ECOLOGY, BEHAVIOR AND BIONOMICS

Nymphal and Adult Performance of *Euschistus heros* (Fabr.) (Hemiptera: Pentatomidae), as a Potential Alternative Host for Egg Parasitoids Multiplication

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Neotropical Entomology 30(4): 535-540 (2001)

Desempenho de Ninfas e Adultos de *Euschistus heros* (Fabr.) (Hemiptera: Pentatomidae), Como Hospedeiro Alternativo Potencial na Multiplicação de Parasitóides de Ovos

RESUMO – Este trabalho teve como objetivo avaliar o potencial de *Euschistus heros* (Fabr.) (Hemiptera: Pentatomidae) como hospedeiro na multiplicação de parasitóides de ovos, através da determinação do desempenho de ninfas e de adultos, de laboratório e campo, de *E. heros*, comparativamente a *Nezara viridula* (L.) (Hemiptera: Pentatomidae), em condições massais. A partir de 100 ovos colocados entre as folhas de uma planta de soja contida em gaiola (50x50x70 cm), determinou-se o número de ninfas que atingiram a fase adulta e o tempo de desenvolvimento ninfal. As ninfas foram alimentadas com vagens verdes de soja e grão secos de soja e amendoim. Para estudar a sobrevivência e o desempenho reprodutivo, 100 casais de *E. heros* e *N. viridula*, provenientes do campo e laboratório, foram alocados em gaiolas contendo a mesma dieta das ninfas e observados durante 13 semanas (fevereiro a maio - 1999). Verificou-se que o tempo de desenvolvimento das ninfas de *E. heros* e *N. viridula* foi 33,0 e 34,0 dias e que 65,0% e 71,3% das ninfas atingiram a fase adulta, respectivamente. Adultos de *E. heros* criados em laboratório produziram 2,5 vezes mais ovos (5547,0 ovos/gaiola) do que aqueles provenientes do campo (2262,7 ovos/gaiola). Os adultos de *E. heros* provenientes do campo apresentaram redução na sobrevivência e no número de ovos produzidos devido ao elevado índice de parasitismo por *Hexacladia smithii* Ash. (Hymenoptera: Encyrtidae). Os adultos de *N. viridula* provenientes do campo apresentaram produção de ovos 1,7 vezes maior (6304,9 ovos/gaiola) do que a dos percevejos criados em laboratório (3609,2 ovos/gaiola). *E. heros* criado em laboratório é um promissor hospedeiro na multiplicação de parasitóides de ovos, quando comparado com *N. viridula* coletado no campo.

PALAVRAS-CHAVE: Insecta, *Glycine max*, percevejo verde, percevejo marrom, criação.

ABSTRACT – This research aimed to evaluate the potential of *Euschistus heros* (Fabr.) (Hemiptera: Pentatomidae) as host for multiplication of egg parasitoids, by determining the nymphal and adult performance of *E. heros* from laboratory and the field, comparing with *Nezara viridula* (L.) (Hemiptera: Pentatomidae), under mass conditions. One hundred eggs of *E. heros* and *N. viridula* were placed among the leaves of soybean plants contained in cages (50x50x70 cm) and observation were made until adult emergence. The nymphs fed on soybean pods, dry soybean and peanuts seeds. The number of nymphs that reached adulthood and the development time were calculated. The survivorship and reproduction performance of laboratory and field populations of *E. heros* and *N. viridula* were evaluated during 13 weeks in February-May 1999. The number of eggs produced by 100 pairs of stink bugs per cage containing the same diet was recorded. Nymphal development time of *E. heros* and *N. viridula* was 33.0 and 34.0 days and 65.0% and 71.3% of nymphs reached adulthood, respectively. Adults of *E. heros* reared under laboratory conditions produced 2.5 times more eggs (5547.0 eggs/cage) than those collected in the field (2262.7 eggs/cage). The adult field population of *E. heros* had reduced reproduction and longevity due to parasitism by *Hexacladia smithii* Ash. (Hymenoptera: Encyrtidae). The *N. viridula* adults collected in the field produced 1.7 times more eggs (6304.9 eggs/cage) than those reared in the laboratory (3609.2 eggs/cage). *E. heros* laboratory reared is a promising host for egg parasitoids multiplication when compared with *N. viridula* collected in the field.

KEY WORDS: Insecta, *Glycine max*, southern green stink bug, neotropical brown stink bug, rearing.

Stink bugs of the Pentatomidae family are today considered the main pest of soybean *Glycine max* (L.) Merrill (Fabaceae) and are especially important during the reproductive development of the crop. They form a stink bug complex of more than 25 species (Panizzi & Slansky 1985) where the neotropical brown stink bug, *Euschistus heros* (Fabr.), southern green stink bug, *Nezara viridula* (L.) and small stink bug, *Piezodorus guildinii* (Westwood) (Hemiptera: Pentatomidade), are economically important due to their high reproductive potential and mainly to their ability to cause damage.

Outbreaks of harmful stink bug populations occur frequently in soybean crops and are normally controlled by chemicals. A biological control program using the egg parasitoid *Trissolcus basalis* (Wollaston) (Hymenoptera: Scelionidae) has been developed and implanted as an alternative to insecticide use and is an important strategy for perfecting soybean integrated pest control (Corrêa-Ferreira 1993, Corrêa-Ferreira & Moscardi 1996).

In Paraná State, the biological control program of stink bugs by mass release of *T. basalis* depends on egg production of its preferential host, *N. viridula*. The southern green stink bug adults are field collected, taken to a colony and maintained as a continuous source of host egg. However the increasing difficulty in collecting a large number of *N. viridula* adults and, consequently, obtaining a high egg production has been observed. Because of the dynamic faunal changes in soybean fields the *N. viridula* population has been reduced and *E. heros* has become the most abundant stink bug in those fields, especially in the region between the North of Paraná state and the Central Region of Brazil (Panizzi 1997, Corrêa-Ferreira & Panizzi 1999).

T. basalis and *Telenomus podisi* Ashmead (Hymenoptera: Scelionidae) parasitoid in *E. heros* eggs are naturaly found in soybeans in several regions of Brazil (Foerster & Queiróz 1990, Corrêa-Ferreira & Moscardi 1995, Medeiros *et al.* 1997). This suggests that *E. heros* is a potential host and the rearing of this stink bug as an alternative host for *T. basalis* or as preferential host for *T. podisi* multiplication is useful in biological control of soybean stink bugs. The suitability of *E. heros* eggs to mass multiplication *T. basalis* and *T. podisi* was studied by Peres (2000) and the methodology for parasitoids multiplication on *E. heros* eggs was developed by Peres & Corrêa-Ferreira (unpublished).

The knowledge of the nymphal and adult performance of *E. heros* in mass conditions is necessary to determine its potential as a host for multiplication of egg parasitoids. The objective of the present work was to study the development time, survivorship and reproduction of laboratory and field populations of *E. heros* under mass conditions, comparing with *N. viridula*.

Material and Methods

Nymph Performance. The performance of *E. heros* and *N. viridula* nymphs was assessed in a room with controlled conditions (25±2°C, 60±10% RH and 14L:10D). The egg masses were obtained from stink bugs field collected and maintained in the cages. Close to eclosion, 100 eggs of each species were transferred to net cages (50 x 50 x 70 cm) containing a soybean plant of the Paraná cultivar at the pod filling stage. The eggs were placed on the leaves and among the stems of the plant.

The hatched nymphs remained inside the rearing cage, feeding on the soybean pods, dry soybean and peanuts seeds, which is commonly used to mass rear southern green stink bug in the laboratory (Corrêa-Ferreira 1985). The fruits of Japanese privet *Ligustrum lucidum* Thunb. (Oleaceae) were offered to *N. viridula* as a food supplement. The development time was calculated when 70% of the individuals reached adulthood. A completely randomized design with two treatments and six replications was used and the means of the nymph performance were compared by the t test at 5% probability.

Adult Performance. The reproductive performance of the adults was observed under controlled conditions (25±2°C, 60±10% RH and 14L:10D), and field and laboratory *E. heros* populations were compared with *N. viridula* populations in similar conditions. *N. viridula* and *E. heros* nymph laboratory populations were obtained by breeding in rearing cages.

The stink bugs were sexed at two days of adult life and 100 couples from each species were transferred to net cages (50 x 50 x 70cm) containing the same food sources offered to the nymphs. Dead stink bugs were replaced during the pre-oviposition period. During February 1999, *N. viridula* and *E. heros* adults were collected on soybean plants growing in the Empresa Brasileira de Pesquisa Brasileira (Embrapa) farm at Londrina county, northern Paraná state (latitude 23º 11'S, longitude 51º 11'W). Stink bug adults were brought to the rearing room, sexed and placed in the cages at the number of 100 couples per cage.

The field and laboratory *E. heros* and *N. viridula* populations were observed daily for 13 weeks (February - May 1999) or until total stink bug mortality. The egg masses were collected, the number of eggs counted and the mortality was evaluated. The presence of parasitoids in the field *E. heros* population was recorded. A completely randomized design was used with four treatments and six replications. The mean (±SEM) number of eggs per cage of laboratory and field populations during each week were compared by the t test at 5% probability. The mean (±SEM) number of eggs per cage were compared at the end of the observation period by the chi-square test at 5% probability.

Results and Discussion

Nymph Performance. Of the 100 eggs, 65.0% of *E. heros* and 71.3% of *N. viridula* completed their nymph development reaching the adulthood, in a total mean time of 33.0 and 34.0 days, respectively. The number of nymphs that reached adulthood for the two species was lower when compared with those obtained in studies with individualized *E. heros* (93.3%) and *N. viridula* (87.7%) nymphs (Cividanes & Parra 1994 a,b). However, it was higher when compared to the number of nymphs that reached adulthood (13%) found in studies with 30 *N. viridula* nymphs per cage (Costa 1991). The assessed methodology has the advantage that little time is spent maintaining the nymph colony, which is handled as little as possible, an important factor to be considered in insect mass rearing.

Adult Performance. When the reproductive performance of the *E. heros* populations from the laboratory and field were compared, the total egg production was 2.5 times higher for the laboratory population (Table 1). Laboratory *E. heros* produced 5547.0 eggs per cage, which differed significantly (χ^2 = 1013.36; $\chi^2_{(1;0.05)}$=3.84) from the 2662.7 eggs produced by the field population. However, the *N. viridula* population collected in the field produced 1.7 times more eggs than the laboratory raised population, obtaining a mean of 3609.2 and 6304.9 eggs per cage produced by laboratory and field stink bugs, respectively. These total values differ significantly (χ^2=732,88; $\chi^2_{(1;0.05)}$=3.84) (Table 1).

The egg production and survivorship of the *N. viridula* and *E. heros* adults field collect were influenced by many factor as uneven age, heterogeneous sexual activity population (virgins, mated just once, mated several time), parasitism occurrence, nutritional diversity and quality of host plants.

Fig. 1 shows the egg laying rhythm of the field and laboratory populations of the two stink bug species. A mean production of 550.8±119.48 and 563.0±119.19 eggs was found for the *E. heros* laboratory reared population in the first and second weeks, respectively (Fig. 1). Oviposition peaked in the third week, and remained high until the fifth week of observation, with a mean production of 809.8±188.11, 769.4±127.92 and 744.0±177.32 eggs per cage, respectively. Egg production of the *E. heros* laboratory reared population decreased from the fifth observation week onwards, probably due to female aging and death over time

Table 1. Reproductive performance and mortality (mean per cage) of laboratory reared and field collected *E. heros* and *N. viridula* adult populations, kept under controlled conditions (25±2ºC, 60±10% RH and 14h L:10h D), during February – May, 1999. Londrina, PR.

	E. heros		*N. viridula*	
	Field	Laboratory	Field	Laboratory
Total egg production (nº)	2262,7	5547,0*	6304,9	3609,2*
Eggs / mass (nº)	6,76	6,84	60,70	52,86
Total mortality (%)				
3rd week	33,34	22,55	82,35	68,26
7th week	74,58	44,15	99,09	96,01
13th week	86,79	66,45	100	100

* Significant difference between laboratory reared and field collected populations using chi-square at 5% probability.

The mean number of eggs per mass, at the end of the 13 weeks of observation, was similar statistically, with values of 6.8 and 6.8 for the laboratory and field *E. heros* populations, respectively. The mean number of eggs per mass was 60.7 for the *N. viridula* stink bugs from the field and did not differ significantly from the 52.9 eggs per mass found in the *N. viridula* population reared in laboratory (χ^2=0.54; $\chi^2_{(1;0.05)}$=3.84). Values close to those reported in the literature for the egg mass size were found for the two populations. Several authors obtained a mean number of eggs per mass for *E. heros* between 7.0 and 11.0 (Villas-Bôas & Panizzi 1980, Pinto & Panizzi 1994, Malaguido & Panizzi 1999) and between 47.0 and 58.4 eggs per mass for *N. viridula* (Panizzi & Alves 1993, Panizzi *et al.* 1996).

Generally, adult *E. heros* had lower mortality than adult *N. viridula*. The *E. heros* collected in the field had higher mortality indexes when compared to those reared in the laboratory. The *N. viridula* collected in the field had, in the first three weeks, higher mortality indices (82.3%) than the laboratory raised population (68.3%) and the mortality for the two populations from the seventh week onwards was over 96% (Table 1).

(Fig.1). The inverse proportion between the oviposition rate and female age was also observed by Costa *et al*. (1998) and Cividanes & Parra (1994b).

The higher egg production period of the *E. heros* stink bugs brought from the field was in the first week, where a mean of 1645.2±183.29 eggs per cage was produced. The stress caused by handling capture, transport, sex separation and distribution of the stink bugs into the cages, along with the high fecundity of the stink bugs, may have stimulated oviposition. There was a sharp decrease from then onwards, with a mean production of 732.8±49.06 and 171.2±25.11 eggs per cage in the second and third week, respectively. Egg production in this population remained low from the third week onwards, and was nil from the tenth week onwards.

Field *E. heros* egg production was statistically higher than that of the population reared in the laboratory only in the first week. The productions were similar in the second week and, from the third week onwards, the reproductive performance of laboratory females was significantly higher than field females (Fig.1). This lower production may be partly explained by the age of the females collected in the

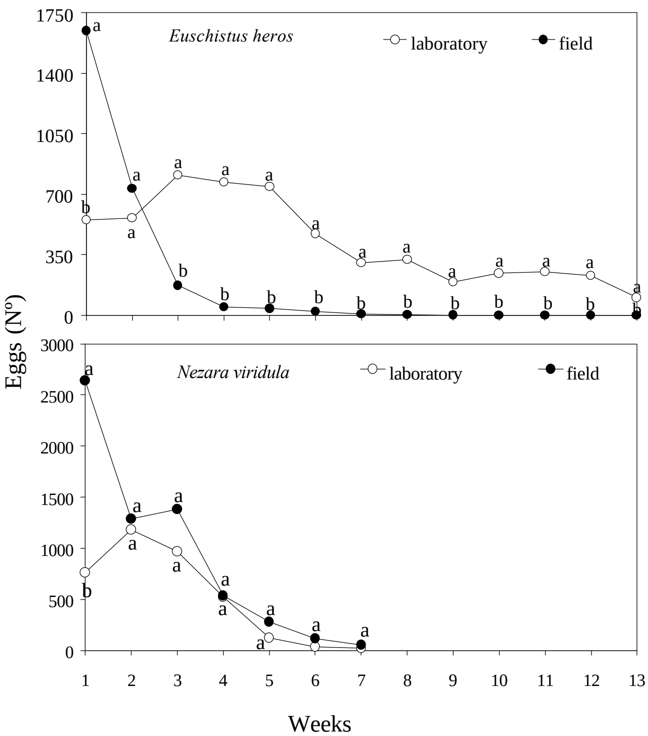

Figure 1. Mean number of eggs per cage of laboratory reared and field collected *E. heros* and *N. viridula* populations, kept under controlled conditions (25±2ºC, 60±10% RH and 14h L:10h D), during February – May, 1999. Londrina, PR. Means followed by the same letter do not differ significantly(p<0,05%) using t test.

field, when compared to the uniform age shown by the laboratory population.

The laboratory reared *N. viridula* had a mean egg production of 760.0±203.33 per cage in the first week, and egg production peaked in the second week with a mean of 1181.1±231.83 eggs per cage (Fig.1). This oviposition rhythm was different from the results obtained by Costa (1991) for *N. viridula* reared in the laboratory, where the highest egg production was observed in the third week. Oviposition peaked in the first week for adult *N. viridula* brought from the field, with a mean production of 2641.8±387.03 eggs.

Egg production decreased in the laboratory reared *N. viridula* from the second week onwards, and in those from the field, from the third week, with statistically equal values (Fig 1). This behavior agree with Azmy (1976) who stated that *N. viridula* oviposition begins with a maximum number of eggs, decreasing with the increase in female longevity. Egg production in the *N. viridula* population brought from the field fell compared with the first week, where a mean of 1290.7±169.19 and 1383.3±217.34 eggs per cage were recorded in the second and third weeks, respectively. This low egg production may be explained by the high mortality rate found in the cages, caused by female aging, reaching almost 100% adults in the *N. viridula* populations in the seventh week (Table 1). Similar results were reported by Azmy (1976).

Throughout the 13 weeks of observation, laboratory *E. heros* and *N. viridula* males and females always survived longer than adults collected from the field and the *N. viridula* populations showed a more marked reduction than the *E. heros* populations (Figs. 2 and 3).

Survival decreased throughout the experimental period in the laboratory reared *E. heros* populations, and was more marked during the second, third, fourth and sixth observation weeks for the females, and during the first two observation weeks for the males. A higher survival decrease was observed in the *E. heros* population brought from the field, both for the males and females, in the first, second, sixth and seventh observation weeks (Fig. 2).

Survival decreased in the *N. viridula* population brought from the field and reared in the laboratory mainly in the first two weeks of the experiment. At the end of the second week, only 48.6±7.45% of the females, and 48.5±6.36% of the males of the initial laboratory reared population were found alive and 31.3±4.07% of the females and 24.8±4.49% of the males from the initial population brought from the field were found alive (Fig. 3).

The emergence of the parasitoid *Hexacladia smithii* Ashmead (Hymenoptera: Encyrtidae) in the *E. heros* field population was observed in the second week of the study (Fig. 2). This parasitoid was removed from the cages on the day of its emergence at egg collection time, but this did not prevent adult *E. heros* in the cages from being parasitized.

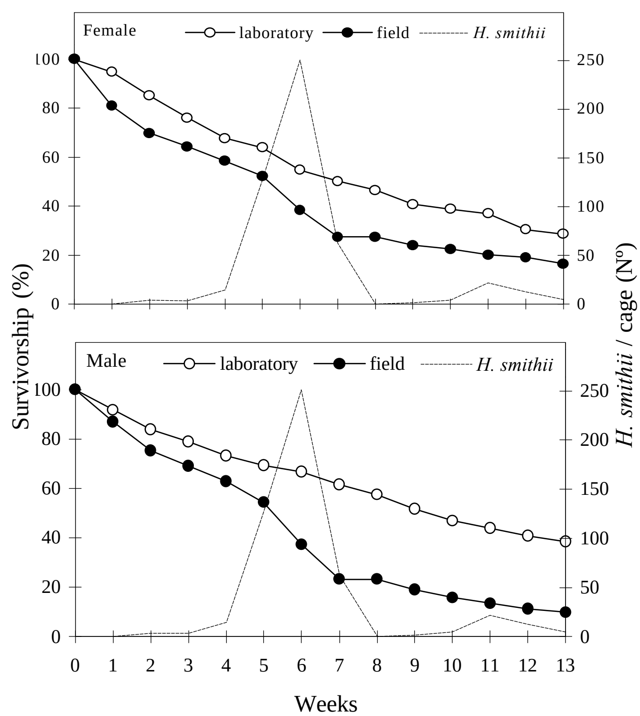

Figure 2. Mean survivorship of laboratory reared and field collected *E. heros* population, kept under controlled conditions (25±2ºC, 60±10% RH and 14h L:10h D) and *H. smithii* emergence, during February – May, 1999. Londrina, PR.

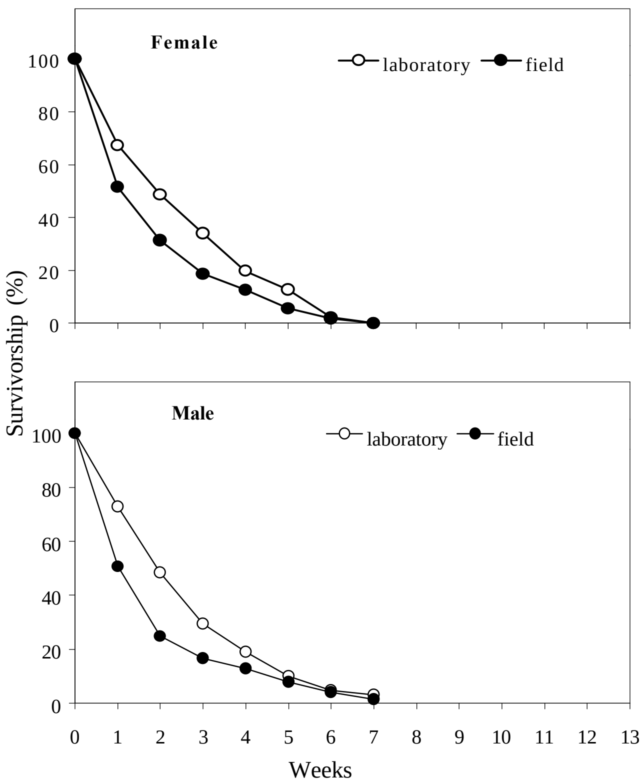

Figure 3. Mean survivorship of laboratory reared and field collected *N. viridula* population, kept under controlled conditions (25±2ºC, 60±10% RH and 14h L:10h D) during February – May, 1999. Londrina, PR.

The parasitism inside the cages resulted in a high density of the parasitoid about four weeks later, when an average of 250.8±59.37 adults emerged/cage, causing significant mortality in the stink bug population from the field. The parasitism that occurred inside the cage, along with the already parasited stink bugs from the field, were the cause of the great reduction in the number of eggs produced per cage in this population, explaining the rapid decrease in the reproductive capacity observed in this study, starting in the second week of observation (Fig. 1).

When the period of highest reproductive performance of *E. heros*, reared in laboratory or brought from the field, is known by finding the highest egg production period, unnecessary expenses in maintaining unproductive stink bugs can be avoided (Costa *et al.* 1998). Thus that *E. heros* adults collected in the field in February should be kept in a controlled room for only two weeks is recommended, whereas *E. heros* adults reared in the laboratory can be kept in cages with 100 couples for the first seven oviposition weeks. *E. heros* shows diapause and no reproductive activity during the autumn/winter (April - September) in North of Paraná State, as recorded by Panizzi & Vivan (1997) and Mourão & Panizzi (2000). Because of this behavior, the period of colect and use of *E. heros* population found in the field is extremely important.

N. viridula collected in the field in February had higher egg production compared to the laboratory population, which can be explained by the high fecundity of this stink bug specie and low parasitism index for Tachinidae, which occurs in this period in field populations (Corrêa-Ferreira & Panizzi 1999). However, *N. viridula* collected in the field for setting up a large scale colony may be used with criterion, because parasitism rates by Tachinidae can be high in some periods of the year (Panizzi & Oliveira 1999) and, as a consequence, the egg production can be reduced (Corrêa-Ferreira & Godoy, unpublished).

In conclusion, *E. heros* laboratory reared is a promising host for egg parasitoids multiplication. It was proved easy to rear and showed development time, survivorship and eggs production similar to *N. viridula* collected in the field during soybean season.

Acknowledgments

We thank Drs. Daniel R. Sosa-Gómez and A. Catellan for revising and early draft of the manuscript. This study was sponsored by the Universidade Federal do Paraná (UFPR) and by the Empresa Brasileira de Pesquisa Agropecuária (Embrapa), Centro Nacional de Pesquisa de Soja. W. A. A. Peres was supported by a scholarship from the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq). This paper was approved for publication by the head of Research and Development of Embrapa Soja as manuscript number 025/2000.

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Received 13/09/00. Accepted 30/08/01.