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PREDATION BY NATIVE ARTHROPODS ON THE AFRICAN PARASITOID *PROROPS NASUTA* (HYMENOPTERA: BETHYLIDAE) IN COFFEE PLANTATIONS OF MEXICO

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The establishment or colonization of natural enemies is a critical period of adjustment for the introduced individuals in the target area. Successful colonization and its effectiveness in control, depend on the intrinsic capabilities of the species and the interaction of physical and biotic factors (Callan 1969). Although the concept of establishment is simple, in practice it is a difficult task. From 4,769 introductions of predators and parasitoids made up to 1990, only 1,445 (30.3%) were established (Greathead & Greathead 1992). Diverse reasons have been mentioned of the traits likely to reduce the establishment of biological control agents. Among the most important are: adverse climatic condition, insufficient genetic variation, poor searching capacity, interference from chemicals or cultural practices, inadequate numbers of individuals introduced, lack of synchrony with the host and interference by native organisms (Hopper et al. 1993, Hopper 1996).

Prorops nasuta Waterston is an African parasitoid of the coffee berry borer (CBB) *Hypothenemus hampei* (Ferrari) (Coleoptera: Scolytidae), which is considered as the main pest of coffee worldwide (Le Pelley 1968, Baker 1999). *P. nasuta* females usually spend most of its life inside of a coffee fruit infested by the CBB. The wasp feeds on all juvenile stages, but only paralyses and oviposits on the full-grown larvae and pupae. The larva starts to feed externally after hatching and one host is sufficient for the development of each wasp. When the parasite larva is fully developed, it spins a cocoon and enters to the pupal stage (Hargreaves 1935; Infante 1998). The life cycle of *P. nasuta* form egg to adult lasts 28 days at 22°C (Infante 2000), but adults remain in the coffee fruit for a few days more in order to copulate. As with other bethylids, this species has males emerging before their sisters with which they mate. The new generation of wasps leave the berry during the day, searching for infested coffee fruits (Hargreaves 1935, Murphy & Moore 1990).

In the last few years this parasitoid has been introduced to Mexico, Guatemala, El Salvador, Honduras, Ecuador, Colombia, Jamaica, Indonesia and India. In all these countries *P. nasuta* has been released and is presently under evaluation as a biological control agent (Klein-Koch et al. 1988, Barrera et al. 1990, Baker 1999). In the case of Mexico, repeatedly releases of parasitoids have been carried out in Chiapas since 1992. Recovery surveys indicated that up to now, there is no evidence of the establishment of *P. nasuta* in the country (Infante et al. 2001). Identifying the factors that interfere in the establishment of *P. nasuta* is essential to the success of biological control programmes for the CBB. For that reason, the present paper reports on some native arthropods that were found predating on this species in coffee plantations of Chiapas.

The wasps used in releases were reared in the laboratory on borer infested coffee fruits. Parasitoids were taken to the field as adults and released from one liter plastic jars directly onto the branches of coffee trees. From 1992 to 1996, ca. 156,000 individuals were released in the field usually in the morning (before 12:00 hr). Colonization sites for releases consisted of 22 locations, each approximately one-fourth of a hectare. Because few people observe insects under field conditions (P. S. Baker, personal communication), we stayed in the field for about 1-2 hours following parasitoid liberations, to observe the wasps and any possible interaction with other organisms. The organisms detected as interacting with *P. nasuta* were collected and taken to the laboratory for identification.

A list of arthropods preying on adults of *P. nasuta* is presented in Table 1. Meantime females were searching for infested fruits, they were easy prey for ants, which normally were present on coffee trees. It was possible to detect at least five species of ants preying on adults of *P. nasuta*. Also six species of spiders caught parasitoids on their webs. As spiders were collected in alcohol, it was not possible to verify their predation on *P. nasuta*. However, we would assume they do, considering they are generalist predators. Recent studies have reported that spiders, such as, *Cyclosa caroli*, *Leucauge mariana* and *L. vetusta* capture and consume individuals of the CBB and its bethylid parasitoid *Cephalonomia stephanoderis* (Henaut et al. 2001).

Because of the small size of *P. nasuta* (2mm), observations were especially difficult to carry out. We could not measure the intensity in which predators were acting, but presumably they are only important during releases, or maybe when the

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TABLE 1. SOME SPECIES OF ANTS AND SPIDERS IDENTIFIED AS PREDATORS OF *P. NASUTA* UNDER FIELD CONDITIONS IN CHIAPAS, MEXICO.

Species	Family	Location	Observations
Pseudomyrmex sp.	Formicidae	El Encanto	There were three species. Individuals of one species foraged inside coffee fruits. Possible predator of the CBB, as well.
Azteca sp.	Formicidae	S. Enrique	Predator of adults only.
Tapinoma sp.	Formicidae	Laboratory	Ants foraged inside fruits and predated on juveniles of wasps and borers. Possibly the wasp was dead before ants entered.
Uluborus nr *campestratus*	Uloboridae	La Gloria	Adult parasitoids were found in the web.
Cyclosa caroli	Araneidae	S. Anita	Adult parasitoids were found in the web.
Dolichognatha sp.	Tetragnathidae	R. Izapa	Adult parasitoids were found in the web.
Leucauge sp.	Tetragnathidae	R. Izapa	Adult parasitoids were found in the web.
Theridion nr *nudum*	Theridiidae	R. Izapa	Some spiders make their web in the base of the bunch of fruits.
Chrysso cambridgei	Theridiidae	Maravillas	Adult parasitoids were found in the web.

new progeny of wasps leave the coffee fruits in searching for new hosts. Arthropods preying on *P. nasuta* were associated with old coffee trees and abundant shade. It is possible there are other species of ants and spiders predating on *P. nasuta*, as there is a great diversity and abundance of these organisms associated with coffee trees in Chiapas (Ibarra-Nuñez 1990, Ibarra-Nuñez & García-Ballinas 1998). Callan (1969) emphasized the jeopardy due to ants when colonizing natural enemies for classical biological control. Notwithstanding, Le Pelley (1968) stated that this sort of predation is incidental and only has a transitory effect, since there is no continuing association between predator and prey. According to the poor results in the establishment of *P. nasuta* in Mexico (Infante et al. 2001), is possible that predation is only a part of several factors that impede the establishment of *P. nasuta*. On the other hand, releasing parasitoids in the adult stage may not be favorable for this species. Because of that, it would be worth trying to release other biological stage. For instance, parasitoids could be taken from the laboratory to the field, in the pupal stage while they are still inside the coffee fruits. Coffee fruits could be placed inside a small cage hanging on a branch of coffee with a thread covered with grease to avoid ants and non-flying organisms. In this way, the wasps would emerge when favorable conditions exist. This sort of release might overcome some problems with predators and it would have the additional advantage of giving refuge and shelter to the wasps.

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SUMMARY

Prorops nasuta is an African parasitoid that has been imported into Mexico for the biological control of the coffee berry borer, *Hypothenemus hampei*. After being released for several years, the establishment of this parasitoid was never achieved. In the present paper we report some native arthropods that were found interfering with *P. nasuta* in coffee plantations of Chiapas during the release of parasitoids. Presumably predation by ants and spiders on adults of *P. nasuta* is only a component of several factors that impede the establishment of *P. nasuta* in this country. Releasing *P. nasuta* in the pupal stage instead of adults is discussed in order to enhance the potential of this species as a biocontrol agent.

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