NOTE

Parasitism of *Pseudoplusia includens* (Lepidoptera: Noctuidae) by *Copidosoma truncatellum* (Hymenoptera: Encyrtidae) Using Various Laboratory Procedures[1]

R. M. McPherson

The University of Georgia, Department of Entomology
Coastal Plain Experiment Station
Tifton, GA 31793-0748

J. Entomol. Sci. 28(4):331-334 (October 1993)

KEY WORDS Insecta, soybean looper, *Pseudoplusia includens, Copidosoma truncatellum, Heliothis virescens, Spodoptera frugiperda, Galleria mellonella, Trichoplusia ni,* parasitism.

The soybean looper, *Pseudoplusia includens* (Walker), is an economic threat of field crops and vegetables throughout the southern United States (Herzog, 1980. *In* Kogan and Herzog (eds.), Springer-Verlag). In most years, *P. includens* is the most serious pest of Georgia soybeans, creating more than $9 million in insecticide costs and crop damage (Douce and McPherson, 1991. Ga. Agric. Expt. Stn. Spec. Publ. 70). Beach and Todd (1986, Entomophaga 31: 237-242) found that the polyembryonic parasitoid *Copidosoma truncatellum* (Dalman) was commonly reared from *P. includens* in Georgia. They reported that parasitized larvae developed more slowly and consumed more foliage than nonparasitized larvae when reared on both resistant and susceptible soybean genotypes. Orr and Boethel (1985, Environ. Entomol. 14: 612-616) reported similar results in Louisiana with different soybean genotypes.

Hunter and Stoner (1975, Environ. Entomol. 4: 381-382) and Stoner and Weeks (1976, Environ. Entomol. 5: 323-328) reported on the potential of *C. truncatellum* as a biological control agent for the cabbage looper, *Trichoplusia ni* (Hübner). They concluded that mass-rearing of *C. truncatellum* for integrated biological control may not be justified because parasitized larvae consumed 35% more food than nonparasitized larvae. However, renewed interest in *C. truncatellum* as a biocontrol agent for *P. includens* has been renewed as insecticide resistance has developed (Mink and Boethel, 1992. J. Econ. Entomol. 85: 1056-1062). Also, the increasing concern about environmental and ground water contamination has required that alternatives to chemical insecticides be investigated. Therefore, this study was undertaken to examine the parasitization success of *C. truncatellum* reared on *P. includens* and other hosts under selected laboratory techniques.

[1] Accepted for publication 07 July 1993.

A colony of *C. truncatellum* was initiated in 1991 with parasitoids reared from *P. includens* collected from soybeans in Mitchell County, Georgia. Newly-emerged *C. truncatellum* were placed in a 18.9-liter clear plastic cylindrical container (36 cm high × 30 cm diam) which held 8-h-old *P. includens* eggs on cheesecloth that was suspended from the top of the cage with Scotch® tape. The *P. includens* eggs were collected from a colony being maintained in the insectary on a pinto bean diet (Burton, 1969. USDA, ARS 33-134) at the Coastal Plain Experiment Station, Tifton, GA. After a 24-h exposure to *C. truncatellum,* the eggs were transferred to a heavy-duty plastic bag (20 cm × 10 cm × 45.5 cm) until hatching occurred. Newly-hatched *P. includens* larvae were placed singly in 30-ml plastic cups containing 15 ml of diet. The cups were capped and placed into an environmentally controlled chamber maintained at 22°C, 75 ± 5% RH, and 14:10 (L:D) photoperiod. Parasitoids used in the various rearing studies were obtained from the rearing chamber as needed.

In the initial study to evaluate the effect of parasitism on host development, two cohorts of 8-h-old *P. includens* eggs were examined in two separate 18.9-liter containers. One cohort was exposed for 24 h to parasitism by *C. truncatellum* that emerged from two cadavers (about 2500 parasites), while the other cohort was left unparasitized. Upon hatching, 135 neonate larvae from each cohort were randomly placed in 30-ml diet cups as previously described. On days 7, 12, 14, 16, 18, and 20, each larva was weighed, and then returned to its rearing cup. The number of days to pupation, or death in the prepupal stage (if parasitized), also was recorded for each larva. Larval weights were subjected to a Student's *t* test. Prior to parasite emergence, 25 parasitized larvae were randomly selected from the prepupal weights to assure a wide range in larval size (from 115 to 654 mg) and held in the environmentally controlled chamber. After the parasites had emerged and died (2-3 days if left in the rearing cup with no water or sugar water), they were removed and the total number recorded. A linear regression analysis (SAS Institute, 1989. SAS User's Guide, Version 6, SAS Inst., Cary, NC) was performed on larval weight and number of parasitoids produced.

In a second study to examine the effects of host age on parasitism, 8, 32, and 56-h-old *P. includens* eggs were exposed for 24 h to parasitism by *C. truncatellum* that had emerged from two cadavers in each of three 18.9-liter containers as described earlier. As eggs of *P. includens* hatched, 120 larvae from each age class were placed individually in 30-ml diet cups and observed until pupation or death due to parasitization occurred, afterwhich percent parasitism was determined. Also, 120 neonate *P. includens* larvae were exposed to parasitoids for 24 h to determine whether parasitization would occur. This study was repeated four times and the percent parasitism was compared using χ^2 tests for significance.

In a third parasite rearing study, approximately 300 *P. includens* 8-h-old eggs were placed into one of three different clear plastic cylindrical containers that were 18.9, 3.8, or 0.9 liters, respectively. The eggs were exposed for 24 h to parasites that emerged from two cadavers (ca 2500 parasitoids). One hundred twenty larvae from each container were placed singly into 30-ml diet cups and observed for parasitism. This procedure was repeated four times for each container, and percent parasitism was compared using χ^2 tests for significance.

In the final study to evaluate host range of *C. truncatellum,* eggs of the cabbage looper, *T. ni*, greater wax moth, *Galleria mellonella* (L.), tobacco budworm, *Heliothis virescens* (F.), and fall armyworm, *Spodoptera frugiperda* (J. E. Smith), were placed into 18.9-liter containers and exposed for 24 h to *C. truncatellum.* Eggs were then removed and held in plastic bags until hatching occurred. One hundred twenty neonate larvae of each species were placed singly in 30-ml cups containing pinto bean diet where they remained until either moths or parasites emerged. The percent parasitism of each lepidopteran species was determined.

Parasitized *P. includens* larvae weighed significantly more than unparasitized larvae on all four days that comparisons were made (Table 1). All unparasitized *P. includens* pupated within 18 d of hatching, and the mean number of days to pupation was 16.4 d (range 14 to 18 d). In contrast, most parasitized larvae were still actively feeding 18 d after hatching. The mean days to prepupal death was 18.8 d (range from 17 to 22 d). Adult parasitoids emerged from the cadavers 10 d after host death. An average of 1258 parasitoids (ranged from 652 to 1674) emerged from parasitized P. includens larvae. This was higher than the 992 parasitoids per host reported by Orr and Boethel (1985, Environ. Entomol. 14: 612-616). There was a significant linear regression **[Pa = 906.9 + 0.8 LW]** with larval weight (LW) in mg and parasitoid number (Pa) ($F = 5.37$ with 1,20 df; $P = 0.03$, $R^2 = 0.21$).

Table 1. Weight (± standard error of the mean) of soybean looper larvae parasitized or unparasitized by *C. truncatellum* on selected days after eclosion.

Larval age (days)	Larval weight (mg) ± SEM	
	Parasitized	UnParasitized
7	23.1 ± 1.6*	12.2 ± 0.2
12	142.1 ± 2.9*	111.4 ± 6.1
14	289.6 ± 8.3*	229.6 ± 9.0
16	347.3 ± 5.5*	305.0 ± 3.7
18	396.4 ± 6.2	–
20	417.9 ± 14.2	–

*Significant difference between larval weights of parasitized and unparasitized larvae for specific larval age, *t* test, $P = 0.05$.

Percent parasitism of *P. includens* eggs of different ages exposed for 24 h to *C. truncatellum* did not differ significantly. Parasitism was 69.7, 65.4 and 55.2%, respectively, for 8-, 32-, and 56-h-old eggs. Only 2.5% of the neonate larvae were parasitized. Parasitism of 53.2, 63.3, and 58.5% of hosts in the 18.9, 3.8, and 0.9 liter containers, respectively, also did not differ significantly.

C. truncatellum parasitism of *T. ni* (55.3%) was similar to that of *P. includens* (60.2%), and both hosts appear equally suitable for mass rearing in the laboratory. *C. truncatellum* did not parasitize *H. virescens, S. frugiperda,* or *G. mellonella* in this study. Although these three species are easily maintained in the laboratory, they are not suitable hosts for *C. truncatellum.*

Field observations have revealed that *C. truncatellum* can be a highly efficient regulator of populations of *P. includens*. From 10-12% of the field collections of *P. includens* in Georgia soybeans were parasitized by *C. truncatellum* during August 1991 and 1992, and parasitism exceeded 50% in September in these two years (McPherson, unpublished data). The current studies reaffirm that larvae of *P. includens* continue to feed and likely cause plant damage after being parasitized by *C. truncatellum.* However, because of the relative ease with which this highly fecund parasitoid can be reared in laboratory culture, opportunities exist to mass propagate *C. truncatellum.* These parasitoids could be used in inundative releases directed against incipient seasonal generations of this important pest of American agriculture, before *P. includens* populations reach economically damaging levels.

I am grateful to M. L. Padgett, J. D. Taylor, and D. Griffin for their technical support, J. W. Todd for identifying the parasites, and G. A. Herzog and H. R. Gross for supplying some of the lipidopteran species used in this study.