HOST ACCEPTANCE CHANGES OF *CATOLACCUS GRANDIS* AN ECTOPARASITE OF THE BOLL WEEVIL AFTER TEN GENERATIONS REARING ON ITS FACTITIOUS HOST CALLOSOBRUCHUS MACULATUS

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Abstract

Catolaccus grandis, an ectoparasitoid of the boll weevil was reared in laboratory conditions on the cowpea weevil (*Callosobruchus maculatus*), as an alternative host for cost reduction in a mass propagation system. Total fecundity, daily oviposition, net reproductive rate, and sex ratio were evaluated and compared to females reared on boll weevils. The data showed that to a certain degree, the cowpea weevil was a viable alternative host for the rearing of *C. grandis*. It was seen, that after 10 generations of continuous rearing, *C. grandis* females showed a significant switch in host acceptance as an oviposition site; reason for which, it is not recommendable the rearing of *C. grandis* on cowpea weevils for more than one generation. However, alternating hosts may be an acceptable practice, given that no significant preference effects were recorded on first generation *C. grandis* females reared on the cowpea weevil.

Introduction

Inundative releases of *Catolaccus grandis* (Burks) (Hymenoptera: Pteromalidae) have shown to be effective in controlling the boll weevil (*Anthonomus grandis grandis* Boheman) (Coleoptera: Curculionidae) in cotton fields in the Lower Rio Grande Valley of Texas (Summy et al. 1995, Morales Ramos et al. 1991, 1995; King et al. 1995, and Coleman et al. 1996).

An artificial diet for *in vitro*-mass propagation of this wasp has been developed (Rojas et al. 1996) and their effectivity in controlling the boll weevil was valuated (Morales-Ramos et al. 1998). Nevertheless, adult *C. grandis* need to be in contact with host for 2 d to attain full fecundity (Morales-Ramos et al. 1996) and since the production of boll weevil is expensive (Robinson et al. 1995), studies on factitious or unnatural hosts (Fedde et al. 1982, Rojas et al. 1995) (to reduce production costs) for *C. grandis* were done by Rojas et al. (1998). The results of these studies showed that the cowpea weevil, *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae) could be used for rearing and female conditioning prior to field release. Eventhough that *C. grandis* developed on its factitious host, the quality of the progeny reared on this weevil for several consecutive generations is unknown. The objectives of this research work were to determine the changes in *C. grandis* biological characteristics after 10 generations of rearing on its factitious host.

Materials and Methods

Cowpea weevils used in this study were reared on black eyed pea at our laboratories in Weslaco, TX. Boll weevils were purchased from the GAST insect rearing facility, Mississippi State, MS and used as control.

Catolaccus grandis were reared on boll weevils and cowpea weevils as reported by Cate (1987). One hundred and fifty females and 50 males per generation were placed in a 2.8 L Rubbermaid^{R} semiclear-white plastic container (No. 6). Each group was provided with honey and water and kept into a Percival environmental chamber at 27 ± 1°C, 50 ± 10% RH, and 14:10 (L:D) photoperiod. Two treatments and a control group were compared. Treatment 1 (CM-1) consisted of *C. grandis* females reared on cowpea weevils for 1 generation. Treatment 2 (CM-10) consisted of *C. grandis* females reared on cowpea weevils for 10 generations. The control group consisted of *C. grandis* females reared on bol weevils.

Fecundity and Progeny Sex Ratio

Forty eight newly emerged F1 (treatment 1) and F10 females (treatment 2) reared on cowpea weevils, and control (reared on boll weevil third instars) were individually placed in square (9.5 X 9.5 cm) disposable Petri dishes with a male reared on their corresponding host. At the age of 3 d old, each female was provided with 12 encapsulated, third instar cowpea weevils or third instar boll weevils. The hosts were replaced every 24-h for 15 consecutive days (Morales-Ramos and Cate 1992). The Parafilm capsules containing the parasitized hosts were opened to count the number of eggs oviposited; then the Parafilm sheets were resealed and placed in the environmental chamber for development as above described. Ten days after, the Parafilm sheets were reopened to count and record the number of *C. grandis* male and female pupae.

Following the criteria reported by Morales-Ramos and Cate (1992), the total number of eggs oviposited by each control female and the mean number of eggs oviposited per day during the 15-d period were statistically compared to treatments by ANOVA, and GLM (SAS Institute 1988), respectively. Mean differences between the control and the 2 treatments were analyzed by *t*-LSD test and GLM's *t*-test at $\alpha = 0.05$ level of significance (SAS Institute 1988), respectively. The sex of all the female's progeny was recorded and their sex ratio was calculated and statistically compared by GLM's *t*-test as above.

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Net reproductive rate (R_o)

Defined as the number of females produced by each female, was calculated according to the formula reported by Krebs (1985), and a modification of Tukey's Jackknife technique (Roff 1992) was used to estimate R_o variability among control and treatments. This method estimates 36 R_o values from the data obtained from 72 females of each, control and treatments, after deletion of 12 randomly selected observations. Once a data point was obtained, the data set was restored to its original 72 data points and the next series of 12 random numbers was used to select the next deletions. The *t*-student test was used to statistically compare the obtained R_o values (SigmaStat sofware).

Results and Discussion

The statistical analyses of the data showed that when evaluated on boll weevil larvae, there was not significant difference in total fecundity among the control group (*Catolaccus grandis* females developing on boll weevil larvae) and treatment 1 (first generation of females reared on cowpea weevil larvae) (Table 1). However, when evaluated on cowpea weevil larvae, the control group had a significantly higher total fecundity than treatment 1 (Table 1).

It was also observed that when evaluated on boll weevil larvae, treatment 2, (tenth generation of *C. grandis* females reared in cowpea weevil larvae) had a significantly lower total fecundity when compared to both, the control and treatment 1; but, when evaluated on cowpea weevils, the total fecundity of treatment 2 was not significantly different than the control or treatment 1 (Table 1).

The control group had a significantly higher daily oviposition rate and R_o than treatments 1 and 2 when evaluated on both, boll weevils and cowpea weevils (Tables 2 and 3). On the other hand, daily oviposition and R_o values were significantly different among treatments, but they were higher in treatment 1 when evaluated on boll weevil larvae and they were higher in treatment 2 when evaluated on cowpea weevil larvae (Tables 2 and 3).

On the other hand, the progeny sex ratio of treatment 2 was significantly lower (producing less females per male) than that of the other 2 treatments when evaluated on boll weevil larvae; and no significant difference was observed on sex ratio among treatments when evaluated on cowpea weevil larvae (Table 4). However, the progeny sex ratio in all treatments was significantly higher when evaluated on boll weevil larvae than on cowpea weevil larvae. The above results indicate that in general, parasitoid females from the control group showed a higher fitness than those of the other 2 treatments; indicating that the cowpea weevil is a comparatively poor host for *C. grandis*.

However, some adaptations to the cowpea weevil were observed in *C. grandis* females after 10 generations of continuous rearing on this host, being evident by the daily oviposition rates, which showed that CM-1 females appear to accept boll weevils as hosts more readily, while CM-10 females appear to accept cowpea weevils as host more frequently; and as shown above, the progeny sex ratio was higher when *C. grandis* females were evaluated on boll weevils than when evaluated on cowpea weevils in all treatments. This was probably due to the difference in size between boll and cowpea weevil larvae, the later being significantly smaller than the former. Pteromalid parasitoids such as *C. grandis* have the ability to choose the sex of the progeny according to the size of their host (Godfray 1994).

We conclude from this work that the cowpea weevil, *C. maculatus*, is a viable alternative host to a certain degree, for *C. grandis* mass propagation since a significant degree of adaptations occur on *C. grandis* after 10 generations of continuous rearing on cowpea weevil. These adaptations include a significant switch in host acceptance as oviposition site. Based on the information above presented, the rearing of *C. grandis* on cowpea weevils for a large number of generations is not recommended; but the cowpea weevil can be safely used to rear *C. grandis*, if it were alternated with boll weevil every other generation, since no evidence of host acceptance switch was observed in treatment 1. Finally, additional studies are required to determine if the changes observed on treatment 2 were permanent or reversible after one generation of being reared on its natural host, the boll weevil.

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Table 1. Total eggs produced per female during a 15-d period starting with 48 3-d old females per treatment and host.

	Evaluated on[a]	
Treatments	*A. grandis*	C. maculatus
Control	229.35 ± 146.50 a	187.63 ± 118.21 a
CM-1	191.50 ± 76.60 a	119.17 ± 94.97 b
CM-10	129.15 ± 95.41 b	158.85 ± 100.86 ab

[a]Mean ± standard deviation. Means with the same letter are not significantly different at $\alpha = 0.05$, $df = 188$, and $P < 0.002$ after *t*-LSD test.

Table 2. Daily oviposition in eggs per female per day. Evaluation started with 48, 3-d old females per treatment and host for a 15-d period.

	Evaluated on[a]			
Treatments	*A. grandis*	n	*C. maculatus*	n
Control	15.55 ± 9.75 a	708	13.36 ± 11.68 a	674
CM-1	14.06 ± 8.12 b	654	8.39 ± 8.91 d	682
CM-10	9.79 ± 8.10 c	633	12.40 ± 8.48 b	615

[a]Mean ± standard deviation. Means with the same letter among are not significantly different at $\alpha = 0.05$, $df = 2443$ and 2615, respectively, and $P < 0.09$ after GLM's *t*-test.

Table 3. Net reproductive rate R_o determined by the Jackknife method using 40 observations from a set of 60 R_o calculations by randomly deleting 8 observations at the time.

	Evaluated on[a]	
Treatments	*A. grandis*	C. maculatus
Control	168.75 ± 7.72 a	110.24 ± 5.31 a
CM-1	131.09 ± 4.31 b	71.57 ± 4.88 d
CM-10	67.63 ± 5.33 c	84.03 ± 4.68 c

[a]Mean ± standard deviation. Means with the same letter are not significantly different at $\alpha = 0.05$, $df = 236$, and $P < 0.0001$ after *t*-LSD test.

Table 4. Progeny sex ratio in females per male. Calculated from the progeny of 48 females per treatment and host. Females that did not produce progeny were eliminated from the data set.

	Evaluated on[a]			
Treatments	*A. grandis*	n	C. maculatus	n
Control	3.75 ± 2.60 a	40	2.02 ± 1.51 a	42
CM-1	3.84 ± 2.70 a	46	1.84 ± 1.50 a	39
CM-10	2.46 ± 3.25 b	40	1.52 ± 1.52 a	46

[a]Mean ± standard deviation. Means with the same letter are not significantly different at $\alpha = 0.05$, $df = 143$ and 163, respectively, and $P < 0.065$ after GLM's *t*-test test.