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Citrus Leafminer Parasitoid, *Ageniaspis citricola* Logvinovskaya (Insecta: Hymenoptera: Encyrtidae)[1]

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Introduction

The encyrtid parasitoid *Ageniaspis citricola* was first imported into Florida from Australia in 1994 in a classical biological control program against the citrus leafminer, *Phyllocnistis citrella* Stainton (Hoy and Nguyen 1994a). A second strain of *Ageniaspis citricola* was introduced into Florida from Taiwan in 1997, although there is no evidence that this second strain ever established (Hoy and Nguyen 1997). The citrus leafminer was first detected in Florida in 1993, and quickly spread throughout all 860,000 acres of citrus, posing a serious threat to the state's citrus industry. The population of *A. citricola* from Australia quickly established and dispersed throughout the state, reaching parasitism levels near 100% in some areas (Hoy et al. 1995ab, Knapp et al. 1995, Bullock et al. 1996, Pomerinke and Stansly 1998). *Ageniaspis citricola* is consistently the dominant parasitoid of citrus leafminer in Florida.

Distribution

Ageniaspis citricola is well-adapted to humid tropical and subtropical climates. *Ageniaspis citricola* was originally described from Vietnam (Logvinovskaya), and is also found in Thailand and Taiwan (Morakote and Nanta 1996a, Ujiye 1996). Through classical biological control programs, successful introductions of *A. citricola* have been made in Queensland Australia, Florida, Louisiana, the Bahamas, Honduras, Brazil and Peru. Releases have also been made in Morocco, Israel and Spain, although *A. citricola* does not perform well in those arid Mediterranean climates.

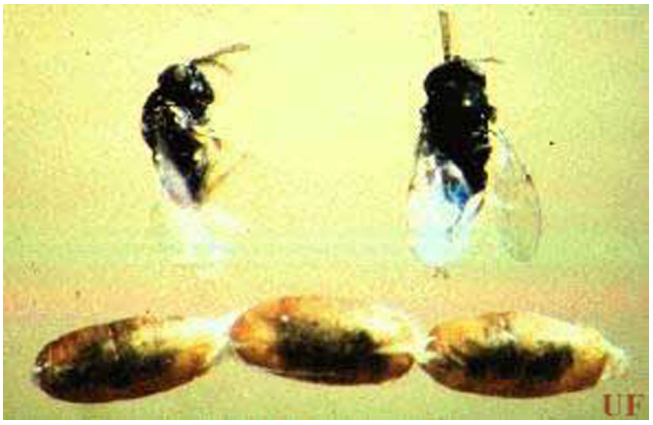

Figure 1. Adult females and pupae of *Ageniaspis citricola* Logvinovskaya. Credits: SW Florida Research and Education Center, University of Florida

1. This document is EENY-285 one of a series of Featured Creatures from the Entomology and Nematology Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Published: March 2003. This document is also available on Featured Creatures Website at **http://creatures.ifas.ufl.edu**. Please visit the EDIS Website at **http://edis.ifas.ufl.edu**. Additional information on these organisms, including many color photographs, is available at the Entomology and Nematology Department website at **http://entnemdept.ifas.ufl.edu/**.

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When *A. citricola* was introduced into Florida from Australia, it was reported to disperse rapidly, up to 300 km within a year (Pomerinke and Stansly 1998). *Ageniaspis citricola* is now well established in all citrus-producing areas of the state.

Description

Ageniaspis citricola is approximately 0.7 to 0.8 mm long. The abdomen of the female is small and triangular, and the thorax is considerably longer than the abdomen. Both males and females are black in color, with fine silvery white pubescence, and with tarsi and portions of the tibiae colored yellow. Antennae are clubbed, 7-segmented and yellowish-brown in color, with a darker scape and pedicel.

Figure 2. Adult female of *Ageniaspis citricola* Logvinovskaya. Credits: M. Hoy, University of Florida; and R. Nguyen, Division of Plant Industry

Ageniaspis citricola pupae are small, elliptical and linked together in chains of approximately two to eight pupae. Pupae are cream colored early in development, but become darker brown, and then black just before adult emergence. Pupae of *A. citricola* may be found by opening the pupal cell of the citrus leafminer, which often is at the leaf margin. Citrus leafminer larvae that have been parasitized by *A. citricola* appear slightly darkened.

Biology

Ageniaspis citricola is a host-specific, koinobiont, endoparasitoid of citrus leafminer eggs and early instar larvae. All stages of the parasitoid develop within the citrus leafminer host. After being

Figure 3. Pupal cell in leaf with two to four *Ageniaspis citricola* Logvinovskaya pupae. Credits: M. Hoy, University of Florida; and R. Nguyen, Division of Plant Industry

parasitized, the citrus leafminer will continue to feed and develop in leaf mines, going on to form a pupal chamber at the end of the mine. At this point, *A. citricola* kills its host and pupates within the exoskeleton of the citrus leafminer in the pupal chamber. Adult *A. citricola* emerge from the pupal chamber by chewing a hole in the silk holding the leaf chamber together. One female can produce one to 10 progeny per single host, with an average of 2.8±1.1 *A. citricola* emerging per pupal chamber under laboratory conditions (Smith and Hoy 1995).

Both females and males are produced, contrary to previous reports of thelytoky (Evans 1995). Thus, *A. citricola* is arrhenotokous, meaning that unmated females will produce only haploid males. The average sex ratio in laboratory colonies is approximately 1 male: 1.8 females (Smith and Hoy 1995).

Ageniaspis citricola takes approximately 16 to 18 days to complete its life cycle at greenhouse conditions of approximately 30°C and 80 to 90% RH (Smith and Hoy 1995). Adults live an average of two to five days, with the greatest longevity at 96% humidity (Edwards and Hoy 1998).

Several authors (Neale et al. 1995, Smith and Hoy 1995, Argov and Rossler 1996, Smith and Beattie 1996, Smith and Neale 1996) have reported on the difficulties of mass-rearing *A. citricola*. Adults require very high humidity levels (Yoder and Hoy 1998), are short-lived, are susceptible to desiccation and rough handling ie., aspiration, and are easily trapped and drowned in moisture or honey drops.

Hoy et al. (2000) and Alvarez and Hoy (2002) conducted genomic analyses (RAPD-PCR) and analyses of actin gene sequences of *A. citricola* populations from Australia and Taiwan, and found differences suggesting the two populations are cryptic species. The two strains were observed to have different net water loss rates in the adult stage (Yoder and Hoy 1998).

Classical Biological Control

Ageniaspis citricola was introduced into Queensland, Australia from Thailand in 1991 to control the citrus leafminer. Based on the success of that introduction, *A. citricola* was imported into Florida from Australia in 1994 upon discovery of the citrus leafminer. Approximately 3000 pupae were hand carried from Australia into quarantine facilities at the Department of Plant Industries, Gainesville, FL. The first releases of *A. citricola* took place in Florida citrus groves on 30 April 1994. Parasitism rates by *A. citricola* as high as 86% were observed in some groves (Hoy and Nguyen 1997, Pomerinke and Stansly 1998).

Ageniaspis citricola were subsequently shipped to Louisiana, where parasitism levels were reported to be 60 to 100% in some areas of the state within the first year (Johnson et al. 1998). Additional classical biological control programs for *A. citricola* have been implemented in the Bahamas, Honduras, Brazil and Peru.

Johnson et al. (1998) found that insecticide use may limit *A. citricola*'s effectiveness based on parasitism levels in routinely sprayed vs. unsprayed orchards in Louisiana. Villanueva and Hoy (1998) and Villanueva et al. (2000) evaluated the relative effects of pesticides on *A. citricola* and identified several IPM-compatible pesticides for use in citrus groves and nurseries.

Ageniaspis citricola has all the attributes of a highly effective natural enemy: 1) host specificity, 2) high reproductive rate, 3) high dispersal rate, and 4) high searching rate. It has performed exceptionally well as a natural enemy given the correct climatic conditions, ie., high relative humidity. However, several recent years of drought conditions in Florida had a negative effect on *A. citricola* populations, resulting in parasitoid populations lagging behind leafminer populations. An additional parasitoid may be imported, evaluated and released to complement the control provided by *A. citricola* in Florida.

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