CHEMICALLY MEDIATED ASSOCIATIVE LEARNING: AN IMPORTANT FUNCTION IN THE FORAGING BEHAVIOR OF Microplitis croceipes (CRESSON)

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Abstract—When experienced by contact with feces from hosts feeding on cowpeas, laboratory-reared females of Microplitis croceipes, a larval parasitoid of Heliothis spp., orient and fly to odors of the same feces, whereas naive laboratory-reared females do not. Flight-tunnel studies revealed that associative learning occurs during female encounters with hosts and host products. When females antennate host feces, they learn to recognize the volatile odors associated with the feces. Females even can be conditioned to respond to novel and otherwise unattractive odors such as vanilla extract by exposure to these volatile substances in association with a water extract of the feces. They apparently link the volatile odors with a nonvolatile host-specific recognition chemical found in the feces. The antennating stimulant, 13-methylhentriacontane, was found to be a valuable ingredient, apparently as a facilitator of the initial antennation and subsequent linkage of the volatiles to the nonvolatile host recognition cue.

Key Words—Microplitis croceipes, Hymenoptera, Braconidae, parasitoid, host-finding, behavior, feces odors, attraction, 13-methylhentriacontane, associative learning.

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INTRODUCTION

The survival of an insect parasitoid species is dependent upon the ability of the ovipositing females to locate host insects for attack. The host insects are often highly mobile and sporadically distributed among massive amounts of plant foliage or other habitat material. Furthermore, the host insects employ various evasive techniques to minimize exposure, such as feeding in concealed crevices, feeding in bursts and then moving, leaving sites, and falling from the plant when the parasitoid approaches. The hosts may be found in a variety of habitats including different parts or growth stages of a plant as well as different plant species. Consequently, parasitoids can be expected to employ a sophisticated repertoire of search tactics that includes an acute perception of physical and chemical cues that increase their host-location prospects. Moreover, they need the ability to make effective strategy adjustments for varying situations. Vet and Janse (1984) clearly demonstrated the ability of the two parasitoids of Drosophilidae, *Asobara tabida* (Nees) and *A. rufescens* (Foerster), to vary their preference for different habitats through associative learning of the different habitat odors after oviposition experience. Turlings et al. (1990) and Ding et al. (1989) demonstrated how parasitoids exploit plant odors to locate herbivorous hosts. Wardle and Borden (1986) showed that a parasitoid's prior experience on an artificial system may diminish its tendency to respond to the habitat of a natural host. Vinson (1984) and Van Alphen and Vet (1986) reviewed numerous other studies that present evidence of learning in parasitoids. Yet, relatively little is known about the mechanisms and role of learning in parasitoid foraging.

A number of studies have demonstrated the importance of chemical cues in the host-searching behavior of *Microplitis croceipes* (Cresson), a parasitoid specific to the larvae of the genus, *Heliothis*. Lewis and Jones (1971) demonstrated that *Heliothis zea* (Boddie) feces elicited intense host-seeking antennation, and Jones et al. (1971) identified 13-methylhentriacontane as the compound eliciting the antennation response. Gross et al. (1975) demonstrated that exposure of *M. croceipes* at time of release to *H. zea* larval frass reduced their dispersal and prolonged their retention in the area of release. Drost et al. (1986) demonstrated that *M. croceipes* females reared from hosts fed artificial diet rarely flew upwind to odors of hosts feeding on cowpea seedlings unless they were provided a previous "experience" consisting of contact with host feces. Herard et al. (1988a) demonstrated similar results with females of *M. demolitor* Wilkinson. Drost et al. (1988), while working with *M. croceipes*, and Herard et al. (1988b), while working with *M. demolitor*, found that inexperienced parasitoids reared from hosts fed cowpeas responded significantly more often to *H. zea* larvae feeding on cowpeas than those from artificial-diet-reared hosts. Herard et al. (1988b) further demonstrated that *M. demolitor* reared from hosts fed cowpeas obtain an important experience from the cocoons before or at the...