

RELEASE AND RECOVERY OF THE CITRUS WHITEFLY
PARASITE *ENCARSIA LAHORENSIS* (HYMENOPTERA:
APHELINIDAE) IN NORTH CAROLINA

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The citrus whitefly, *Dialeurodes citri* (Ashmead), is a pest of a variety of ornamental and crop plants grown in the southeastern United States, including citrus, gardenia, ligustrum and viburnum. Host damage results from the large quantities of sap consumed, and by the sooty mold that grows on excreted honeydew. North Carolina, together with the coast of Virginia, is the northern limit of citrus whitefly in the eastern United States (Weems 1973). In this extreme part of its range, the host plants of *D. citri* are overwhelmingly *Gardenia* spp. (*G. fortuniana*, *G. radicans*, and *G. jasminoides*), but it also has been reported from *Hibiscus* spp. and *Ligustrum* spp. (D. L. Stephan, N.C. State University Plant Disease and Insect Clinic, pers. comm.). A survey of plant nurseries in the southeast quadrant of North Carolina conducted by the Agricultural Extension Service of North Carolina State University in 1979 indicated that gardenias present at each site were infested with citrus whitefly (J. R. Baker, Entomology Department, N.C. State University, personal communication).

The parasitic wasp *Encarsia lahorensis* (Howard) (Hymenoptera: Aphelinidae) parasitizes late instar larvae of citrus whitefly and has become successfully established in Florida (Ru & Sailer 1979, Sailer et al. 1984), Alabama (Hudson & Williams 1986), and California (Rose & DeBach 1981). Based largely on the success of Florida's statewide release program, the United States Department of Agriculture's (USDA) Animal and Plant Health Inspection Service, Plant Protection and Quarantine, in 1981 initiated a large scale program for the release of *E. lahorensis* in 8 southeastern states, including North Carolina; the program was administrated through the USDA Biological Control Laboratory in Mission, Texas. The Plant Protection Section of the North Carolina Department of Agriculture has cooperated with the federal program since its onset, and continued release and survey activities after the USDA ceased activities in 1988. This report is a summary of the *E. lahorensis* release program in North Carolina.

Two baseline surveys were conducted prior to the initial releases of the parasite in 1982. The goal of the first survey was to determine if natural introductions of *E. lahorensis* were occurring via nursery stock; 20 infested gardenia leaves from 10 nurseries in 8 counties in eastern North Carolina were collected and inspected for parasitized citrus whitefly. Although one pupa and two emergence holes suggestive of parasitism were found on plants shipped from Baker Co., Florida, these represented just 0.1% of the insects examined. We concluded that the importation of citrus whitefly parasites into North Carolina on nursery stock was inconsequential. The second survey was conducted to locate suitable locations for inoculative releases of *E. lahorensis* planned for 1982. Two hundred gardenias in urban areas were located with the cooperation of the Garden Club of North Carolina, Inc. and sampled by collecting and inspecting 10 leaves. Citrus whitefly was present in 94% of 200 surveyed sites. Additional hosts were subsequently located, for a total of 215 planned release sites in 53 counties in the eastern half of North Carolina.

The method of parasite distribution by the USDA was one that already had proven successful in Florida. Potted *Gardenia radicans* (approx. 15 cm tall) were infested with citrus whiteflies, which were, in turn, parasitized by *E. lahorensis*. These "nurse

plants" were then placed in the ground beneath infested hosts at the release site, allowing for short term continuous emergence of adult wasps. Two or 3 nurse plants with an estimated 20 immature parasites per plant were placed at each site. Releases were conducted annually in North Carolina between 1982 and 1990 (Table 1). The USDA Facility in Texas was the source of parasites between 1982 and 1987. In 1988 and 1989, pupae of *E. lahorensis* were collected by F. D. Bennett (University of Florida) in Alachua Co., Florida, on chinaberry, *Melia azedarack* or *Viburnum* sp. and shipped to North Carolina; these were held in quarantine until emergence, then released as adults in infested sites. The sole release in 1990 was a redistribution of *E. lahorensis* already established in North Carolina.

Surveys were conducted annually between 1983 and 1990 and were simple qualitative assessments of parasitism on the host plants, i.e., the presence of an emergence hole, or of a larva or pupa of *E. lahorensis*. Initial surveys were encouraging; samples taken in 1983 from all 215 initial release sites indicated 25% establishment, with *E. lahorensis* present in 26 counties. After the survey in 1983, re-releases were made in 80 of the original sites (36 counties).

During December of 1983, killing frosts for three consecutive nights caused significant damage to gardenias throughout the North Carolina parasite release area. On the coast (Wilmington) temperatures dipped below -12°C on December 24, 25 and 26. In a survey mailed to homeowners at release sites, 49% of 209 respondents reported 90-100% leaf drop on gardenias. Parasite surveys in 1984 reflected the effect of the freeze on *E. lahorensis*; sites positive for parasitism had dropped to 11%, with parasites in just 5 of 42 counties surveyed. A second winter of severe weather devastated the remaining parasites. In 1985, temperatures reached a minimum of -19 and -23°C in Raleigh and -11 and -15°C in Wilmington on January 20 and 21. In a survey of 48 sites in 26 counties in spring of 1985, no *E. lahorensis* were found to have survived the harsh winter, primarily due to the nearly 100% defoliation of gardenias in the state, and the subsequent loss of host material for parasites that may have survived in leaf litter. A majority of the host gardenias died, or were uprooted or cut back by homeowners.

Parasites were optimistically re-released in September of 1985 in 6 sites in Wilmington (New Hanover Co.) where the presence of citrus whitefly was detected at low levels; surveys of these sites the following month indicated presence of the wasp at

TABLE 1. RELEASES OF *ENCARSIA LAHORENSIS* IN NORTH CAROLINA. NUMBERS OF PARASITES RELEASED ARE BASED ON AN ASSUMED AVERAGE OF 20 PARASITES PER NURSE PLANT.

Year	Total No. Sites	Total No. Counties	Total No. Released	No. Released in Wake Co.	No. Released in N. Hanover Co.
1982	215	53	4300	200	260
1983	80	36	4000	120	660
1984	44	26	3600	160	640
1985	6	2	720	0	660
1986	4	1	240	0	240
1987	16	5	960	0	400
1988	1	1	205	205	0
1989	1	1	174	174	0
1990	1	1	200	200	0

half the sites. Yearly releases of *E. lahorensis* continued until 1990, concentrating initially in coastal counties and, after 1988, at a single site in Raleigh (Wake Co.). Yearly surveys from 1986 to 1990 suggested that *E. lahorensis* was regaining its foothold in North Carolina; between 44% and 83% of the sampled sites were positive for parasitism in the five years these surveys were conducted (n=4 to 17 sites/survey).

In spring of 1995, a survey was conducted in Wilmington to determine if *E. lahorensis* had persisted since 1987, the last time releases were made at the coast. Collections were made 13 March 1995 from 10 sites, with 15 leaves collected at each site. Heavily infested hosts were sampled by collecting leaves at random, but in lightly infested hosts, a directed search for leaves with whiteflies was made. *D. citri* was rare in all but 4 of the sites. At the lightest degree of infestation, 15 leaves with citrus whitefly could not be found; whiteflies were found on only 3 leaves of the bush. The sooty mold indicative of high whitefly infestation levels was found at just 1 site. Collected leaves were brought back to the laboratory and the number of live and parasitized whitefly nymphs counted. Leaves were then held in glass petri dishes and the parasites allowed to emerge. Parasitized nymphs were collected from all sites; both larvae and pupae of the parasite were present. Overall parasitism rate was about 10% (92 of 962 whiteflies) but ranged widely between sites. Emerged parasites were identified as *E. lahorensis*; one individual was an unknown species of *Encarsia*. A plot of the data indicates that a proportional increase in the number of whiteflies present was associated with a linear increase in parasitism by *E. lahorensis* (Fig. 1). Parasitism averaged 50% at the 4 sites that had 10 or fewer whiteflies present on the 15 sampled leaves, but 15% and 4% in sites with 108 and 724 live whiteflies, respectively. These results are compelling because *E. lahorensis* is known to be able to reproduce at extremely low host densities, but does not always respond rapidly to host population increases (Rose & DeBach 1981).

Because it has persisted for eight years since the last releases were made in Wilmington, *E. lahorensis* may be considered well established in coastal North Carolina. There are also indications that the parasite has spread from points of release; 3 sites negative in 1989 were positive in 1995, and 3 positive sites were found several kilometers from known release points. Inspection of the gardenia in Raleigh that served as a release site between 1988 and 1990 suggests a 5 year persistence of *E. lahorensis* in the central piedmont of the state.

Because gardenias in North Carolina are susceptible to cold injury, populations of *E. lahorensis* are likely to be lost if we experience another winter severe enough to cause defoliation. However, parasites that have spread to citrus whitefly on gardenias in protected locations, or on hardy evergreen hosts (ex., *Ligustrum* sp.), may serve as reservoirs from which the insect may again disperse.

I thank Lloyd Wendel and Fred Bennett for supplying the parasites, Mrs. J. Moncrief and the Garden Club of North Carolina for assistance in the location of release sites, and USDA-APHIS-PPQ for the inclusion of North Carolina in the parasite release program. The extensive release and survey activities would not have been possible without the participation of both the USDA and NCDA field staff; thanks go to Al Martin, John Scott, Fred Planer and Bruce Roggenstein for the coordination of activities. I am grateful to Dave Stephan for host records in North Carolina, Jim Baker for unpublished data, Ken Ahlstrom for taxonomic expertise, and Kathy Kidd for help in the 1995 survey.

SUMMARY

Releases of the citrus whitefly parasite *Encarsia lahorensis* in the eastern half of North Carolina in 1982 and 1983 resulted in establishment. Subsequently, two severe

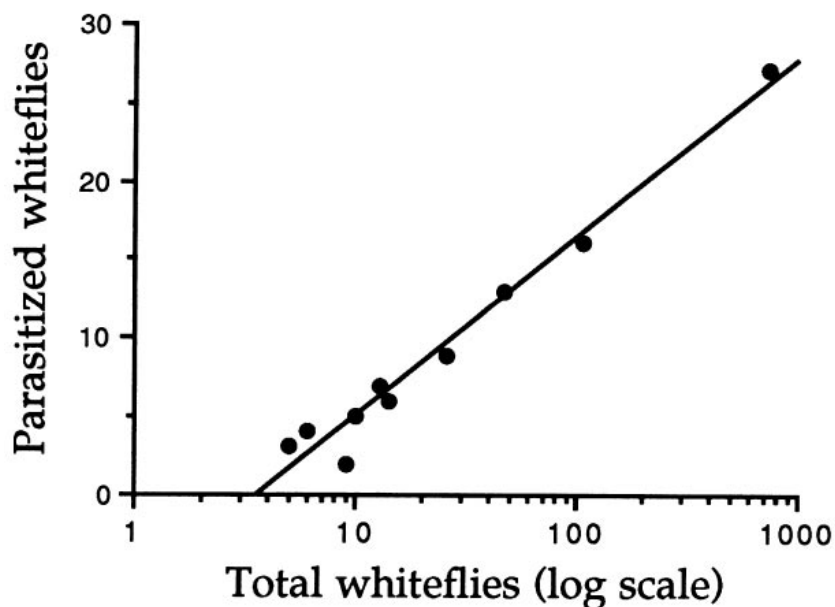


Fig. 1. The number of parasitized citrus whiteflies per 15 leaf sample as a function of the logarithm₁₀ number of live whitefly larvae and pupae overwintering at 10 sites in Wilmington, North Carolina in 1995. The relationship is described by the expression $y = -6.34 + 11.37(\log x)$; $R^2 = 0.97$.

winters reduced populations of the parasite to non-detectable levels. Yearly releases from 1984-1990 have led to re-establishment in the southeast corner of the state and a local population in the central piedmont.

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