ECOLOGY, BEHAVIOR AND BIONOMICS

Mating, Ovipositional Rhythm and Fecundity of *Nezara viridula* (L.) (Heteroptera: Pentatomidae) Fed on Privet, *Ligustrum lucidum* Thunb., and on Soybean, *Glycine max* (L.) Merrill Fruits

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Cópula, Ritmo de Postura e Fecundidade de *Nezara viridula* (L.) (Heteropera: Pentatomidae) Alimentando-se de Frutos de Ligustro, *Ligustrum lucidum* Thunb., e Soja, *Glycine max* (L.) Merrill

RESUMO - Conduziram-se estudos em laboratório sobre a cópula, ritmo de oviposição e fecundidade do percevejo verde, *Nezara viridula* (L.), alimentando-se de frutos imaturos de ligustro, *Ligustrum lucidum* Thunb., e de soja, *Glycine max* (L.) Merrill. Um número maior de casais foi observado em cópula em ligustro (27 a 37 %) do que em soja (22 a 23 %). O período de pré-oviposição foi significativamente menor quando as fêmeas alimentaram-se de ligustro (15,5 dias) do que quando se alimentaram de soja (23,9 dias). Os intervalos de tempo entre as quatro primeiras oviposições e entre a primeira e a quarta oviposição foram menores em ligustro do que em soja (1,9 a 3,3 dias menos no primeiro alimento). Maior percentagem de fêmeas de *N. viridula* ovipositou e a fecundidade foi maior em ligustro do que em soja. Em ligustro, observaram-se picos de oviposição nos dias 11 e 17 da vida adulta; em soja, não foram observados picos de oviposição.

PALAVRAS-CHAVE: Insecta, Hemiptera, reprodução, cópula, fecundidade, alimento.

ABSTRACT - Laboratory studies were conducted on mating, ovipositional rhythm, and fecundity of the southern green stink bug, *Nezara viridula* (L.) fed on immature fruits of privet, *Ligustrum lucidum* Thunb. and soybean, *Glycine max* (L.) Merrill. A greater number of pairs were observed mating on privet (27 to 37 %) than on soybean (22 to 23 %). The preoviposition period was significantly shorter when females fed on privet (15.5 days) than when they fed on soybean (23.9 days). The intervals of time between the first four ovipositions, and between the 1st and the 4th oviposition were shorter on privet than on soybean (range of 1.9 to 3.3 days less on the former food). Greater percentage of females *N. viridula* oviposited and showed greater fecundity on privet than on soybean. On privet, the oviposition rhythm peaked at days 11 and 17; however, no peaks on oviposition were observed on soybean.

KEY WORDS: Insecta, Hemiptera, reproduction, copulation, fecundity, food.

The southern green stink bug, *Nezara viridula* (L.) is cosmopolitan and polyphagous (Todd 1989). Among the many cultivated and uncultivated host plants, privet, *Ligustrum lucidum* Thunb. (Oleaceae), was recently found to be an important host of this stink bug in Londrina, Paraná state (latitude 23° 11' S, longitude 51° 11' W) (Panizzi *et al*. 1996).

Privet is very abundant and is used as an ornamental tree in the urban area of Londrina. During most of the year, plants carry fruits (berries), providing an abundant source of food to this and several other species of pentatomids that inhabit this plant (A. R. Panizzi, unpublished).

Depending on the food fed upon, heteropterans may show differences in the many parameters commonly used to estimate the reproductive performance, including preoviposition period, daily mating rhythms, number of copulations, fecundity, and egg hatchability (e.g., Schotzko & O'Keeffe 1990 a, b, McLain *et al.* 1990, Wang & Millar 1997, Panizzi 1997 and references therein).

In a previous study, *L. lucidum* (which was misidentified as *L. japonicum*), was found to be a very suitable food to mass rear *N. viridula* in the laboratory (Panizzi *et al.* 1996). In order to further investigate the reproduction of this pentatomid on this host plant, a study was conducted on mating, ovipositional rhythm, and fecundity of adult *N. viridula* feeding on fruits of privet. Soybean pods, which is one of its preferred food (Panizzi 1997), was used as comparison.

Material and Methods

N. viridula eggs were obtained from the mass rearing colony kept in the laboratory. Egg masses were collected on the day of oviposition and placed in petri dishes (9.0 x 1.5 cm) lined with moistened filter paper. On the 1st day of the 2nd stadium (1st instars do not feed), nymphs were removed and placed in plastic rearing boxes (12.0 x 12.0 x 3.8 cm) with moistened filter paper and covered with a lid. Ten nymphs were placed in each box. They were fed soybean pods (immature) cv. Paraná plus fruits of privet.

At the day of adult emergence, single female/male pairs were placed in a rearing plastic box, as described above. Forty pairs were fed immature fruits of *L. lucidum* and 40 pairs were fed soybean pods. Food was replaced every 2 d. The plastic boxes were placed at random in an environmental chamber maintained at 25 ± 1 °C and 65 ± 5% RH with a photoperiod of 14:10 (L:D) h.

During March to July 1997, daily observations were made and the occurrence of mating and egg laying were recorded. After the 1st week of adult life, the number of mating reproductive pairs were recorded at each hour, starting at 9:00 AM until 4:00 PM, on five occasions, to check for a possible variation in the number of mating pairs along the day time. The number of egg masses laid during the 1st 30 days of adult life were calculated. Data on the preovipositon period, and the intervals between the 1st-2nd, 2nd-3rd, 3rd-4th, and 1st-4th ovipositions were calculated. Percentage of females ovipositing, female age at 1st oviposition, and total mean number of egg masses and eggs/female, and percentage of egg hatch were also calculated. Data were compared using student's *t*-test ($P \leq 0.05$).

Results and Discussion

After the 1st week of adult life, when the reproduction activity starts, the number of *N. viridula* pairs copulating when fed on berries of privet were consistantly greater compared to those fed on soybean pods, throughout the eight observation periods (Fig. 1). Although, in some cases these differences were not sig-

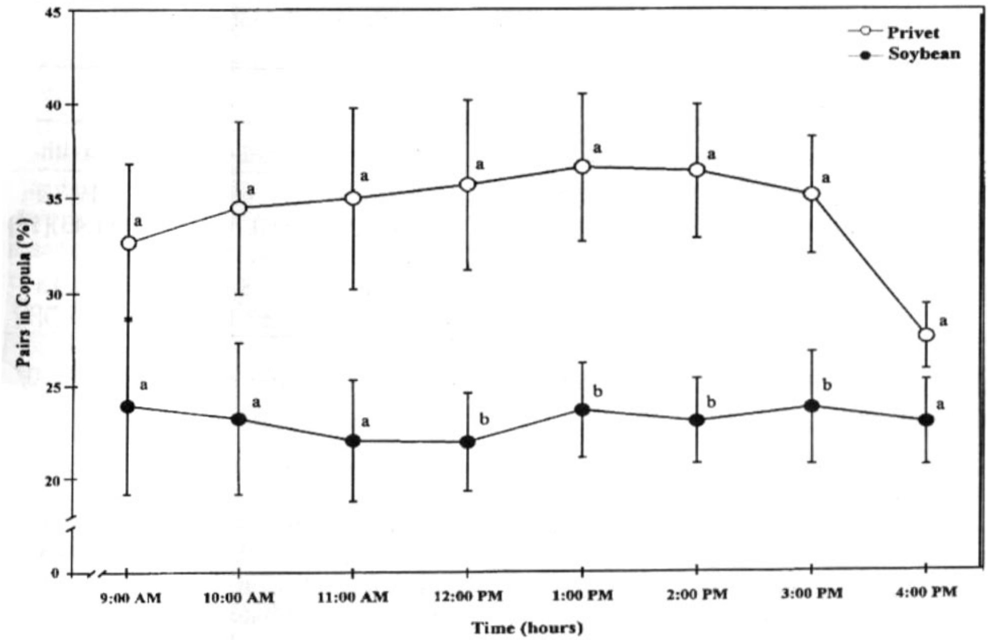

Fig. 1. Mean percentage (± SEM) of *N. viridula* adults mating at different times of the day when fed on berries of privet or pods of soybean in the laboratory (n = 40 pairs for each food). Means (at each time between foods) followed with the same letter do not differ significantly (P ≤ 0.05) using student's *t* test.

nificant, it always tended to be greater on privet than on soybean. Except for the last hour of observation, when 27% of *N. viridula* pairs were observed mating when fed on privet, 33 to 37 % of the pairs were observed in copula on this food; on soybean, these values varied from 22 to 23 %. These data demonstrate that the insects were greatly stimulated to mate when they fed on privet than when they fed on soybean.

Considering the different times of the day from 9:00 AM to 4:00 PM, no substantial variation on the number of pairs mating was observed on both foods, except on privet when it decreased from 37% at 1:00 PM to 27% at 4:00 PM (Fig. 1). Perhaps, if these observations were extended to night time, a greater variation in the number of pairs mating could be observed, but at this point this can only be speculated. A mating cycle, with significantly more mating at 4:00, 5:00, 6:00 and 7:00 AM, than on the remaining hours, was reported for the pentatomid *Thyanta pallidovirens* (Stål) (Schotzko & O'Keeffe 1990a).

In a similar way, the time needed for the 1st oviposition was significantly shorter when females *N. viridula* fed on privet than when fed on soybean, taking 8.4 days less on the former food (Table 1). This indicates that the eggs matured earlier for those females fed on privet compared to those fed on soybean. The time required for the subsequent ovipositions, considering the time intervals between the 1st-2nd, and 2nd-3rd ovipositions, were shorter on privet than on soybean; it also tended to be shorter for the 3rd-4th, and 1st-4th oviposition intervals (range of 1.9 to 3.3 days less on the former food). In a similar study, Schotzko & O'Keeffe (1990a) found differences in time between clutches of another

Table 1. Mean ± SEM time (days) of preoviposition and subsequent oviposition intervals of *N. viridula* fed on berries of privet or on pods of soybean in the laboratory [n].

Food	Time interval (X ± SEM)[1]				
	Preoviposition	1st-2nd	2nd-3rd	3rd-4th	1st-4th
Privet	15.5 b (±1.08)[33]	5.9 b (±0.52)[26]	6.9 b (±0.60)[24]	6.8 a (±0.70)[18]	19.7 a (±1.43)[18]
Soybean	23.9 a (±1.91)[28]	9.2 a (±0.53)[15]	10.1 a (±1.92)[8]	8.7 a (±2.18)[3]	23.0 a (±5.77)[3]

[1]Means in the columns followed with the same letter do not differ significantly (P < 0.05) using student's *t* test.

pentatomid, *T. pallidovirens*, feeding on peas (*Pisum sativum* L.) and on green beans (*Phaseolus vulgaris* L.) (5.1 and 5.8 days, respectively), compared to those feeding on lentils (*Lens culinaris* Medik) (9.4 days). However, the duration of the preoviposition period did not correlate (positively or negatively) with fecundity in their study.

A greater percentage of females *N. viridula* oviposited on privet than on soybean, and those females that oviposited showed a greater fecundity on the former than on the latter food; egg hatchability, however, was similar on both foods (Table 2).These data confirm previous studies which demonstrated the greater fecundity of *N. viridula* on privet than on soybean (Panizzi *et al.* 1996). Our present study demonstrates, however, that this

Table 2. Reproductive performance of *N. viridula* feeding on fruits of privet and soybean in the laboratory [n = number of females ovipositing].

Food	% females ovipositing	Number/female[1,2] X (± SEM)			Egg hatch[3] %
		Egg mass	Eggs	Eggs/mass	
Privet	82.5 [33]	3.7 a (± 0.33)	261.0 a (± 25.92)	70.1 a (± 4.98)	70.7 a (± 3.07)
Soybean	70.0 [28]	2.0 b (± 0.21)	116.8 b (± 13.53)	59.5 b (± 2.94)	65.3 a (± 4.78)

[1]Means followed by the same letter in each column do not differ significantly (P < 0.05) using *t* test.
[2]Data from female ovipositing.
[3]Data transformed to arcsine for analysis.

greater fecundity is due to the greater mating activity on privet, on which plants the bugs not only copulated more, but reduced the preoviposition period, and reduced the intervals between subsequent ovipositions. We suspect that on privet the mating period is longer than on soybean, but we are not sure that the bugs which were found mating during two subsequent hours were continuing their same mate or were copulating another time.

Considering the first 30 days of adult life, the egg laying rhythm was drastically different according to the food (Fig. 2). On privet, oviposition started earlier and showed two peaks: One at day 11 and another at day 17; the oviposition rhythm remained at a much lower level thereafter, except at day 24, when it increased somewhat. The day after the two peaks of oviposition, the bugs did not lay eggs. These occasional pauses in oviposition, after peaks of egg laying or not, and which may be prolonged for several days, have been reported for many species of insects, including the hemipteran *Lygus hesperus* (Knight) (Strong *et al.* 1970; see also Schotzko & O'Keeffe 1986 and references therein).

On soybean, no sharp peaks on the oviposition rhythm were observed, with a much less amount of egg masses being laid. Oviposition increased, however, at days 20 and 22, but in a much lower rate than that recorded for females fed on privet (Fig. 2). These data on the egg laying rhythm further demonstrate that privet fruits are a more suitable food for *N. viridula* reproduction than soybean fruits, allowing faster egg maturation, and greater egg production.

In conclusion, these laboratory studies on the reproduction of *N. viridula* adults feed-

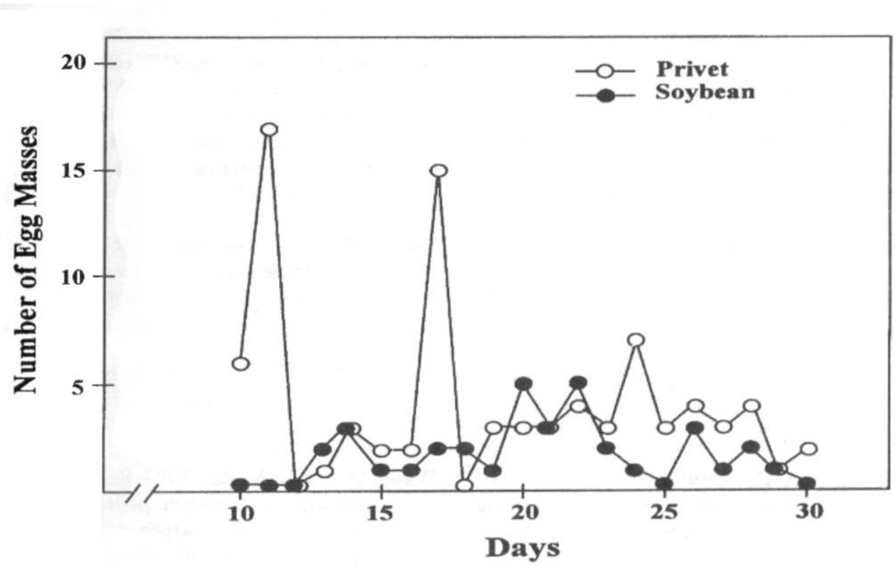

Fig. 2. Total number of egg masses laid by *N. viridula* females during the first 30 days of adult life when fed on berries of privet or pods of soybean in the laboratory (n = 40 pairs for each food at the beginning of the experiment).

ing on privet and soybean fruits, partially complete the former investigations conducted by Panizzi *et al.* (1996), which have indicated the greater reproductive performance of this bug on the former food. This greater reproduction is, at least in part, explained by the greater mating activity, which in turn leads to a more intense ovipositional rhythm and fecundity. However, some questions such as those related to the identification of biochemical and physical characteristics of privet fruits, which make them a more suitable food to *N. viridula* reproduction than soybean pods, remain unanswered, and deserve further investigations.

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