BIOLOGICAL CONTROL OF EUCALLIPTERUS TILIAE [HOM. : APHIDIDAE] IN SAN JOSE, CALIF., THROUGH ESTABLISHMENT OF TRIOXYS CURVICAUDUS [HYM. : APHIDIIDAE]

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Trioxys curvicaudus Mackauer, an introduced parasitoid which had already proven successful in bringing the linden aphid, Eucallipterus tiliae L., under biological control in Berkeley, Calif., was released in 1978 in San Jose, Calif., where the aphid was still a pest. Recovery of the parasitoid was made later the same season. Monitoring and dissection studies of E. tiliae in 1979 and 1980 demonstrated that T. curvicaudus had become established in San Jose and was exerting a controlling influence on the aphid. Native natural enemies did not appear to have any appreciable effect on aphid numbers. It is proposed that prior to the introduction of T. curvicaudus, the aphid’s major limiting factor was the occurrence of mean daily temperatures above 22 °C.

Personnel from the John Muir Institute (JMI) have been working with the City of San Jose, Calif, since 1974 to develop an integrated program for managing the City’s streetside shade trees. In 1976, attention was directed to a stand of big-leaf lindens, Tilia platyphyllos Scopoli, with high numbers of an aphid, Eucallipterus tiliae L. (Richards, 1965). Only 1 parasitoid was detected, an unidentified species of Mesidiopsis (Hym. : Aphelinidae). Though the aphids did not appear to pose a threat to the health of the trees, the sticky honeydew they produced was a major nuisance to the homeowners and people passing underneath the trees. This paper reports the study conducted from 1976 through 1980 which recorded aphid numbers, honeydew production, natural enemy occurrence, and measured the effectiveness of an imported biological control agent.

Previous to this, 2 other aphids had been brought under biological control in California through parasitoid importations: the spotted alfalfa aphid, Therioaphis maculata (Buckton), and the walnut aphid, Chromaphis juglandicola (Kaltenbach) (van den Bosch et al., 1959; van den Bosch et al., 1970). The latter case was especially noteworthy as it involved the establishment of only a single species, Trioxys pallidus (Haliday), which was promptly recovered and demonstrated immediate effectiveness.

In 1970, a biological control effort was undertaken by workers from the University of California, Berkeley, to control E. tiliae in Berkeley. A solitary parasitoid, Trioxys curvicaudus Mackauer (Mackauer, 1967), was imported from France and Italy and released (Olkowski et al., 1982). The parasitoid proved perfectly capable of bringing E. tiliae under control in Berkeley, so when E. tiliae was also found to be a problem in San Jose, Calif. (a city about 100 km south of Berkeley), Dr. Olkowski, director of the JMI Pest Management group, decided to attempt to
colonize $T. \text{curvicaudus}$ there. Adult $T. \text{curvicaudus}$ collected in Berkeley were released in San Jose in 1978. Evidence of $T. \text{curvicaudus}$ parasitism was noted later that same season, and observations in 1979 and 1980 indicated that the parasitoid had become firmly established in San Jose and had brought $E. \text{tiliae}$ substantially under control.

**MATERIALS AND METHODS**

In 1976, a stand of $T. \text{platyphyllos}$ on Clark Way in San Jose was surveyed for $E. \text{tiliae}$. The 5 trees with the highest aphid populations were noted and monitored thereafter on a weekly basis. Monitoring was conducted by walking around each tree and randomly sampling 20 leaves from the lower, inner canopies. Each leaf was examined for aphids, parasitoid mummies, predators and honeydew accumulation. In 1978 the sample size was increased to 40 leaves/tree and the number of trees monitored reduced to 4. Monitoring continued each year until leaf senescence in the fall. Beginning in 1977, 25 late-instar or adult aphids were collected each week and dissected to determine the percent parasitism by aphidiid or aphelinid species. In 1980 the number of dissections was increased to 50/week. The mean daily temperature in San Jose was obtained from the monthly meteorological summary prepared by the city’s Office of Emergency Services. These daily temperatures were averaged on a weekly basis to correspond with each sampling date. These studies were continued through the fall of 1980.

In 1978, $T. \text{curvicaudus}$ mummies were collected from the leaves of a tree at one of the original release sites in Berkeley. Emerging hyperparasites were noted and destroyed. Emerging $T. \text{curvicaudus}$ ♀ and ♂ adults were placed in vials and observed until they mated. A total of 8 mated ♀♀ and 3 ♂♂ was released in San Jose between July 27 and Sept. 12. All releases took place on a tree at 1134 Clark Way by opening the vials and allowing the adults to walk out upon leaves with late-instar or adult aphids present. The parasitoids were observed for as long as possible, and oviposition attempts by some ♀♀ were noted. Resulting $T. \text{curvicaudus}$ mummies found from 1978 to 1980 were collected and put in vials. Emerging $T. \text{curvicaudus}$ and hyperparasite adults were noted and recorded.

**RESULTS**

Figures 1 and 2 show the average number of aphids/leaf, incidence of $T. \text{curvicaudus}$ parasitism and mean daily temperature (MDT) in San Jose for 1976 through 1980. Before the release of $T. \text{curvicaudus}$, $E. \text{tiliae}$ typically remained at a low level (usually less than 5 aphids/leaf) through the spring and early summer. The population would then rise rapidly in mid-summer to peaks of up to 32 aphids/leaf, which led to copious honeydew production. The aphid populations remained high until the MDT surpassed 22 °C. Within 2 weeks of this event, the populations fell to a level of less than 10 aphids/leaf, with a corresponding decrease in honeydew production. In 1977 the aphid population remained low for the rest of the season; in 1976 and 1978 a 2nd (though smaller) peak was observed in the fall. MDTs in excess of 22 °C were always associated with declines in aphid numbers.

The presence of several predacious species ($\text{Chrysopa}$ spp., $\text{Coccinellidae}$, $\text{Hemerobiidae}$ and $\text{Syrphidae}$) was noted. However they were seen only sporadically and had little apparent effect on aphid numbers. The incidence of a naturally-occurring $\text{Mesidiopsis}$ sp. was also quite low, showing 0 % in 71 out of 92 dissection samplings, and with one exception, never rising above 5 %. The single exception occurred in the fall of 1977, when the $\text{Mesidiopsis}$ parasitism rate rose dramatically over a 9 week period, culminating in a peak of 64 % on Oct. 5.