TEMPERATURES LETHAL FOR CITRUS BLACKFLY PARASITES, 
ENCARSIA OPULENTA AND E. SMITHI [HYM.: APHELINIDAE]

C.R. THOMPSON (1)

2309 Iowa st. Cedar Falls, IA 50613, U.S.A.

Seasonally acclimatized adult and immature parasites of the citrus blackfly (CBF), *Aleurocanthus woglumi* Ashby, were exposed to high or low temperature extremes for 3 h periods. Death of all summer adults of *Encarsia opulenta* Silvestri and *E. smithi* Silvestri occurred between 35° and 40°C. Within CBF hosts, *E. opulenta* were not able to emerge when temperatures reached between 45° and 50°C. In winter experiments adults of both *Encarsia* species succumbed between − 5° and − 10°C. In a comparison of the 2 seasonal tests, a higher percentage of *E. smithi* adults were able to survive both higher and lower temperatures than *E. opulenta*, but the main interspecific difference was the ability of *E. opulenta* within CBF to survive − 10° to − 15°C while *E. smithi* did not. Limited data for *Amitus hesperidum* Silvestri [Hym. : Platygasteridae] indicated that the immatures survived better at low, and not as well at high, temperatures as either species of *Encarsia*.

KEY-WORDS : Citrus, parasites, Aphelinidae *Encarsia* spp., lethal temperatures.

Climatic conditions are a factor of major importance when a biological control agent is being considered for importation. Aside from consultation of climatic records, however, studies are rarely directed toward experimentally determining the physiological limits of the species under consideration.

For citrus blackfly control, a multi-parasite approach was used in both Mexico and the United States (Ketner & Rosier, 1978 ; Dowell et al, 1979). In Mexico, several species of parasites, including the platygasterid *Amitus hesperidum* Silvestri, and the aphelinids *Encarsia opulenta* Silvestri and *E. smithi* Silvestri were imported and released as widely as possible. Local climate appeared to be a major factor in parasite success or failure and in the final distribution of those that were successfully established. In Mexico, *E. clypealis* Silvestri was more adapted to high temperatures than *A. hesperidum*. During a hot spring in 1953, daytime temperatures reached 43° to 47°C and *A. hesperidum* mortality reached 90 % (Arrieta Mateos, 1963). Jiménez Jiménez (1961) noted that *A. hesperidum* was established in all except hot, dry regions, whereas *E. opulenta* was present over the entire country. *Encarsia smithi* was successfully established, but continued to do well only in humid coastal area of Mexico (Flanders, 1969 ; Smith et al., 1964).

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Smith (1958) asserted that humidity influenced interspecific competition between *A. hesperidum* and *E. opulenta*. He predicted that *A. hesperidum* would dominate in areas of high CBF populations, high humidity and moderate temperatures. In hosts parasitized by both species, he found that only *E. opulenta* emerged when conditions were dry, while *A. hesperidum* emerged when conditions were humid.

The lethal temperature limits of CBF and one of its parasites, *A. hesperidum*, were not investigated until much later (Cherry, 1979). Cherry found that both winter and summer acclimatized parasite adults were more temperature sensitive than CBF adults. High temperatures were most deleterious to the parasite.

Successful biological control efforts in Texas (Summy et al., 1983) and Florida (Nguyen et al., 1983) indicate that *E. opulenta* becomes dominant when the CBF populations fall to a non-economic level. This parasite is the species of greatest value in maintaining the host’s non-economic status. This paper reports the lethal temperatures of *E. opulenta* and the CBF parasite *E. smithi*, now established in Florida.

**METHODS AND MATERIALS**

Tests of field-collected CBF and the parasites *E. opulenta* and *E. smithi* were made in a constant (± 0.1°C) temperature chamber. Parasites from summer (June-Sept. 1981) populations were tested at 35, 40 and 50°C with controls at 23°C and under high and low humidity regimes (> 90 %, < 20 %). About 20 individuals were tested at each temperature-humidity combination for 3 h. High humidity levels were achieved by lining a glass beaker with fully saturated paper towels which extended into a pan of water below the beaker. Vials of adult parasites or leaves with CBF pupae were placed on the towels inside the beaker. Winter populations (Dec. 1981 - Feb. 1982) of parasites were tested at 0, - 5, - 10 and - 15°C, with controls at 23°C, and high and low humidity regimes. For comparison, limited trials with *A. hesperidum* in CBF pupae at 0, - 5, - 10 and - 15°C, with controls at - 23°C, and high and low humidity regimes were also conducted. Adult insects were examined immediately after testing and again at 24 h. The CBF pupae were held 2 weeks for emergence at ca. 24°C in clear, 0.0015 mm-thick poly-bags. Unemerged pupae were then dissected. Because the percent parasitization of the hosts could not be determined in advance, most trials with CBF 4th instars had to be repeated several times to obtain adequate numbers of parasitized hosts. This prevented computation of standard error values.

**RESULTS AND DISCUSSION**

At high temperatures, no significant differences in mortality of the parasite species occurred between low and high humidities; therefore, data were pooled (table 1). More adults of *E. smithi* than *E. opulenta* survived at 35°C. Some immatures of both species survived temperatures 10°C higher than adults, indicating a probable protective effect of the CBF host body. Throughout the experiment, no recovery or additional mortality occurred in adults examined 24 h later.

Immature *A. hesperidum* in CBF 4th instars were not able to survive 45°C and no significant differences occurred between low and high humidity trials. Cherry (1979) reported survival of 4th instars of this parasite at 45°C.