Notes on the Ovipositional Behavior of Trichogramma fuentesi (Hymenoptera: Trichogrammatidae), an Egg Parasitoid of Cactoblastis cactorum (Lepidoptera: Pyralidae)

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NOTES ON THE OVIPOSITIONAL BEHAVIOR OF *TRICHOGRAMMA FUENTESI* (HYMENOPTERA: TRICHOGRAMMATIDAE), AN EGG PARASITOID OF *CACTOBLASTIS CACTORUM* (LEPIDOPTERA: PYRALIDAE)

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Trichogramma fuentesi Torre (Hymenoptera: Trichogrammatidae) is an arrhenotokous egg parasitoid of *Cactoblastis cactorum* (Berg) (Lepidoptera: Pyralidae). The parasitoid was identified attacking *C. cactorum* eggs at several north Florida locations in 2010 (Paraiso et al. 2011). Low incidence of this natural enemy in the field suggested a need for inundative releases of this parasitoid if it were to exert pressure on *C. cactorum* populations. Effect of important biological parameters on the efficiency of parasitoid mass rearing has been evaluated (Paraiso et al. 2012). However, there was a need to examine basic parasitoid behaviors for improved manipulation of parasitoid populations. Our study characterized host searching and the oviposition sequence of *T. fuentesi*.

Experiments were conducted at the facilities of the USDA-Agricultural Research Service and Florida Agricultural and Mechanical University - Center for Biological Control in Tallahassee, Florida, USA. *Trichogramma fuentesi* females used in this study originated from a field collected rearing colony. Parasitoid identity was confirmed by R. Stouthamer (Department of Entomology, University of California, Riverside, California) by analyzing ribosomal DNA Internal Transcribed Spacer 2 (ITS-2) sequences. Mass rearing of *T. fuentesi* populations was implemented as described by Paraiso et al. (2012). The colonies were maintained in a growth chamber at 28 ± 1 °C, 16:8 h L:D, and 60-80% RH. Individual mated and fed female *T. fuentesi* and a 1-day old *C. cactorum* eggstick with 10 eggs were placed in a plastic Petri dish (30 × 10 mm) lined with filter paper. Host searching and oviposition behaviors of *T. fuentesi* females were studied under a stereoscopic microscope (Keyence-VH 5910) using online Windows Media to record all parasitoid behaviors. Behavioral events were scored using the event recording software Observer® XT version 8.0 (Noldus Information Technology, Wageningen, The Netherlands 2008). Observations were conducted on each Petri dish for a 10 h period (from 9 am to 7 pm). The experiment was replicated five times with different randomly chosen female parasitoids.

Host searching behaviors of *T. fuentesi* were found to be different from most species of *Trichogramma* described in the literature. Most *Trichogramma* spp. are synovigenic; female adults emerge with a partial set of mature eggs and need to feed on host haemolymph and/or tissue to acquire the necessary nutrients for additional egg maturation (Kidd & Jervis 1989). However unlike several other *Trichogramma* species, such as *T. platneri* Nagarkatti, *T. pretiosum* Riley, and *T. brassicae* Bezdenko (Blanché et al. 1996; Mills & Kuhlmann 2004), our study showed that *T. fuentesi* females did not host feed following oviposition. *Trichogramma fuentesi* displayed six types of behavior: walking, resting, grooming, drumming, drilling, and egg laying. Host feeding has been considered a fitness trade-off for parasitoids (Rivero & West 2005). Parasitoids that host feed can increase their longevity and future production of eggs, or they can forgo host feeding and slowly starve, decreasing their longevity but increasing their immediate ovipositional output of their current eggs (Lewis et al. 1998; Rivero & West 2005). Our results suggested that to achieve a high reproductive rate, a *T. fuentesi* female minimized her time spent on host feeding so that the majority of time was spent on oviposition. The general sequence of behaviors, total duration of each behavior, mean duration per behavioral event, and rate (the mean frequency of behavioral event per hour) for each behavior was determined (Table 1). During a 60 min period, walking accounted for 65% of the observation time suggesting that the majority of the energy reserve of *T. fuentesi* was spent on searching and not ovipositing (Table 1). Over a 60 min observation period, a female spent an average of 48 min host searching (walking and drumming) and 7 min parasitizing (drilling and egg laying) *C.*

TABLE 1. TOTAL MEAN TIME, MEAN TIME PER BEHAVIORAL EVENT, AND FREQUENCY OF EACH BEHAVIORAL EVENT (± S.E.) DISPLAYED BY 5 FEMALE *TRICHOGRAMMA FUENTESI* OVER A 10 H OBSERVATION PERIOD AVERGAGED TO 60 MIN FOR 6 HOST SEARCHING AND OVIPOSITIONAL BEHAVIORS WHEN ASSOCIATED WITH *CACTOBLASTIS CACTORUM* EGGS.

	Behavior					
Parameters	Walking	Grooming	Resting	Drumming	Drilling	Egg laying
Total duration (seconds)	2332 ± 160	50 ± 11	188 ± 53	563 ± 62	146 ± 40	300 ± 76
Mean time/behavioral event (seconds)	95 ± 13	15 ± 2.4	82 ± 13	22 ± 3.2	79 ± 21	143 ± 15
Frequency of behavioral event	23± 12	3 ± 2	2.9 ± 0.5	24 ± 13	1.9 ± 0.7	1.9 ± 0.5

cactorum eggs (Table 1). The rate for drilling and egg laying behavior was compared using analysis of variance (PROC GLIMMIX) and fit to a model of a Poisson distribution. Statistical analysis revealed no significant difference between the frequencies of drilling and egg laying behaviors suggesting that female parasitoids oviposited an egg at each drilling event (Table 1). Grooming and resting were infrequent behaviors, and of relatively short duration, especially grooming (Table 1). The mean duration for ovipositional behaviors (drilling and egg laying) decreased as the observation time increased and it was highest for the first and seventh hours (Fig. 1). Conversely, host searching (walking and drumming behaviors) was at its lowest level in the first hour and increased as time elapsed. However, a sharp decrease was observed at the seventh hour, the same hour that oviposition behaviors sharply increased (Fig. 1). The mean duration for egg laying activity was greatest during the first and second hours of observation and least for the last (10 h) hour of observation. A linear regression analysis showed that the mean duration of the egg laying behavior significantly declined as the observation time increased ($F = 5.74$; df = 1, 36; $P < 0.05$). Non-host feeders use sources of carbohydrates for maintenance while relying on proteins and fat reserves acquired during larval stage for egg maturation (Bernstein & Jervis 2008). However, when sources of carbohydrates become limited, female wasps might use the proteins reserves for somatic maintenance which may result in egg resorption (Bernstein & Jervis 2008). Our study suggested that to increase mass rearing efficiency of *T. fuentesi*, female parasitoids may increase their fecundity if they were provided with a source of carbohydrates, and their exposure to *C. cactorum* hosts lasted at least 2 h.

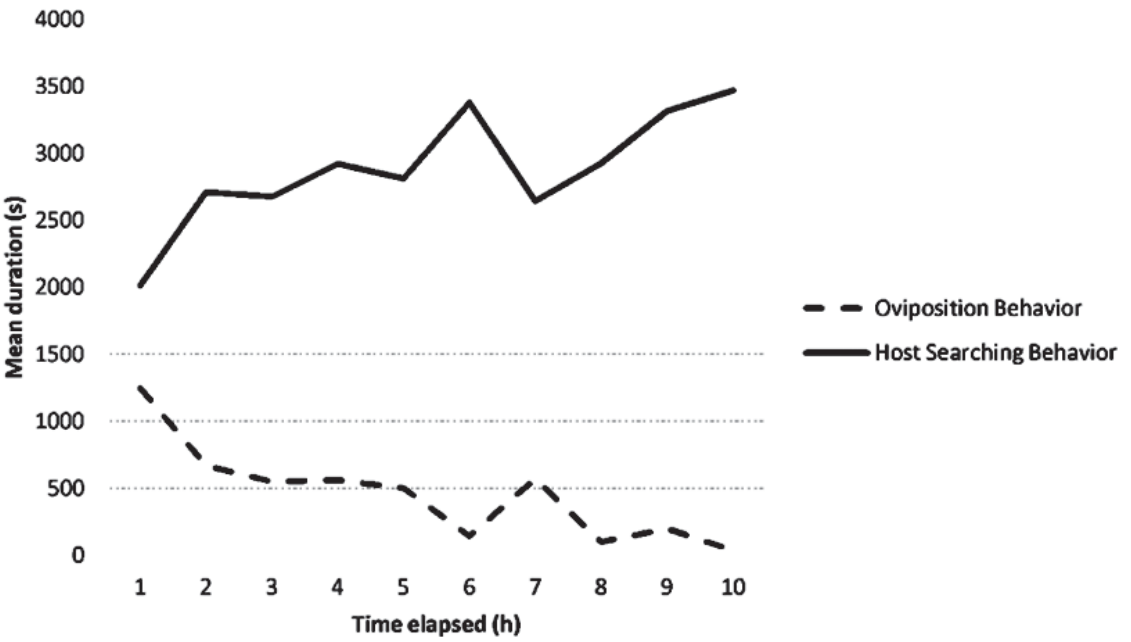

Fig. 1. Mean duration for ovipositional and host searching behaviors by 5 *Trichogramma fuentesi* females on *Cactoblastis cactorum* eggs for each h of 10 h of observation.

SUMMARY

Our study characterized host searching and oviposition ability of *T. fuentesi*. In general, female wasps walked to a *C. cactorum* egg, drummed over the surface, drilled into the chorion, and deposited an egg. Grooming and resting behaviors were observed infrequently and host feeding was never recorded. In a typical observation period of 60 min with eggs of the exotic *C. cactorum*, female parasitoids spent 16% of their time drumming, 4% drilling, and 8% egg laying into the selected host. Most of the oviposition behaviors happened in the first hour.

Key Words: drilling, drumming, grooming, host searching, resting

RESUMEN

Nuestro estudio caracterizó la búsqueda de hospedero y la capacidad de oviposición de *Trichogramma fuentesi*. En general, las avispas hembras caminaron hacia los huevos de *Cactoblastis cactorum,* pegaron sus antenas sobre la superficie de los huevos como un tambor (en tamboreo), perforaron el corion y depositaron su huevo adentro. Los comportamientos de aseo y de descanso fueron observados con poca frecuencia y la alimentación sobre el hospedero no fue registrada. En un período de observación típica de 60 min con los huevos de la especie exótica *C. cactorum*, los parasitoides hembras pasaron el 16% de su tiempo en tamboreo, el 4% perforando y el 8% poniendo huevos dentro de los hospederos seleccionados. La mayoría del comportamiento de oviposición ocurrió en la primera hora.

Palabras Clave: perforando, sonando, aseo, busqueda del hospedero, descanso

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