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THE OCCURRENCE OF PARASITOIDS ATTACKING CITRUS WEEVIL EGGS ON SAINT LUCIA

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The island of St. Lucia was explored for parasitoids attacking citrus weevils during Jun 6-10, 2005, as part of an effort to increase biological control of *Diaprepes abbreviatus* (L.) (Coleoptera: Curculionidae) in Florida, Texas, and California. *D. abbreviatus* is native to the Caribbean and was presumably introduced to Florida from Puerto Rico (Lapointe 2004). It was first reported in Florida in 1964 (Woodruff 1964) and is now established across the citrus-producing regions of the state (Hall 1995). More recently, *D. abbreviatus* has become established in the Rio Grande Valley of Texas (Skaria & French 2001) and has been intercepted repeatedly in California where it poses a risk to multiple crops (Grafton-Cardwell et al. 2004). *Diaprepes abbreviatus* is highly polyphagous and is known to have host associations with plants from 59 families (Simpson et al. 1996). It is a significant pest for ornamental growers and is economically very important in the citrus industry (Stanley 1996). No native parasitoids are known to attack *D. abbreviatus* in Florida (Hall et al. 2001). Efforts to establish biological control agents of the weevil are ongoing and include releases of 3 egg parasitoids that attack *D. abbreviatus* in Guadeloupe (*Ceratogramma etiennei* Delvare, Hymenoptera: Trichogrammatidae), Puerto Rico (*Quadrastichus haitiensis* Gahan), and the Dominican Republic (*Aprostocetus vaquitarum* Wolcott) (Hymenoptera: Eulophidae) (Hall et al. 2002). Although *Q. haitiensis* and *A. vaquitarum* have established in extreme southeastern Florida following multiple releases since 2000 (Peña et al. 2005), these species have not expanded their range into central Florida (Castillo et al. 2005; Ulmer et al. 2006). *Ceratogramma etiennei* did not establish in Florida after multiple releases in 1998 (Peña et al. 2005).

One of us (BJU) surveyed 13 locations around St. Lucia for citrus weevils, including regions near the towns of Babonneau, Grande Ravine, Gros Islet, La Fargue, Micoud, and Soufriére.

Citrus is not a major crop on St. Lucia. Consequently, the economic importance of citrus weevils has not been considered. Though most growers were familiar with the weevils, they did not consider them to be significant pests. Much of the citrus investigated was in polycultures consisting of sparsely planted citrus trees among plantations of other crops including banana, papaya, coconut, and various other crops. Under these conditions relatively few or no adult weevils or weevil eggs masses were collected. Weevil abundance was much greater among pure stands of citrus. Of the 184 egg masses collected during the trip, 151 were found at the three sites consisting of pure stands of citrus; only 33 egg masses were collected from 10 mixed plantations. It is unclear whether polyculture itself is responsible for suppressing the citrus weevils or if pest control strategies implemented for the crops among which citrus was grown were negatively affecting the weevils. Regardless, citrus weevils were more abundant under monoculture conditions.

One to two h was spent at each site searching for citrus weevil egg masses and adult weevils. Leaves containing egg masses were placed into plastic vials. Each evening, the egg masses were cut from the leaves leaving the egg mass intact between the leaves but with a minimum of leaf material. Egg masses were then placed individually into 10-mL glass vials. The open end of the vial was covered with 2 plies of tissue (Kimberly-Clarke®, Kimwipes® EX-L) secured with rubber tubing to allow ventilation. Egg masses in vials were shipped in an insulated box to the Animal Plant Health Inspection Service, Plant Protection and Quaratine, Beltsville, MD and forwarded to the University of Florida quarantine facility at the Tropical Research and Education Center in Homestead, FL (USDA-APHIS PPQ form 526 permit no. 68313-E).

Adults of four weevil species were collected from citrus trees during the trip: 15 *D. abbreviatus* (L.), 11 *Litostylus pudens* (Boheman), two *Diaprepes boxi* Marshall, and a single specimen of *Oxyderces cretaceous* (F.). Either *D. abbreviatus* or *L. pudens* was found at each site where egg parasitism occurred and they were often collected at the same site. Though few specimens of other weevils were collected, it is likely that some of the egg masses collected were deposited by other weevil species. As a result it is not readily apparent which species of weevil eggs were host to the parasitoids collected.

Three parasitoid species were reared from weevil eggs collected on St. Lucia. *Haeckeliania sperata* Pinto (Hymenoptera: Trichogrammatidae) parasitized 6% of weevil egg masses collected (Table 1). *Baryscapus fennahi* Schauff (Hymenoptera: Eulophidae) parasitized 5% of egg masses. *Quadrastichus haitiensis* parasitized a single egg mass from which twenty females and three males emerged. *Haeckeliania sperata* was previously found attacking citrus weevil eggs on Dominica (Pinto 2005) and is currently being tested for its efficacy against *Diaprepes abbreviatus* in Florida (Peña unpublished). *Baryscapus fennahi* has been recorded previously from St. Lucia and other islands including Barbados, Jamaica, and Dominica (Schauff 1987) but little is known about its biology. *Quadrastichus haitiensis* has been found parasitizing citrus weevil eggs on various Caribbean islands. Its life history was studied by Castillo et al. (2005). After a failed attempt at establishment in Florida in 1969, *Q. haitiensis* was released again in 2000 and is now established in the extreme southeast region of the state (Peña et al. 2005).

In the laboratory, *B. fennahi* accepted *D. abbreviatus* eggs on both citrus (*Citrus* spp.) and green buttonwood (*Conocarpus erectus*) host plants. It oviposited inside the host weevil egg like other endoparasitoids such as *Q. haitiensis*; however, when *B. fennahi* reached the final instar, it occasionally freed itself from the host egg to feed on surrounding eggs. Thus, the late instar feeding habits and pupation periodically resemble those of an ectoparasitoid such as *A. vaquitarum*. Development from egg to adult took approximately 18 d at 25°C. The sex ratio (F/M) of field-collected material from St. Lucia was 7.8 and was 9.0 among F1 progeny in the laboratory colony. *Haeckeliania sperata* also accepted *D. abbreviatus* eggs on both citrus and green buttonwood in the laboratory. A single host egg supported 2-5 *H. sperata* which developed within individual compartments within the host egg and emerged approximately 21 d after oviposition at 25°C. The sex ratio from field collected material was 6.0 and was 19.1 among F1 progeny in the laboratory.

Weevil egg masses were found at eight of the 13 locations surveyed. Parasitoids were successfully reared from four locations. Parasitism ranged from zero to 67% of citrus weevil egg masses (Table 1). Weevil egg masses parasitized by *H. sperata* suffered almost 100% mortality; those parasitized by *B. fennahi* and *Q. haitiensis* had mortality rates of approximately 93% (Table 2). Parasitized egg masses did not differ in the mean (± SEM) number of eggs they contained (38.7 ± 4.2) compared with unparasitized egg masses (36.7 ± 1.5) (ANOVA: $F_{1,179} = 0.12, P = 0.72$).

Approximately 7% of the egg masses encountered in the field were consumed by an unidentified predator. The egg masses were accessed through one of the leaf surfaces which was completely removed, or consumed; damage was confined to that portion of the leaf that contained eggs. Terrestrial snails were abundant feeding on citrus leaves and the margins of the leaf damage were similar to that observed on the predated egg masses. It seems likely that one or more species of snail was taking advantage of, or even targeting, weevil eggs as a nutrient source. Both ant and coccinellid species also have been reported as weevil egg predators; however, the leaf damage observed was not consistent with predation by these insects (Richman et al. 1983; Stuart et al. 2002). Although the unidentified St. Lucia predator is likely an opportunist and not a candidate for classical biological control, this is the first documented instance of significant levels of citrus weevil egg predation in the field and further investigation is warranted.

TABLE 1. ST. LUCIA CITRUS WEEVIL EGG PARASITISM RATES BY COLLECTION SITE AND PARASITOID SPECIES. AN EGG MASS WAS CONSIDERED PARASITIZED IF ANY PORTION OF THE EGGS IT CONTAINED WAS PARASITIZED.

Location collected	Total masses	Parasitized masses	*H. sperata* (%)	*B. fennahi* (%)	*Q. haitiensis* (%)	Total % parasitism
13°46.61N, 61°02.34W	111	6	0	5 (4.5)	1 (1.0)	5.5
13°49.21N, 61°02.97W	9	1	1 (11.1)	0	0	11.1
13°50.06N, 60°55.83W	1	0	0	0	0	0
13°50.22N, 60°56.57W	11	0	0	0	0	0
13°51.87N, 61°03.13W	18	12	10 (55.5)	2 (11.1)	0	66.6
13°56.95N, 60°55.52W	23	3*	0	2 (8.7)	0	13.0
13°58.39N, 60°57.38W	1	0	0	0	0	0
14°01.55N, 60°57.86W	10	0	0	0	0	0
Totals	184	22*	11 (6.0)	9 (4.9)	1 (0.5)	12.0

*One egg mass was destroyed before parasitoid emergence due to mite infestation.

TABLE 2. PERCENT PARASITIZED HOST EGGS WITHIN INDIVIDUAL EGG MASSES, PERCENT DEAD HOST EGGS RESULTING FROM OTHER FACTORS SUCH AS FUNGAL AGENTS, AND TOTAL HOST EGG MORTALITY AMONG EGG MASSES PARASITIZED BY EACH PARASITOID SPECIES.

Parasitoid	*n*	% Parasitized eggs	% Dead weevil eggs	Total % mortality
H. sperata	11	93.0	6.8	99.8
B. fennahi	9	81.5	11.8	93.3
Q. haitiensis	1	93.5	0	93.5
Unparasitized	161	0	1.7	1.7

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SUMMARY

Three species of hymenopteran egg parasitoid were found attacking citrus weevil eggs on the island of St. Lucia including *Haeckeliania sperata* Pinto (Hymenoptera: Trichogrammatidae), *Baryscapus fennahi* Schauff, and *Quadrastichus haitiensis* Gahan (Hymenoptera: Eulophidae). Overall, 12% of the citrus weevil egg masses found on the island were parasitized, numerous egg masses were also consumed by an unidentified predator. Citrus weevils and their egg parasitoids were more abundant within pure stands of citrus than when citrus was grown as part of a polyculture with other crops such as banana.

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