Notes on the natural enemies of *Etiella zinckenella* in Puerto Rico[1]

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ABSTRACT

Results from an *Etiella zinckenella* (Treit.) natural enemy survey in Puerto Rico are presented. Egg parasitism by *Trichogramma* sp. was found to be very low (3%). Six hymenopterous larval parasitoids were collected from larvae feeding on *Crotalaria pallida* (Ait.). Of these the braconid *Heterospilus etiellae* Rower was the most abundant species, accounting for 74.2% of parasitized larvae. *Iconella etiellae* (Vier.) was the only larval parasitoid recovered from soybeans. Overall percentage parasitism averaged 33.6%, ranging from 5 to 91% at different locations. Notes are presented on the life history of the most common species. One experimental manipulation of accessibility of eggs to *Solenopsis geminata* (Fab.) failed to demonstrate any effect on *E. zinckenella* attack of *C. pallida*. Additional predators recorded include *Polistes* wasps and anole lizards. Strategies for utilization of these natural enemies are briefly discussed.

INTRODUCTION

The natural enemies of *Etiella zinckenella* (Treit.) [the lima bean pod borer] are among the best known of Puerto Rican entomofauna. Two larval parasitoids, the braconid *Heterospilus etiellae* Rohwer and the chalcidid *Eurytoma* sp. were first reported by Leonard and Mills in 1931 (5). Wolcott (11,12) provided notes on the biology of *H. etiellae*, adding *Trichogramma* sp. to the list of natural enemies of *E. zinckenella*. Introductions of five parasitoid species from Europe and North America were unsuccessfully attempted from 1936 to 1938 by Bartlett (1,4). By 1948, Wolcott (13) had added the tachinid parasitoid, *Argyrophylax* sp. (cited as *Agrophylax* sp.) attacking *E. zinckenella* on *Tephrosia toxicaria*. However, questions still remain about additional predators and parasitoid-host plant relationships sometimes left unmentioned by these authors. Therefore, the main objectives of this study were to establish the identity and species composition of larval parasitoids on the borer's preferred wild host (*Crotalaria* spp.) and the economically important soybean (*Glycine max* L.). We also researched the possible role of well known predators such as ants and wasps in regulating borer populations.

MATERIALS AND METHODS

We determined larval parasitoid abundance and identity by collecting green pods containing mature larvae from different localities from 1980-81. Pods were placed individually inside 1 oz. plastic cups. Attacked pods were easily recognized by their large areas of discoloration, usually covering more than 2/3 of the pod's surface. Cups were checked daily until parasitoids or adult moths emerged. Specimens were sent to USDA-IIBII Institute for identification by Dr. Lloyd Knutson. Observations on parasitoid behavior were obtained from field observations and laboratory dissections.

The role of ant predation on egg mortality was determined in an exclusion experiment. An 8 × 8 m plot of *C. pallida* with 64 plants was established in 1983 at the Isabela Agricultural Experimental Substation, where *Solenopsis geminata* (Fab.) was abundant. Plants were sown 1 m apart. Twenty plants were randomly selected from this plot. From each plant 6 flower racemes (with no pods) were selected. A thick layer of tanglefoot adhesive was used to coat three racemes at their base to prevent ants from reaching the developing pods and eggs. The remaining 3 racemes served as checks. The adhesive was regularly checked for its effectiveness as a barrier and added as needed. Data were analyzed with the Nested ANOVA design on Statistical Analysis System.

RESULTS AND DISCUSSION

Egg parasitoids of E. zinckenella on Crotalaria pallida

Egg parasitoids were not common on eggs collected from *C. pallida* pods. Of 233 eggs examined, only 7 (3.0%) contained *Trichogramma* sp. parasitoids. All specimens came from Isabela, Bo. Bajuras, a large plant patch (ca. 5,000 plants). This finding agrees with earlier observations on the rarity of this parasitoid on *E. zinckenella* from Puerto Rico (11).

Larval Parasitoids and Notes on Their Biology

Six species of larval parasitoids were found in patches of *C. pallida*. Two species were recovered from borer larvae feeding on *C. incana*, and one species was collected from *C. anagyroides* and *C. zanzibarica*, respectively. Parasitism rates varied widely from location to location. Rates ranged from 5 to 90.9% with an overall average parasitism rate of 34% for the island (table 1). No apparent differences in parasitism rates due to site elevation were observed.

The most common larval parasitoid found was *Heterospilus etiellae* Rohwer. This braconid was recorded attacking *E. zinckenella* from all susceptible *Crotalaria* species (i.e., *C. pallida*, *C. incana*, *C. zanzibarica*, and *C. anagyroides*). It was the dominant parasitoid in all *C. pallida* patches studied from 1980 and 1981 (table 1). Of 856 specimens of *H. etiellae* collected, 697 (81.4%) were females. The average number

TABLE 1.—Crotalaria pallida *(Ait.) patches at three atitudinal levels and larval parasitoid species found at each location, 1980-1981*

Location	No. pods examined	Parasitism	Parasitoid spp.[1] and (number of indiv.)
		%	
Coastal or Low Elevation (0-100 m)			
Naguabo (Playa)	10	30.0	He(8),Eu2(1)
Yabucoa (Roig)	13	30.8	He(20)
Loíza Aldea	38	52.6	He(52)
Piñones	20	30.0	He(42)
Dorado (Mameyal)	15	20.0	He(14)
Hatillo	20	5.0	He(2)
Isabela (Playa)	26	15.4	He(38)
Isabela (Jobos)	48	29.2	He(27),Ie(3),Ch(1) Eu1(1),Eu2(3),Ep(1)
Middle Elevations (100-500 m)			
Caguas (Cañaboncito)	14	21.4	He(10),Ie(1)
Patillas	7	57.1	He(17)
Villalba (Toa Vaca)	21	19.0	He(24)
Villalba (town)	25	44.0	Eu1(14),He(5)
Utuado (town)	15	6.7	He(7)
Camuy (Bayaney)	48	25.0	He(83),Eu2(2)
San Sebastián	12	58.3	He(18),Eu2(3)
Moca (Las Marías)	15	40.0	He(38)
Aguada	11	90.9	He(20),Eu2(6),Ie(2)
Añasco	35	48.6	He(111)
Añasco (Corcovada)	32	34.4	He(50),Eu2(2)
Higher Elevations (more 500 m)			
Maricao (Bucarabones)	9	33.3	He(24)
Cidra	23	30.4	He(57)
Orocovis	16	6.3	He(7)
Jayuya	23	47.8	He(33),Eu2(4)
Adjuntas	32	31.3	He(24),Eu2(3)
		Mean = 33.6 ± 4.0%	

[1] He = *Heterospilus etiellae*, Ie = *Iconella etiellae*, Eu1 = *Eurytoma* sp1, Eu2 = *Eurytoma* sp2, Ch = *Chelonus* sp., Ep = *Eupelmus* sp.

of individuals emerging from an *E. zinckenella* larvae was 6.5 ± 1.0 (standard error) (n=130 larvae). Both sexes emerged from senescent pods through small exit holes. These holes (1 to 4 per pod) appear in a group, usually near of directly above their cocoons. After paralyzing the larvae, parasitoid females deposit up to 18 eggs (mean=7.2 ± 1.2 (SE) eggs per larva, n=16 larvae) in a cluster on the dorsal or lateral portions of the host epidermis. Eggs are elongated and creamy white, with an apical pedicel. All parasitized *E. zinckenella* larvae with eggs were late instar. Host larvae were frequently observed paralyzed but not oviposited by females. This phenomenon may lead to underestimation of this parasite's importance (10).

Larvae reached maturity rapidly, usually in 3-5 days after oviposition. This finding agrees with that of earlier authors (11). *H. etiellae* exhibited all the typical characteristics of members of its subfamily (Doryctinae): ectoparasitic habits, paralysis of their hosts and rapid larval development (6). The whitish larvae commence eating as soon as they hatch, feeding in a group initially and scattering around the host larvae as they grow. Little remains eventually of the host, except its shriveled body and head capsule. Pupation occurs inside the pod, where mature larvae construct brownish cocoons in a clustered mass. The pupal stage, from 14-17 days, is of considerably longer duration than the larval stage. Flight dispersal is apparently very efficient in this delicate and small brownish wasp, which occurred almost anywhere that *E. zinckenella* appeared on *C. pallida*. This parasitoid accounted for 74.2% of parasitized larvae on *C. pallida*. However, it was never found on larvae feeding on other hosts of economic value, such as soybeans and pigeon peas.

Two species of *Eurytoma* were commonly found attacking *E. zinckenella* in *C. pallida* and *C. incana* patches, with 19.7% of all parasitized larvae attacked by these solitary ectoparasites (table 1). Adults of these species are dissimilar in appearance. These were designated as species 1 and 2 because of the lack of species identification. Species 1 is a small (ca. 1.5 mm), black slender wasp found only occasionally. Immature stages of this species could not be observed. The plump reddish brown species 2 was more abundant and twice the size of species 1. The larvae of sp. 2 were plump and greenish white. They consumed *E. zinckenella* larvae in 4-6 days. This genus contains members with very diverse feeding habits. The role of these two species as possible facultative hyperparasitoids should be further explored. Both species were absent from soybeans at Isabela.

The last of the common parasitoids is the braconid *Iconella (=Apanteles) etiellae* (Vier.). This species has the most potential for biologically controlling *E. zinckenella* on soybean and perhaps on pigeon peas. This microgastrine is a solitary endoparasite of a variety of lepidopterous larvae, including other pod borers. It is distributed throughout North America and the Caribbean. It was found attacking *E. zinckenella* larvae on *C. pallida* and *C. incana,* accounting for 3.4% of all parasitized larvae in the former species. In *C. pallida* plots planted near soybean, *I. etiella* was responsible for up to 83% of all larvae being parasitized. In soybean, this parasitoid accounted for all observed parasitism. Much information is available about the biology of this species. Bennett (2) found that eggs were laid in *Ancylostomia stercorea* (Zeller) during the host early instars. The ability to be attracted to host plants in feral and agricultural environments makes this parasitoid a promising candidate for augmentation and biocontrol conservation efforts.

Two additional larval parasitoids were found: the braconid *Chelonus* sp. and the eupelmid, *Eupelmus* sp. Only one specimen of *Chelonus* sp. and two of *Eupelmus* sp. were collected. Species identification could not be obtained. The genus *Chelonus* is an interesting one because of its habit of ovipositing the eggs of its insect host. Curiously, the mature endoparsitoid larvae emerge during the latter host instars (7). A *Eupelmus* sp. has been found as an hyperparasite of *I. etiellae* on *A. stercorea* boring in pigeon peas in Trinidad (2). Its role as a hyperparasitoid should be explored in future research.

Effect of Solenopsis geminata *as Egg Predators*

Extrafloral nectaries are often associated with ant-plant defense activities (3). Because of their presence in *Crotalaria* species, the possible role of ants as egg predators was briefly investigated. No significant differences in *E. zinckenella* pod attack rates, larvae per raceme, percentage of parasitized larvae, or number of pods per raceme could be detected between ant-excluded or control racemes (table 2). The experimental field contained a large population of *Solenopsis geminata* (Fab.), frequently observed feeding from the nectaries and tending aphids affixed on the raceme. *S. geminata* is a well known egg predator in Puerto Rico (9).

Notes on Predation by Other Organisms

Other enemies observed actively predating on *E. zinckenella* were *Polistes* spp. wasps and *Anolis* spp. lizards. Polistine wasps were frequently seen extracting larvae from the pods of *C. pallida*. The method used to gain access inside the pod was never observed. Anole lizards were active predators of both mature larvae and adults, attacking the former when the larvae exited from the pod to pupate in the soil. Lizards were frequently observed jumping from *Crotalaria* spp. plants to catch pod exiting larvae.

TABLE 2.—*Results of the ant exclusion experiments of* Crotalaria pallida *and their effect on the plant and on* Etiella zinckenella *at the Isabela Exp. Res. Stn., May-August 1983 (mean ± SE)*

Variable	Excluded (N = 52 racemes)	Not excluded (N = 52 racemes)	P
Pods/raceme	10.8 ± 0.7	11.0 ± 0.7	NS[1]
Larvae/raceme	4.5 ± 0.6	3.4 ± 0.4	NS
Parasitized larvae/raceme	1.2 ± 0.2	0.9 ± 0.2	NS
% pod bored	41.8 ± 4.3%	33.0 ± 3.4%	NS
% parasitized larvae	30.4 ± 3.1%	23.9 ± 2.8%	NS

[1] NS = p > 0.05.

CONCLUSIONS

There is a promising future for the manipulation of natural enemy populations of *E. zinckenella* in Puerto Rico. As more research is conducted on each natural enemy, more accurate assessments can be made of their usefulness. For the time being, augmentation and conservation efforts can be directed to increase population levels of *I. etiellae*, and *Polistes* wasps since methods for their rearing and conservation have been tried and tested elsewhere (1,7,8). A second line of defense could be established by considering other parasitoids such as *H. etiellae* or *Trichogramma* sp., on agricultural legumes. Finally, possible natural enemies such as soil carabids and ants could be evaluated to institute further control of *E. zinckenella*.

RESUMEN

Apuntes sobre los enemigos naturales de *Etiella zinckenella* en Puerto Rico

Este trabajo presenta los resultados de un reconocimiento de los enemigos naturales del barrenador *Etiella zinckenella* (Treit.). Solo se encontró *Trichogramma* sp. atacando una baja proporción (3%) de los huevos de *E. zinckenella*. Se informan 6 parasitoides himenópteros atacando los estadios larvales. De estos parasitoides, el bracónido *Heterospilus etiellae* Rower fue el más importante; se encontró en el 74.2% de las larvas parasitadas. El porcentaje medio de parasitismo en las larvas del barrenador fue de 33.6% con valores entre 5 y 91% de diversas localidades. Sólo el bracónido *Iconella etiellae* pudo recobrarse de hospederos de importancia económica, como la soya. Se presentan apuntes sobre la historia natural de las especies parasíticas más comunes. Un experimento en el cual se manipuló el acceso de la hormiga *Solenopsis germinata* (Fab.) a los huevos de *E. zinckenella* en plantas de la hospedera *Crotalaria pallida* no demostró ningún efecto sobre el ataque del barrenador. Se hallaron otros depredadores del barrenador, como las avispas del género *Polistes* y los lagartijos del género *Anolis*.

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