Pre-Oviposition Period, Egg Production and Mortality of Six Species of Hibernating Sap Beetles (Coleoptera: Nitidulidae)[1]

C. Peng and R. N. Williams

Department of Entomology, Ohio Agricultural Research and Development Center
The Ohio State University, Wooster, OH 44691

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ABSTRACT Egg production and mortality of six spp. of hibernating sap beetles (Coleoptera: Nitidulidae), *Glischrochilus fasciatus* (Olivier), *G. quadrisignatus* (Say), *G. sanguinolentus* (Olivier), *Lobiopa undulata* (Say), *(Carpophilus brachypterus* (Say), and *Phenolia grossa* (F.), were studied. Hibernating beetles captured in October oviposited under laboratory conditions without cold treatment. Pre-oviposition periods ranged from 0-14 weeks from date of capture. Five of six spp. maintained on apple laid eggs; the exception was *G. sanguinolentus,* which laid eggs when maintained on tomato. *G. fasciatus* and *G. quadrisignatus* exhibited significantly increased egg production on tomato, but also demonstrated significantly higher adult mortality than on apple.

KEY WORDS Hibernation, mortality, egg production, sap beetles, tomato, apple, *Glischrochilus fasciatus, G. quadrisignatus, G. sanguinolentus, Lobiopa undulata, Carpophilus brachypterus, Phenolia grossa, Beauveria bassiana.*

The sap beetles (Coleoptera: Nitidulidae) are found in various habitats. The majority feed on flowers, fruits, sap, fungi, decaying and fermenting plant tissue or dead animal tissue (Hayashi 1978). Commonly found in woodlots, sap beetles can be vectors of forest pathogens causing wood rots (Skalbeck 1976). Most species hibernate as adults in temperate regions (Parsons 1943).

Osmun and Luckmann (1964) stated that *Glischrochilus quadrisignatus* (Say) overwinter as adults, and it appeared that low temperatures were necessary before they could lay eggs in the spring. Luckmann (1963) collected adults from April through October and found through dissection that only females collected in the spring had functional ovaries and producted eggs. Foott and Timmins (1979) indicated that cold treatment helped synchronize the onset of oviposition but did not reduce the pre-oviposition period for October-collected beetles in relation to date of capture. According to these reports, there appears to be some dispute over the necessity of hibernation for oviposition.

In our study, the pre-oviposition period, egg production and mortality of six spp. of hibernating beetles, *G. fasciatus* (Olivier), *G. quadrisignatus* (Say), *G. sanguinolentus* (Olivier), *Lobiopa undulata* (Say), *Carpophilus brachypterus* (Say), and *Phenolia grossa* (F.), were investigated. Also, the effects of hibernation on beetles were studied.

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Materials and Methods

We collected beetles by attracting them with decomposing cantaloupe near woodlots in Wooster, Ohio in October, 1988. Beetles were confined in a 900 ml plastic container with several layers of moist paper towels. Beetles were transferred to clean containers with food, either fresh apple or fresh tomato. Eggs and dead beetles were counted weekly. Dead beetles with a fungal growth protruding from their exoskelton were recorded separately as they were infected with *Beauveria bassiana* (Bals.) (Foott and Timmins 1979). Sex was determined by dissecting dead beetles and by squeezing the abdomen of living beetles under a dissecting microscope at 12x. Six and five replicates were performed for *G. fasciatus* and *G. quadrisignatus* on each food, respectively. Each replicate contained approximately 30 beetles. Observations on the other four species were conducted without replicates as number of available adults was minimal. The studies of pre-oviposition period, egg production, and adult mortality for each species reared on apple or tomato were conducted in the laboratory at ca. 22°C and a photoperiod (fluorescent lamp) of 16:8 (L:D). Pre-oviposition period was measured based on the date of beetle capture and the date on which beetles oviposited. Egg production and adult mortality data for *G. fasciatus* and *G. quadrisignatus* were analyzed by analysis of variance with mean separation at the 5% level of significance by Duncan's (1955) multiple range test.

Results and Discussion

Pre-oviposition periods varied dramatically among beetle species, ranging from zero to 14 weeks when beetles were maintained under laboratory conditions. *Lobiopa undulata* started to oviposite as soon as they were brought to the laboratory. *Carpophilus brachypterus* started to oviposite after two weeks of laboratory maintenance. Adult females of *P. grossa* were maintained for 11 weeks before they began to oviposite.

Different foods had different effects on the pre-oviposition period of different species of *Glischrochilus*. Pre-oviposition periods for *G. fasciatus, G. quadrisignatus,* and *G. sanguinolentus* maintained on tomato were 2, 2, and 10 weeks, respectively; and when maintained on apple were 14 and 1 week, respectively for *G. fasciatus* and *G. quadrisignatus*. During the 24 weeks of the study, 12 females of *G. sanguinolentus* confined on apple did not oviposite. These results indicate that tomato can considerably decrease the pre-oviposition period for *G. fasciatus* and stimulate egg production of *G. sanguinolentus;* however, tomato did not greatly affect the pre-oviposition period for *G. quadrisignatus*.

Host differences had an important effect on egg production and adult mortality of the three species of *Glischrochilus* (Table 1). When maintained on tomato, *G. fasciatus* and *G. quadrisignatus* demonstrated significantly increased oviposition ($F = 33.2$; $Df = 1, 10$; $P \leq 0.05$; and $F = 37.7$; $Df = 1, 8$; $P \leq 0.05$; respectively) and adult mortality ($F = 47.9$; $Df = 1, 10$; $P \leq 0.05$; and $F = 85.9$; $Df = 1, 8$; $P \leq 0.05$; respectively) than when maintained on apple. Females of *G. fasciatus* oviposited an average of 58 eggs on tomato in 19 weeks, which was 13-fold greater than oviposited on apple. Peak egg production on tomato occurred between weeks 5-6 and weeks 14-16. Within these five weeks, 46.2% of the total eggs were oviposited.

Table 1. Egg production and mortality of six species of hibernating sap beetles (Nitidulidae) maintained on natural hosts in the laboratory, Wooster, OH (1988-1989).

Species	No. of beetles ♀	No. of beetles ♂	Host	Experimental periods (in weeks)	Pre-oviposition periods (in weeks)	Eggs laid per female	Adult mortality (%) during experimental periods
G. fasciatus	94	74	tomato	19 (Oct. 24 - Mar. 6)	2	58.4 ± 22.8a	44.2 ± 11.9a*
	97	83	apple	19 (Oct. 24 - Mar. 6)	14	4.3 ± 2.8b	6.1 ± 4.9b
G. quadrisignatus	73	77	tomato	17 (Oct. 17 - Feb. 13)	2	141.5 ± 33.6a	78.0 ± 13.4a
	68	82	apple	17 (Oct. 17 - Feb. 13)	1	39.2 ± 16.1b	11.3 ± 3.8b
G. sanguinolentus	13	9	tomato	24 (Oct. 24 - Apr. 3)	10	31.0	77.3†
	16	12	apple	24 (Oct. 24 - Apr. 3)	-	0.0	3.6
L. undulata	4	5	apple	19 (Oct. 17 - Mar. 6)	0	405.4	0.0
C. brachypterus	6	5	apple	22 (Oct. 17 - Mar. 20)	2	36.2	27.3
P. grossa	3	3	apple	27 (Oct. 17 - Apr. 24)	11	89.7	16.7

* Means for same species followed by same letter are not significantly different ($P > 0.05$; Duncan's [1955] multiple test). The differences shown reflect differences that occurred between hosts only.

† Statistics were not run for the latter four species as number of available adults was minimal.

No peak in egg production was found on apple. *Glischrochilus quadrisignatus* females oviposited an average of 142 eggs on tomato, that was 3.6-fold greater than on apple. Peak egg production occurred between weeks 8-10, during which 44.5% of the total eggs were oviposited; but on apple, egg production was constant without peaks. Each female of *G. sanguinolentus* oviposited an average of 31 eggs on tomato, and egg production peaked between weeks 20-22; 50.6% of the total eggs were oviposited within the 3-week peak of egg production. It is also interesting to note that *G. sanguinolentus* did not oviposit on apple during this study. Adult mortality on tomato for *G. fasciatus, G. quadrisignatus.* and *G. sanguinolentus* was 44.2%, 78.0%, and 77.3%, respectively, while that on apple was much lower. Most beetles died following peak egg production for *G. quadrisignatus* and *G. sanguinolentus,* and the 2nd peak of egg production for *G. fasciatus.* The higher adult mortality on tomato was attributed to the fact that tomato decayed more quickly and fungi grew more actively on it than on apple. Additionally, beetles confined on tomato oviposited more than they did on apple during the same test periods.

Unlike egg production of *Glischrochilus* spp. maintained on apple, the other three genera had obvious peaks of egg production. Maximum egg production for *L. undulata* occurred between weeks 7-9. During this 3-week period, 42.9% of the total eggs were oviposited. Peak egg production for *C. brachypterus* was between weeks 5-7 and weeks 14-15, accounting for 61.9% of the total eggs oviposited over 22 weeks. Maximum egg production for *P. grossa* occurred between weeks 23-26, and 40% of the total oviposition occurred within the peak period of egg production.

The results demonstrate that all species, except for *G. sanguinolentus,* oviposited when maintained on apple between weeks 17-26. A comparison of the average number of eggs laid per female and adult mortality for all species demonstrates that apple was very suitable food for *L. undulata.* The average number of eggs laid per female was ca. 405, and no dead beetle were found during 19 weeks. Beetles tended to lay eggs around the edges between the layers of paper towelling, and they laid less eggs as the paper towels dried, even though the host was still moist.

All six species of October-collected beetles we tested laid eggs in the laboratory without hibernation, though great variability in pre-oviposition period existed among species. This observation suggests that the beetles can produce eggs when suitable food is available, and the environment is favorable. Hibernation is unnecessary for oviposition of the beetles.

Foott and Timmins (1979) reported that disease caused by *B. bassiana* created a problem in the rearing of *G. quadrisignatus,* especially at high humidity. In this experiment, small numbers of beetles were killed by *B. bassiana* in the first few weeks after they were captured and maintained in the laboratory. This disease was found only in the three species of *Glischrochilus* during the experimental periods. Control of the disease was obtained when moistened but not saturated paper towels were provided as an egg substrate, and clean containers with fresh food were supplied weekly. Additionally, prompt removal of beetles with disease symptoms prevented high mortality. By using these methods, there was no evidence of disease five weeks after beetle rearing began in the laboratory.

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