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AGENIASPIS CITRICOLA (HYMENOPTERA: ENCYRTIDAE) ESTABLISHED IN BERMUDA

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The citrus leafminer, *Phyllocnistis citrella* Stainton (Lepidoptera: Gracillariidae), was first found on November 21, 1998 and rapidly colonized all citrus trees in the 53.3 square km that comprise the islands of Bermuda (Jessey-Aldrich 1999). Management of the citrus leafminer with pesticides or cultural controls soon was found to be difficult and expensive, in part due to the biology of the pest; citrus leafminer females deposit eggs singly upon tender young citrus foliage (flush) and the larva then enters the leaf where it feeds on epidermal cells, producing broad serpentine mines in the leaves (Heppner 1993). High densities of *P. citrella* result in leaves that are twisted and damaged, have reduced rates of photosynthesis and, under severe conditions, may defoliate. Only a few parasitoids were found attacking the citrus leafminer at very low rates (<1%) after its arrival in Bermuda; these were identified as the eulophids *Closterocerus cinctipennis* Ashmead and *Pnigalio minio* Walker (C. Jessey, unpubl.).

Because leaves often contained more than five to six mines on their new growth, a classical biological control program was initiated by the Bermuda Department of Agriculture and Fisheries in January 2000 and the encyrtid *Ageniaspis citricola* Logvinovskaya was imported into Bermuda from a laboratory culture maintained in Florida (Smith & Hoy 1995). *Ageniaspis citricola* had established rapidly in Florida and performed well under Florida's humid subtropical conditions (Hoy & Nguyen 1997; Yoder & Hoy 1998).

Ageniaspis citricola is a koinobiont endoparasitoid and is polyembryonic, producing between one and ten progeny per leafminer host, averaging three (Hoy & Nguyen 1997; Edwards & Hoy 1998). It appears to be specific to the citrus leafminer, having been reared from very few other hosts (Hoy & Nguyen 1997). Parasitoid females attack eggs and small larvae of the leafminer and the developing leafminer pupates before the parasitoid completes its development within the host's pupal chamber.

Prior to releases of *A. citricola*, citrus trees were monitored throughout Bermuda in November 1999 to estimate the relative abundance of citrus leafminers on young flush. The survey indicated that the pest had colonized the entire island and all flush was infested with as many as six mines per leaf. Approximately 600 *A. citricola* were reared in the laboratory at the University of Florida in Gainesville (Smith & Hoy 1995) and shipped to the Bermuda Department of Agriculture and Fisheries as pupae. Pupae were held in the laboratory in plastic bags and emerging adults aspirated out for releases on January 25-27, 31 and February 2-10, 2000. Releases were made at eight sites into citrus trees containing young foliage and abundant citrus leafminers.

In April 2000, citrus trees were monitored to determine the number of mines and the proportion of pupal chambers that contained the citrus leafminer or *A. citricola* and *A. citricola* was already present in the majority of release sites surveyed (data not shown). Another survey was conducted in July 2002 at release and nonrelease sites (19 total) (Table 1). During this survey, intact pupal chambers were opened and the presence of leafminer or *A. citricola* pupae was recorded. An average of 94.3% of all pupal chambers contained *A. citricola* in July 2002. In some sites, fewer than 20 pupal chambers could be sampled because leafminer densities were very low in all trees sampled, always averaging fewer than one leafminer per leaf. Examination of older flushes during this survey indicated that, on average, the leaves on the previous flushes contained fewer than one mine per leaf, as well. The survey data suggest that citrus leafminer populations are lower than prior to the release and establishment of *A. citricola* and homeowners contacted during this 2002 survey indicated that most have discontinued pesticide applications for the citrus leafminer. This work was supported in part with funding from the Bermuda Department of Agriculture and Fisheries and the Davies, Fischer and Eckes Endowment in Biological Control. This is Florida Agricultural Experiment Station Journal Publication R-09858.

SUMMARY

Ageniaspis citricola has overwintered and dispersed since its release in humid subtropical Bermuda in 2000 and was found in all citrus trees sampled in 2002. It has become an important natural enemy of the citrus leafminer in Bermuda.

TABLE 1. SURVEY OF BERMUDA DURING JULY 2002 FOR ESTABLISHMENT AND RELATIVE ABUNDANCE OF *AGENIASPIS CITRICOLA* AND ITS HOST, THE CITRUS LEAFMINER. ATTEMPTS WERE MADE TO EXAMINE 20 PUPAL CHAMBERS FOR PRESENCE OF THE LEAFMINER *OR A. CITRICOLA* PUPAE AT EACH SITE BUT DENSITIES WERE SO LOW THAT FEWER WERE SAMPLED AT SOME.

Date 2002	Location/Parish	No. pupal chambers opened	% parasitized by *A. citricola*	Release site yes/no
7/26	1. Glasglow Lodge/Southampton	20	90	yes
	2. Newstead Hotel/Paget	9	89	no
	3. White Lodge/Pembroke	20	95	no
	4. Shaw Park/Pembroke	20	95	no
7/29	5. Government House/Pembroke	20	100	no
7/29	6. Crestwood/Paget	21	86	yes
7/29	7. Tungate/Paget	20	95	yes
7/29	8. Botanical Gardens/Paget	10	70	yes
7/30	9. Malpas House/Somerset	21	100	no
7/30	10. Old School Lane/Somerset	13	100	no
7/30	11. Parapet/Somerset	20	100	no
7/30	12. Chapel/Ease/St. Davids	22	91	no
7/30	13. Glen Duror/St. Georges	19	100	no
7/31	14. Hexham/Hamilton	21	95	no
7/30	15. Knapton House/Hamilton	2	100	no
7/30	16. Honey House/Hamilton	22	100	no
7/31	17. Windy Bank/Smiths	20	95	no
7/31	18. Sleepy Hollow/Hamilton	20	90	yes
7/31	19. Coral Beach/Paget	20	100	yes

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