TROPHIC INTERACTIONS INVOLVING *HERPETOGRAMMA PHAEOPTERALIS* (LEPIDOPTERA: PYRALIDAE) AND *PASSIFLORA INCARNATA* (PASSIFLORACEAE)

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During several nights in Aug, 2007, I observed tropical sod webworm moths, *Herpetogramma phaeopteralis* Guenée (Lepidoptera: Pyralidae) swarming in large numbers around flowering purple passion vines, *Passiflora incarnata* L. (Passifloraceae) in suburban north central Florida. Tropical sod webworms use a variety of Poaceae species as larval host plants and probably were emerging from sod grass. Upon closer observation with flash photography, I found that moths fed on the extrafloral nectaries (EFN) located on the bracteoles of the plants (Fig. 1). In this note, I am reporting this observation with the understanding that (like many observations in tropical biology) it might be based on a sporadic rather than on a reoccurring interaction. I also discuss potential ecological significance of this interaction while reviewing the pertinent literature.

Exploitation of EFN by a variety of insects has been reported for a number of plants. For instance, *Ipomoea carnea* (Convolvulaceae) in Costa Rica attracts insects of 70 different families of Coleoptera, Hemiptera, Lepidoptera, Neuroptera, Diptera, and Hymenoptera (Keeler 1978). A dry area specialist in northwestern Peru, *Strymon jacqueline* Nicolay & Robbins (Lepidoptera: Lycaenidae), feeds on EFN of *Neoraimondia arequipensis* cactus (Vila & Eastwood 2006). *Hesperopsis graciliae* (MacNeill) (Lepidoptera: Hesperiidae) commutes back and forth between its host plant and mesquite, *Prosopis glandulosa* (Fabaceae), utilizing the EFN of the latter plant (Wesenborn 1997). Pink bollworm moths, *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae) are attracted to cotton flower volatiles that serve as chemical cues for the moths to find the EFN (Wiesenborn & Baker 1990). A variety of African liptenine lycaenid butterflies (Lycaenidae) feed on EFN of bamboos and vines (Callaghan 1992).

Fig. 1. Tropical sod webworm moth, *Herpetogramma phaeopteralis* Guenée, feeding on extrafloral nectary of *Passiflora incarnata* L.

The importance of feeding on EFN was shown in increased fertility in soybean looper, *Pseudoplusia includens* (Walker) (Lepidoptera: Noctuidae). It was even suggested that cultivars of cotton lacking EFN should be used to reduce herbivory and thus increase crop production (Beach et al. 1985). Oviposition by *Heliothis puntigera* Wallengren (Lepidoptera: Noctuidae) on cotton also was correlated with EFN production (Adjei-Maafo & Wilson 1983). Fecundity and longevity of *Grapholita molesta* (Busck) (Lepidoptera: Tortricidae) doubled when moths were provided EFN of peaches (Atanassov & Shearer 2005).

EFN has high nutritional value. It was shown to be better than sucrose for increasing flight ability of *Cotesia glomerata* L. (Hymenoptera: Braconidae) (Wanner et al. 2006), and better than honey for increasing longevity and fecundity of *Microplitis croceipes* (Cresson) (Hymenoptera: Braconidae) (Roese et al. 2006). EFN-feeding had similar beneficial effect on *Trichogramma minutum* Riley (Hymenoptera: Trichogrammatidae) (Shearer & Atanassov 2004) and on lacewing larvae (Limburg & Rosenheim 2001). Attraction of such natural enemies to EFN helps suppress herbivores. For instance, parasitism of Lepidoptera larvae is higher, while diversity of herbivore species is lower on the EFN-bearing plants of *Solanum adherens* Roem. and Shult. (Solanaceae) than on species of *Solanum* lacking nectaries (Gentry 2003).

According to Rudgers (2004), EFN production can have detrimental properties for a plant, by the way of attracting female moths, which not only feed on EFN but also may oviposit on the plant. Ants were thought to be frequently exploitive of EFN-producing plants (e.g., Wheeler 1913). Ants attracted to extrafloral nectaries can deter pollinators such as bees from flowers (Ness 2006). In the neotropics, several coexisting *Passiflora* species develop different degrees of attractiveness to ants through differences in their EFN development and productivity, which suggests that there are costs and benefits to EFN presence (Apple & Feener 2001). Nevertheless, attendance of extrafloral nectaries by ants was shown to reduce herbivory in *Passiflora* (e.g., Labeyrie et al. 2001), and specifically in *P. incarnata* (McLaine 1983). In a field experiment, young *Heliconius* (Lepidoptera: Nymphalidae) larvae disappeared from *Passiflora* plants with EFN at a rate double that of plants without the nectaries (Smiley 1985). By protecting plants against herbivores and nectar-stealing butterflies, ants positively influenced reproductive success of *Passiflora coccinea* in Brazil, where their presence increased fruit and seed production (Leal et al. 2006).

EFN production can be induced by herbivory. Feeding by larvae of *Ceratomia catalpae* (Boisduval) (Lepidoptera: Sphingiidae), increased sugars in EFN of *Catalpa bignonioides* Walter (Bignoniaceae) and led to up to ten-fold increase in attendance by ants (Ness 2003). Similarly, feeding by *Heliconius charithonius* L. and *Agraulis vanillae* L. (Lepidoptera: Nymphalidae) (which was very heavy on the plants in my observation) might be a factor that induced nectar production in EFN of *Passiflora*, and contributed to attracting the moths. The latter supposition, however, needs to be experimentally tested. I must note though, that if not for the EFN and the numerous ants attracted to them during the day, *H. charithonius* and *A. vanillae* larvae would have completely devoured the plants, as happens to the plants when access to ants is denied (pers. obs.). As it was, despite of hundreds of eggs laid on the plants daily, few survived past the first instar due to predation. However, after the first cold temperatures in Nov, the EFNs seemingly shut down production, little attendance by ants was observed, and the survival of the caterpillars feeding on the vines increased dramatically, leading to complete defoliation of the vines. From the view point of benefit to the plants, such strategy is explicable because the above-ground tissues of *P. incarnate* typically are killed by freezing temperatures in north central Florida.

Extrafloral nectar feeding by *H. phaeopteralis* reported here possibly falls into the category of quadro-trophic interactions involving plants, butterfly caterpillars, ants, and adult moths. The fourth level of trophic interactions (moths "stealing" EFN at night) does not necessarily have significant influence on the tri-trophic interaction between plants, herbivores, and ants described by previous authors. Although in a study by Heil et al. (2004) the number of EFN-feeding flies correlated negatively with the number of ants attending the plants, the extent to which *H. phaeopteralis* may have similar effect on ants attending *P. incarnata* is unclear.

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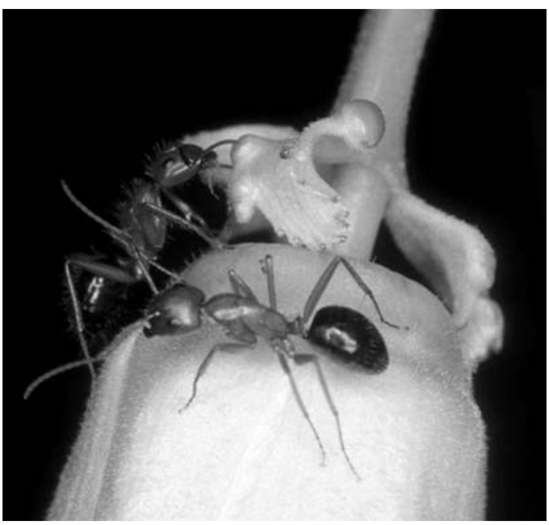

Fig. 2. Florida carpenter ants, *Camponotus floridanus* (Buckley), feeding on extrafloral nectary of *Passiflora incarnata* L.

Summary

Feeding on extrafloral nectar of *Passiflora incarnata* by tropical sod webworm moths, *Herpetogramma phaeopteralis*, in Florida is reported and ecological implications of this observation are discussed.

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