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Evaluation of *Paederus Littorarius* (Coleoptera: Staphylinidae) as an Egg Predator of *Chrysoteuchia Topiaria* (Lepidoptera: Pyralidae in Wisconsin Cranberry Bogs

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EVALUATION OF *PAEDERUS LITTORARIUS* (COLEOPTERA:STAPHYLINIDAE) AS AN EGG PREDATOR OF *CHRYSOTEUCHIA TOPIARIA* (LEPIDOPTERA: PYRALIDAE) IN WISCONSIN CRANBERRY BOGS

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ABSTRACT

A preliminary study was conducted to determine if the rove beetle, *Paederus littorarius* Grav., would exhibit a feeding preference for the eggs of the pyralid moth, *Chrysoteuchia topiaria* Zeller, a pest in Wisconsin cranberry bogs. Individuals were offered a choice of *C. topiaria* eggs or *Drosophila* sp. adults for four days. Total number of prey items eaten was converted to weight using a multiplier based on the mean weight of 20 individuals of each prey item, respectively. A significant preference for *Drosophila* adults was observed in the preference trial; however as many as 24 *C. topiaria* eggs in addition to *Drosophila* offerings were consumed by *P. littorarius* individuals within a 24 h period. Additionally, laboratory and field observations suggests *P. littorarius* is a polyphagous predator.

The cranberry girdler, *Chrysoteuchia topiaria* Zeller (Lepidoptera: Pyralidae) is a sporadic but important pest of cranberries *Vaccinium macrocarpum* Aiton. Larvae attack the plant by chewing the underground stems and disrupting nutrient flow. Control of this pest can be problematic for several reasons. First, larvae may be overlooked because damage is not usually seen until the spring following attack. Second, the larval stage is spent hidden in the leaf litter and soil, and is difficult to monitor. Lastly, the adult, which can be monitored during its 6–8 week flight period, can not be controlled with pesicide applications because the pest's flight period coincides with host plant blossoming. Chemical control can not be used when cranberries are in blossom due to the neccessity of pollinator activity (Roberts 1983, Mahr and Moffitt 1994).

The rove beetle, *Paederus littorarius* Gravenhorst, is a common endemic predator of small arthorpods in North American riparian habitats. It is a polyphagous and opportunistic predator which consumes a variety of prey items in the laboratory (S. Haase-Statz unpublished data). *Paederus* spp. are extra-oral feeders that attack their prey and suck the hemolymph from the body, and discard the exoskeleton. They feed on all life stages of other insects but have been shown to have a preference for eggs and early instar larvae (Ahmed 1957, Kurosa 1958, Manley 1977). However, there is no published information specifically regarding the feeding habits of North American *Paederus*, nor has there been any work evaluating them as predators in North American agricultural systems.

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Paederus spp. in Asia, the Middle East and South America have been identified as important predators of a variety of agriculturally significant phytophagous insects. For example, *P. alferii* Koch has been effective in controlling many cotton pests, *P. fuscipes* Curtis is important in the control of several rice pests, and *P. columbinus* is effective against sugar cane pests. Additionally, *Paederus* spp. occur in clover, maize, peas, beans, potatoes and banana plantations (Frank and Kanamitsu 1987).

The objective of this study was to conduct a preliminary evaluation of P. *littorarius* as a predator in an agricultural system important to Wisconsin. The cranberry system was chosen based on its riparian nature which provides suitable habitat for *Paederus* spp. Additionly, *P. littorarius* had been collected in pitfall traps placed in cranberry bogs, establishing their occurrence there (Coffield unpublished data).

Chrysoteuchia topiaria was selected as the target pest for two reasons: (1) *C. topiaria* eggs are oviposited randomly on the soil surface of the bog and larvae are found in the leaf litter under the cranberry vines (Roberts, 1983). *P. littorarius* is commonly found in leaf litter scavenging on the soil surface where it forages; (2) *C. topiaria* eggs and larvae are present when adult and larval *Paederus* are actively foraging. The study was conducted to answer the following questions: Will *P. littorarius* feed on *C. topiaria* eggs? What is the rate of consumption? And will *P. littorarius* preferentially feed on *C. topiaria* eggs?

METHODS

To determine whether *P. littorarius* would feed on *Chrysoteuchia* eggs and if so, at what rate consumption occurred, adult beetles was placed in 5" petri dishes; one per petri dish. Each petri dish was lined with damp filter paper. Beetles were then starved for 24 h. Sixty *Chrysoteuchia* eggs were placed in each petri dish and the beetles were given 24 h to feed. Remaining food items were removed and counted to determine total number eaten. One replicate was completed. The average number of eggs eaten per beetle for 2 d was calculated.

To determine if *P. littorarius* would feed preferentially on *Chrysoteuchia* eggs, the predators were offered a choice between the target prey and frozen *Drosophila* adults. *Drosophila* were used as the alternative prey item because they had been used to successfully rear *P. littorarius* and were available. This trial used ten female *P. littorarius* and was conducted over four days. Comparisons were based on mean consumption of each individual over 4 days. The predators were placed in individual petri dishes with wet filter paper. Each was starved initially for 24 h and subsequently starved for 6 h between feedings. Beetles were given 24 h to feed. Remaining prey items then were removed and counted. The number eaten was converted to mass using a multiplier (*Drosophila* = 0.8253 mg; *C. topiaria* eggs = 0.0357 mg). The multiplier for each prey item was determined by weighing 20 individuals of each prey item and calculating the mean weight per prey item. At the first feeding, two (» 1.4 mg) *Drosophila* and 15 (» 0.6 mg) *Chrysoteuchia* eggs were placed in each petri dish. Eight of the ten beetles consumed all of the prey items in the first feeding; therefore, five *Drosophila* (» 4.0 mg) and 25 (» 1.0 mg) *Chrysoteuchia* eggs were placed in each dish for subsequent feedings.

The null hypothesis that there was no preferential feeding was tested using a t-test for paired means. The statistical expert in Quattro Pro 5.0 software (MS-DOS version by Borland International, 1994) was used to analyze the data.

Adult *P. littorarius* used for the trials were reared from field collected adults. *C. topiaria* eggs were obtained from field collected adults using the methods of Roberts (1983). *Drosophila* were obtained from a genetics lab at the University of Wisconsin-Madison.

RESULTS

Paederus littorarius adults began feeding on *C. topiaria* eggs immediately after they were placed in the containers. The mean number of eggs consumed in 24 h was 31.5 ± 11.16, range was 21–54 (n=10 for 2 trials).

In the preference trial, ten adult female *P. littorarius* ate between 0–22 eggs per day (Table 1), an average of 8.93 eggs (0.319 ± 0.16 mg) (Fig. 1); and between 0–4 *Drosophila* (Table 1), an average of 2.54 adults (2.094 ± 0.38 mg) (Fig. 1). The t-test showed a significant preference for *Drosophila* ($p < 0.00001$).

DISCUSSION

In the non-preference test, *Paederus* adults were shown to feed readily on the eggs of *C. topiaria*. However, they showed a marked preference for

Table 1. Daily prey consumption by *Paederus littorarius*. Each beetle was provided five *Drosophila* and 25 *Chrysoteuchia topiaria* eggs simultaneously.

Beetle	Day 1	Day 2	Day 3	Day 4	Mean	Mean Wt (mg)
			Number of *Drosophila* eaten per day			
1	2	3	4	0	2.25 (±1.5)	1.86 (±1.2)
2	2	3	3.5	3	2.88 (±0.5)	2.37 (±0.4)
3	2	4	3	4	3.25 (±0.8)	2.68 (±0.7)
4	2	3	1.5	2	2.13 (±0.5)	1.75 (±0.4)
5	2	3.5	5	2	3.13 (±1.2)	2.58 (±1.0)
6	2	3	2	1	2.00 (±0.7)	1.65 (±0.6)
7	2	2	4	0	2.00 (±1.4)	1.65 (±1.2)
8	2	4	4	1	2.75 (±1.3)	2.27 (±1.1)
9	1.5	4	3	0	2.13 (±1.5)	1.93 (±1.3)
10	1.5	3	4	3	2.88 (±0.9)	2.75 (±0.7)
			Number of *Chrysoteuchia topiaria* eggs eaten per day			
1	15	20	11	16	15.50 (±3.2)	0.55 (±0.1)
2	7	0	3	0	2.50 (±2.9)	0.09 (±0.1)
3	1	1	15	6	5.75 (±5.7)	0.21 (±0.3)
4	1	1	19	7	7.00 (±7.3)	0.25 (±0.3)
5	15	0	4	0	4.75 (±6.1)	0.17 (±0.2)
6	14	0	4	13	7.75 (±5.9)	0.28 (±0.2)
7	18	14	14	22	17.00 (±3.3)	0.61 (±0.1)
8	16	7	0	1	6.00 (±6.4)	0.21 (±0.2)
9	18	16	4	8	11.50 (±5.7)	0.41 (±0.2)
10	14	15	8	9	11.50 (±3.0)	0.41 (±0.1)

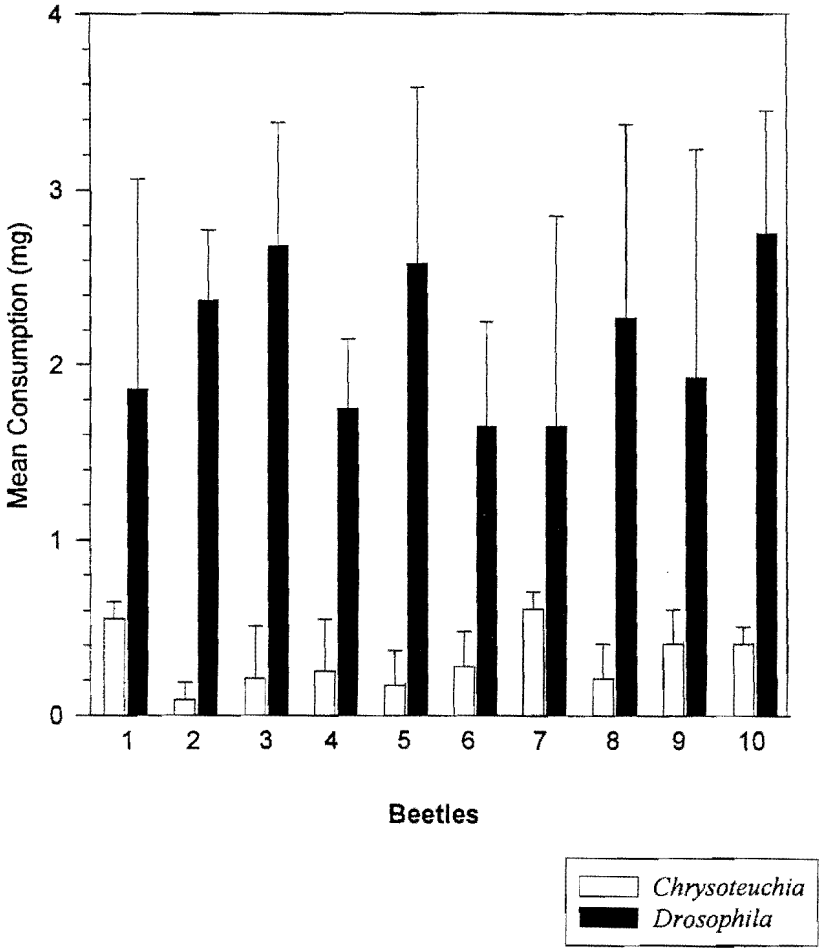

Figure 1. Consumption of *Drosophila* adults and *Chrysoteuchia topiaria* eggs, expressed in milligrams of prey over a period of four days. Each beetle was provided with five *Drosophila* and 25 *C. topiaria* eggs daily.

Drosophila adults when given a choice. There are several possible explanations for this strong showing of preference: (1) *P. littorarius* truly prefer *Drosophila* over all other prey items; (2) they prefer small dipteran prey over other types; (3) there is an energy benefit to taking a few large prey items over several small prey items; or (4) the individual predators had developed an artificial preference for *Drosophila* from having been reared and maintained on this food source.

Additional information about the feeding habits of *P. littorarius* was

gathered during rearing studies. Field collected adults were maintained on a variety of food sources which included: small dipteran adults (Chironomidae and Cecidomyiidae), Collembola and hemipterans (Cicadellidae and Cercopidae) reared adventitiously from soil obtained at *Paederus* collection sites; early instar larvae of *Plodia interpunctella* Hubner (Pyralidae) and *Psuedoplusia includens* Walker (Noctuidae); various large dipteran larvae (Calliphoridae, Sarcophagidae, Muscidae); and a variety of other odd offerings (eg. roast beef, chedder cheese, and bran muffin). thus supporting the assumption that *P. littorarius* is a polyphagous predator. It should be noted, however, that *P. littorarius* did not thrive on many of these prey items and *Drosophila* was the only prey item that has been successfully used to rear Wisconsin *Paederus* spp. in the lab (S. Haase-Statz, unpublished data).

It is unknown if *P. littorarius* contributes to the control of *C. topiaria*. It is probably an important part of the natural enemy complex for this pest. Field observation and collection data for *P. littorarius* indicate that they are found in a variety of moist habitats, including wet meadows, marshes, bogs, roadside ditches and leaf litter such as are found within and surrounding cranberry beds. As stated earlier, a few adult *P. littorarius* were collected in pitfall traps placed within cranberry beds located near Warrens, Wisconsin, in 1991 (Cockfield, unpubl.). I surveyed eight commercial cranberry beds located on three differenct cranberry farms. Although I was not successful in locating any additional specimens in the beds, I did collect *Paederus littorarius* in grass adjacent to beds and along streams and drainage ditches in the vacinity of commercial cranberry production.

Based on collection data, it seems reasonable to assume that *P. littorarius* is more likely to be found in unmowed grassy areas around cranberry beds than in the beds themselves. Kamm et al. (1983) concluded that the cranberry girdler prefers grassy areas surrounding cultivated areas, and leave that habitat when it becomes undesirable. Therefore, *P. littorarius* could be useful in regulating cranberry girdler populations in source habitats.

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