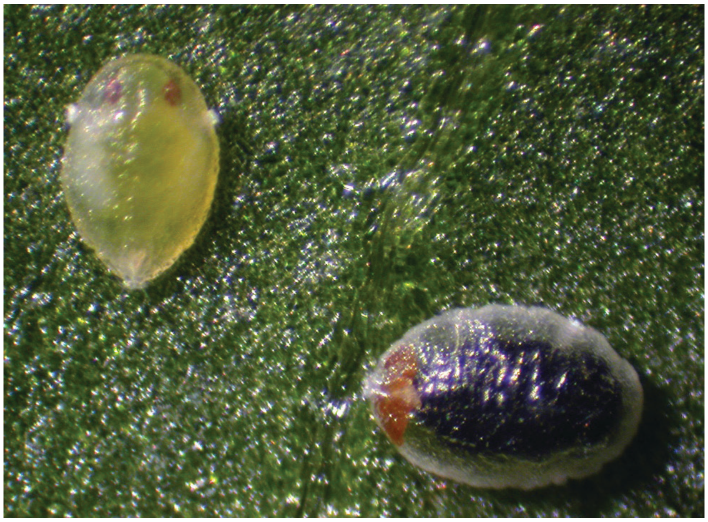

Figure 3. Change in color of parasitized (lower right) vs non-parasitized (upper left) nymphs of *Bemisia tabaci*.
Credits: Jack K. Clark, UC IPM

Biology

Like many *Encarsia* species, *E. sophia* is a solitary heteronomous facultative hyperparasitoid. Females develop as primary parasitoids on whitefly nymphs, while males develop as hyperparasitoids of conspecific females or other parasitoid species (Hunter and Kelly 1998). Conspecific hyperparasitism in *E. sophia* can occur as early as the late 2nd instar of the female parasitoid host (Chen et al. 2013). Like *E. formosa*, *E. sophia* can develop in all *B. tabaci* nymphal stages, but it prefers to oviposit in older instars (third and fourth instar). Development of *E. sophia* can be affected by the whitefly species and the host stage parasitized. Larger host species such as *T. vaporiorum* yielded larger adults than those parasitizing *B. tabaci* (Luo and Liu 2011), which ultimately has consequences for parasitoid fitness. As an endoparasitoid, the egg, larval, and pupal stages of *E. sophia* occur within the host. At 25°C, development time from egg to adult emergence can take about 12.8 days. *Encarsia sophia* females live for about 21.9 days, and within this period, they can lay about 79 eggs in *B. tabaci* nymphs (Zhou et al. 2010). Male development takes as little as nine days (Osborne et al. 1990). Successful emergence is evident from holes emerging adults leave in the whitefly pupal casings (Figure 4). Development can be affected by the whitefly species and the host stage parasitized. Larger host species such as *T. vaporiorum* yielded larger *E. sophia* adults than those parasitizing *B. tabaci* (Luo and Liu 2011), which ultimately has consequences for parasitoid fitness. In addition to parasitism, adult female *E. sophia* can also kill the host by host-feeding using their ovipositors to pierce the nymphs and extracting the hemolymph (Gerling 1983). Early whitefly stages are preferred for host-feeding activities.

Figure 4. A hole in old whitefly pupal casing (dark colored) made by an emerged adult parasitoid.
Credits: Jack K. Clark, UC IPM

Economic Importance

Encarsia sophia has a strong dispersal and host searching ability. It is known to attack > 25 species of whitefly species among which *B. tabaci*, and *T. vaporiorum,* are of great economic concern (Heraty and Polaszek 2000; Polaszek et al. 1992; Luo and Liu 2011; UCD 2017). Other organisms parasitized include: *T. variabilis* Quaintance (papaya whitefly), *T. ricini* Misra (castor bean whitefly), *Acaudaleyrodes rhachipora* Singh (Hayat 1989), *Aleurocybotus indicus* David and Subramaniam (rice whitefly), *Aleurodicus dispersus* Russell (spiraling whitefly), *Parabemisia myricae* Kuwana (bayberry whitefly) (Polaszek et al. 1992), *Pealius hibisci* Kotinsky (hibiscus whitefly), *Aphis sacchari* Zehtner (sugarcane aphid) (Timberlake 1926), and *Diaphorina citri* Kuwayama (Asian citrus psyllid) (Polaszek et al, 1992).

In the United States, *E. sophia* was released under a classical biological program for the invasive *B. tabaci* (MEAM1 also known as B biotype) at multiple sites during the mid-1990's (Hoelmer and Gooslby 2002). Later it was found to be established in California, Texas, Arizona, and the southern United States. Depending upon the target crop and the whitefly population level, *E. sophia* can be applied in greenhouses as augmentative or inoculative releases. Currently, the use of a banker plant system for their establishment and dispersal in greenhouses is actively practiced by commercial growers. The banker plant method involves placing plants with established whitefly (alternate prey host) and parasitoid colonies in the greenhouse; usually, with a whitefly that cannot establish on the target cash crop. Banker plants support parasitoid survival, multiplication, and their movement by providing the ecological infrastructure needed for their successful establishment within the protected culture. A papaya whitefly-based banker plant system for the control of *B. tabaci* on tomato has been well documented (Xiao et al. 2011). The system consists of (1) papaya as a banker plant hosting *T. variabilis* (papaya whitefly); (2) T. variabilis as an alternative host of *E. sophia*, which feed on papaya plants, but are not a pest of tomato; (3) *E. sophia* as the natural enemy, which exhibits strong dispersal ability and great parasitism to both *B. tabaci* and *T. variabilis*; and (4) *B. tabaci* is the target pest of tomato which is a major fresh vegetable crop (Figure 5). The system works well in regulating *B. tabaci* in tomato and poinsettia nurseries in Florida (USDA 2012). This is a vital strategy due to the difficulty in controlling *B. tabaci* populations (MED and MEAM1) with reduced susceptibility to multiple classes of chemical insecticides, as well as their status as a vector for several plant damaging viruses. It also offers organic greenhouse/nursery growers an efficient tool to reduce *B. tabaci* outbreaks in their production units.

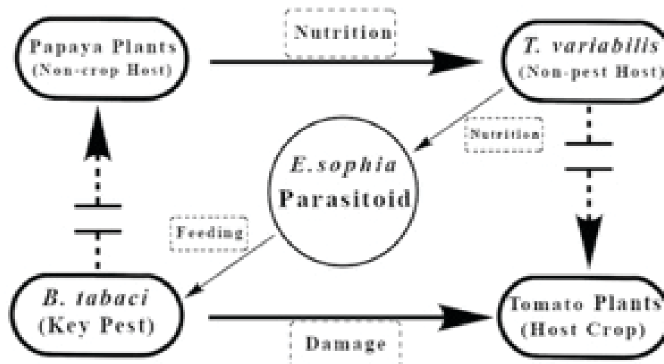

Figure 5. Schematic of an *Encarsia sophia–Trialeurodes variabilis* papaya banker plant system for control of *Bemisia tabaci*.
Credits: Yingfang Xiao, University of Florida

Selected References

Chen TH, Li M, Wang JH, Zhang F, Li YX. 2013. Vulnerability window for laying male eggs and superparasitism in producing female offspring of *Encarsia sophia* on *Bemisia tabaci* B biotype. *BioControl* 58:27–36.

Fauna Europaea (FE). 2017. https://fauna-eu.org/cdm_dataportal/taxon/9914864c-1beb-444b-b84c-06e32b9a2ccd. 10 July 2017.

Gerling D. 1983. Observations of the biologies and interrelationships of parasites attacking the greenhouse whitefly, *Trialeurodes vaporariorum* (West.), in Hawaii. Proceedings of Hawaiian *Entomological Society* 24: 217–225.

Giorgini M,Baldanza F.2004.Species status of two populations of *Encarsia sophia* (Girault and Dodd) (Hymenoptera: Aphelinidae) native to different geographic areas. *Biological Control* 30:25–35.

Global Biodiversity Information Facility (GBIF). 2017. http://www.gbif.org/species/1365395. 10 July 2017.

Hayat M. 1989. A revision of the species of *Encarsia foerster* (Hymenoptera: Aphelinidae) from India and the adjacent countries. *Oriental Insects* 23: 1–131.

Heraty JM, Polaszek A. 2000. Morphometric analysis and descriptions of selected species in the *Encarsia strenua* group (Hymenoptera: Aphelinidae). *Journal of Hymenoptera Research* 9: 142–169.

Hoelmer K, Goolsby J. 2002. Release, establishment and monitoring of *Bemisia tabaci* natural enemies in the United States. Proceedings of the 1st International Symposium on Biological Control of Arthropods, Honolulu, Hawaii, 14–18 January 2002. United States Department of Agriculture, Forest Service, Washington, USA, 2002. 58–65.

Hunter MS, Kelly SE. 1998. Hyperparasitism by an exotic autoparasitoid: secondary host selection and the window of vulnerability of conspecific and native heterospecific hosts. *Entomologia Experimentalis et Applicata* 89:249–259.

Luo C, Liu TX. 2011. Fitness of *Encarsia sophia* (Hymenoptera: Aphelinidae) parasitizing *Trialeurodes vaporariorum* and *Bemisia tabaci* (Hemiptera: Aleyrodidae). *Insect Science* 18:84–91.

Polaszek A, Evans GA, Bennet FD. 1992. *Encarsia* parasitoids of *Bemisia tabaci* (Hymenoptera: Aphelinidae, Homoptera: Aleyrodidae): a preliminary guide to identification. *Bulletin of Entomological Research* 82: 375–392.

Timberlake PH. 1926. New species of Hawaiian chalcid flies (Hymenoptera). *Proceedings of the Hawaiian Entomological Society* 2: 305–321.

Universal Chalcidoidea Database (UCD). 2017. Natural History Mueseum, United Kingdom. http://www.nhm.ac.uk/our-science/data/chalcidoids/database/detail.dsml?VALSPECIES=sophia&VALDATE=1915&FamilyCode=BD&HOMCODE=0&ValidAuthBracket=true&VALGENUS=Encarsia&VALAUTHOR=%28Girault+and+Dodd%29&&listPageURL=browseMedia%2edsml%3f&tab=distribution. 7 July 2017.

United States Department of Agriculture (USDA). 2012. Banking on plants as storehouses. *AgResearch Magazine* 60:20-21. https://agresearchmag.ars.usda.gov/AR/archive/2012/Sep/plants0912.pdf. July 12 2017.

Xiao Y, Chen J, Cantliffe D, Mckenzie C, Houben K, Osborne LS. 2011. Establishment of papaya banker plant system for parasitoid, *Encarsia sophia* (Hymenoptera: Aphilidae) against *Bemisia tabaci* (Hemiptera: Aleyrodidae) in greenhouse tomato production. *Biological Control* 58: 239–247.

Zang LS, Liu TX. 2008. Host feeding of three whitefly parasitoid species on *Bemisia tabaci* Biotype B, with implications for whitefly biological control. *Entomologia Experimentalis et Applicata* 127: 55–63.

Zhou CQ, Li YX, Liu TX, Zhang F, Luo C. 2010. Development and morphology of female immature of *Encarsia sophia* and their longevity and fecundity. *Chinese Journal of Biological Control* 26:113–118.