

Natural parasitism in eggs of *Anticarsia gemmatalis* Hübner (Lepidoptera, Noctuidae) by *Trichogramma* spp. (Hymenoptera, Trichogrammatidae) in Brazil

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ABSTRACT. Natural parasitism in eggs of *Anticarsia gemmatalis* Hübner (Lepidoptera, Noctuidae) by *Trichogramma* spp. (Hymenoptera, Trichogrammatidae) in Brazil. Field surveys were carried during four soybean seasons in Southern Brazil to evaluate the occurrence of parasitoids in eggs of *Anticarsia gemmatalis* Hübner, 1818 and their incidence along the crop season. Eggs were collected by visual search on soybean leaves and from plants kept inside cages where *A. gemmatalis* moths were allowed to lay eggs. *Trichogramma acacioi* Brun, Moraes & Soares, 1984 was recorded for the first time in eggs of *A. gemmatalis* and the citations in the literature of *Trichogramma lasallei* Pinto, 1998 in Brazil were based on the material collected in this survey. Apart from these species, *Trichogramma pretiosum* Riley, 1879, *Trichogramma rojasi* Nagaraja & Nagarkatti, 1973 and *Trichogramma atopovirilia* Oatman & Platner, 1983 were also collected, all of which have been previously recorded in this host. Parasitized eggs were collected all over the period of occurrence of *A. gemmatalis*, from January to April each year. Total parasitism ranged from 4.8% in 2000 and 2002, 23.3% in 2001 and 28.9% in 2003. *T. pretiosum* and *T. acacioi* accounted for more than 80% of the parasitoids emerged each year, followed by *T. atopovirilia*, *T. rojasi* and *T. lasallei*, with less than 20% of incidence. Both the sex ratio and the mean number of parasitoids/egg did not differ among the species. Searching for *A. gemmatalis* eggs proved to be time consuming in comparison to the collection of eggs laid by moths inside the cages, which showed to be a useful method to provide qualitative estimates of parasitism in eggs of *A. gemmatalis*.

KEYWORDS. Biological control; soybeans; velvetbean caterpillar.

RESUMO. Parasitismo natural em ovos *Anticarsia gemmatalis* Hübner (Lepidoptera: Noctuidae) por *Trichogramma* spp. (Hymenoptera: Trichogrammatidae) no Brasil. Levantamentos de campo foram realizados durante quatro safras de soja na região Sul do Brasil, visando avaliar as espécies de parasitóides que ocorrem em ovos de *Anticarsia gemmatalis* Hübner, 1818 e a incidência de parasitismo ao longo do ciclo da cultura. Os ovos foram coletados visualmente em folhas de soja e com a colocação de gaiolas em campo contendo adultos de *A. gemmatalis* para que realizassem oviposições. A espécie *Trichogramma acacioi* Brun, Moraes & Soares, 1984 foi registrada pela primeira vez parasitando ovos de *A. gemmatalis* e *T. lasallei* Pinto, 1998 teve seu primeiro registro no Brasil através destes levantamentos. Foram também encontradas as espécies *T. pretiosum* Riley, 1879, *T. rojasi* Nagaraja & Nagarkatti, 1973 e *T. atopovirilia* Oatman & Platner, 1983, já registradas anteriormente neste hospedeiro. Ovos parasitados foram coletados durante todo o período de ocorrência de *A. gemmatalis*, de janeiro a março de cada ano. Os índices de parasitismo foram de 4,8% em 2000 e 2002, 23,3% em 2001 e 28,9% na safra 2003. *T. pretiosum* e *T. acacioi* foram responsáveis por mais de 80% do parasitismo nos ovos coletados a cada ano, enquanto *T. atopovirilia*, *T. rojasi* e *T. lasallei*, apresentaram menos de 20% de incidência. Não houve diferença significativa entre a razão sexual e o número de parasitóides emergidos por ovo hospedeiro entre as espécies de *Trichogramma* coletadas. A coleta de ovos naturalmente depositados foi menos eficiente em comparação à coleta de ovos depositados por fêmeas no interior das gaiolas, o qual mostrou-se um método satisfatório para a estimativa qualitativa de parasitismo em ovos de *A. gemmatalis*.

PALAVRAS-CHAVE. Controle biológico; lagarta da soja; parasitóide de ovos.

The velvetbean caterpillar *Anticarsia gemmatalis* Hübner, 1818 is the most destructive noctuid attacking soybeans in Brazil. Until 1997 there was only one report on the incidence of egg parasitoids in eggs of *A. gemmatalis* (Hohmann *et al.* 1989). Polaszek & Foerster (1997) described *Telenomus cyamophylax* Polaszek, 1997 from eggs of *A. gemmatalis* and Foerster & Avanci (1999) reported the occurrence of *Trichogramma pretiosum* Riley, 1879, *T. rojasi* Nagaraja & Nagarkatti, 1973 and *T. atopovirilia* Oatman & Platner, 1983 parasitizing eggs of the velvetbean caterpillar.

Despite the worldwide use of *Trichogramma* species for the control of lepidopterous pests (Li 1994), few attempts have been made in Brazil to include these species in biological control

programs. Soybean pest management is underway in Brazil since the early 1970's (Kogan *et al.* 1975); natural control agents of velvetbean caterpillar include the entomogenous fungus *Nomuraea rileyi* (Farlow) Samson and the nuclear polyhedrosis virus *Baculovirus anticarsia*. However, the efficiency of these entomopathogens may be restricted under unfavorable climatic conditions (Moscardi 1998) and the utilization of egg parasitoids of *A. gemmatalis* has not been taken into account so far. In these circumstances the use of egg parasitoids of the genus *Trichogramma* would complement the action of entomopathogens in integrated control programs of the velvetbean caterpillar.

Due to the lack of knowledge on the natural incidence of

parasitism in eggs of *A. gemmatalis*, field surveys were conducted in Paraná State, Southern Brazil during four soybean seasons, in order to identify the species of *Trichogramma* and to evaluate their incidence levels and relative abundance.

MATERIAL AND METHODS

Naturally laid eggs of *A. gemmatalis* were randomly searched on soybean leaves twice a week between January and April during the soybean seasons of 1999/00, 2000/01, 2001/02 and 2002/03 in the county of Fazenda Rio Grande (25°37'32''S, 25°41'33''S; 49°15'29''W, 49°17'27''W), Southeastern Paraná State, Brazil. From 175 to 783 eggs were collected each year; the eggs were taken to the laboratory and individualized in gelatin capsules until parasitoid emergence.

In order to facilitate the localization of *A. gemmatalis* eggs in the plants, moths were caged on soybean plants to lay eggs. Four iron sticks 1.2 m high were buried 20 cm into the soil around the plants and a nylon cover was inserted into the sticks, standing 1m above the soil with a soybean plant inside. Six couples of *A. gemmatalis* moths were released inside the cage and left to lay eggs on the plant. The mesh size of the nylon (1 mm) allowed access of egg parasitoids to the inside of the cage, and after three-four days the eggs found on the plants were collected and transferred to the laboratory to evaluate the incidence of parasitism, sex-ratio and number of parasitoids emerged per host egg. The number of collected and parasitized eggs was recorded, as well as the species of *Trichogramma* emerging from each egg. The mean number of adults emerged per host egg and the sex ratio (N°. of females/ N°. of females + N°. of males) of the *Trichogramma* species collected in the field were determined by the pooled results obtained during the four years and sampling methods. The species of *Trichogramma* were identified according to morphological characters of the male genitalia (Nagaraja & Nagarkatti 1973; Oatman & Platner 1983). Statistical comparisons between the two methods of collection of host eggs were made by the χ^2 test ($p < 0.05$), and data on sex-ratio and number of adults emerged/host egg were submitted to Anova. On each sampling date the developmental stage of

the crop was recorded (Fehr *et al.* 1971). The larval density of *A. gemmatalis* in the field was evaluated weekly by the shake cloth method in 10 points within the experimental area (Shepard *et al.* 1974). Voucher specimens of the *Trichogramma* species collected are deposited in the Coleção Entomológica "Pe. J. S. Moure", at the Departamento de Zoologia, Universidade Federal do Paraná, Brazil.

RESULTS

Apart from the species recorded by Foerster & Avanci (1999), two other *Trichogramma* species were collected in *A. gemmatalis* eggs, namely *T. acacioi* Brun, Moraes & Soares, 1984 and *T. lasallei* Pinto, 1998. This is the first record of *T. acacioi* in eggs of *A. gemmatalis* in Brazil and the citation of *T. lasallei* in Brasil by Foerster *et al.* (2000), Querino *et al.* (2000) and Querino & Zucchi (2003) where based on the material collected in this survey.

Parasitism rates ranged from 4.8% (2000 and 2002) to 23.3% (2001), considering all eggs collected by both methods (Table

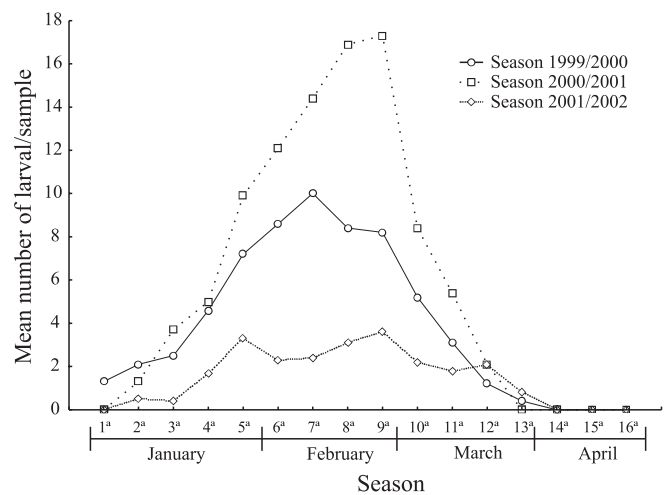


Fig. 1. Mean number of *Anticarsia gemmatalis* larval (large and small) sample during the 1999/2000, 2000/01 and 2001/02 soybean seasons. Fazenda Rio Grande, PR.

Table I. Total number of *Anticarsia gemmatalis* eggs collected by the two sampling methods and proportion of parasitized eggs. Fazenda Rio Grande, Paraná, Brazil.

Season	N.º of eggs	Cages		Visual search		Total	
		N	%	N	%	N	%
1999/2000	Collected	499		698		1197	
	Parasitized	31	6.2 a	26	3.7 b	57	4.8
2000/2001	Collected	500		783		1283	
	Parasitized	299	41.8 a	90	11.5 b	299	23.3
2001/2002	Collected	292		175		467	
	Parasitized	12	4.1	9	5.1	21	4.8
2002/2003	Collected	- ²	- ²	246		246	
	Parasitized	- ²	- ²	71	28.9	71	28.9

¹Values followed by different letters between the two collection methods for each year differ statistically by the χ^2 test ($p < 0.05$).

²Cages were not used in this season.

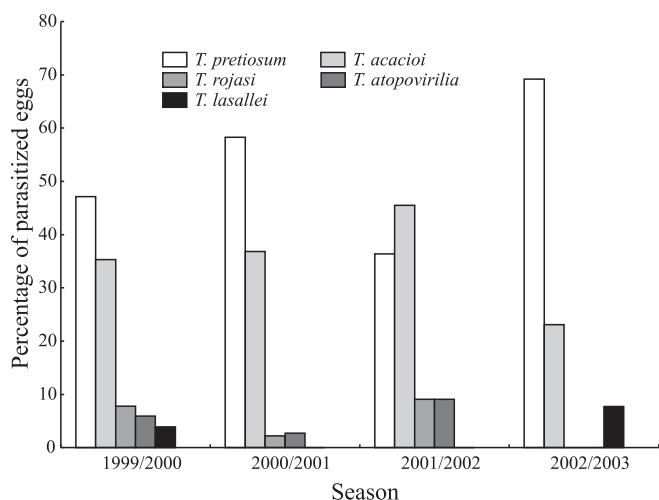


Fig. 2. Percentage of eggs of *Anticarsia gemmatalis* parasitized by *Trichogramma* species found during the 1999/2000, 2000/01, 2001/02 and 2002/03 season. Fazenda Rio Grande, Paraná, Brazil.

I). In 2002/03, only naturally laid eggs were collected and 28.9% of the eggs found were parasitized (Table I). Parasitism levels were related to host availability as indicated by the density of caterpillars in the crop; in 1999/2000 and 2001/02 field populations of *A. gemmatalis* larvae were well below the economic injury level established for the species (Hoffmann-Campo *et al.* 2000), whereas in 2000/01 their incidence was highest among the three years, although still below the economic threshold (Fig. 1). In 2000 and 2001 percentages of parasitism were higher in the eggs laid by moths in caged plants, while in 2002 similar parasitism rates were recorded in both cases (Table I). Eggs of *A. gemmatalis* are laid individually on stems and leaves of soybean plants and random collection is a time-consuming procedure. The release of moths in caged plants proved to be useful to detect egg parasitism and was less time-consuming than the visual search in the foliage.

Trichogramma pretiosum and *T. acacioi* were the predominant species, accounting for more than 80% of the parasitoids collected (Fig. 2). In Brazil, *T. pretiosum* is the main

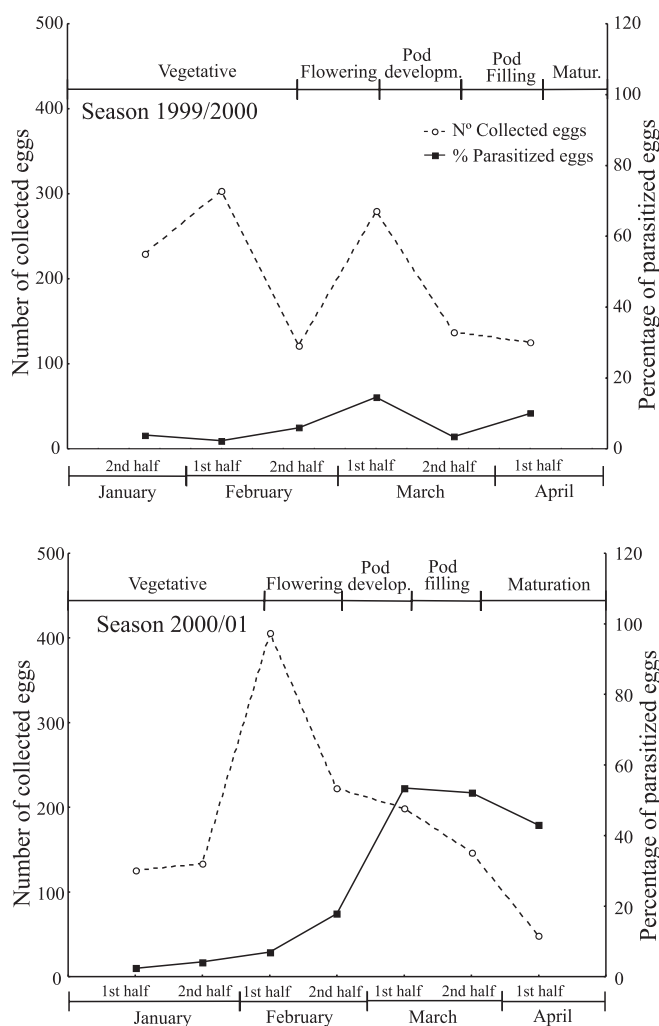


Fig. 3. Percentage of parasitism in eggs of *A. gemmatalis* and number of eggs collected during the 1999/2000 and 2000/01 soybean seasons. Fazenda Rio Grande, PR.

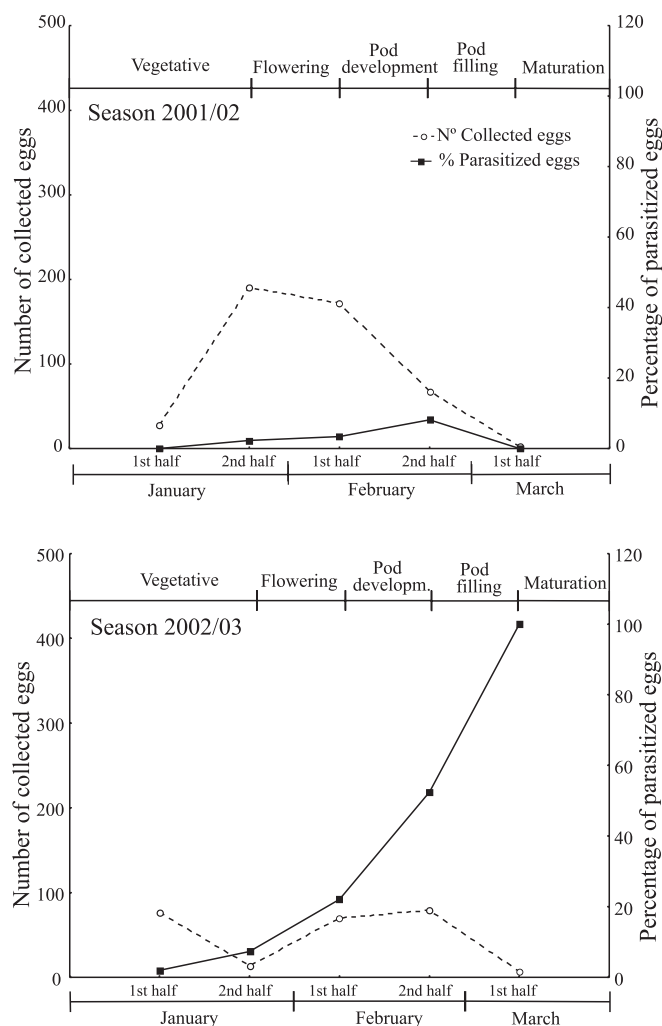


Fig. 4. Percentage of parasitism in eggs of *A. gemmatalis* and number of eggs collected during the 2001/02 and 2002/03 soybean seasons. Fazenda Rio Grande, PR.

Table II. Number of parasitoids emerged, mean number (\pm SE) of adults emerged per host egg and sex-ratio of *Trichogramma* species. Fazenda Rio Grande, Paraná, Brazil.

Species	N	N° parasitoids emerged	Adults emerged / host egg	Sex-ratio ¹
<i>T. pretiosum</i>	168	376	2.2 \pm 0.06 NS ²	0.69 \pm 0.02 NS ²
<i>T. acacioi</i>	114	256	2.3 \pm 0.07	0.73 \pm 0.03
<i>T. rojasi</i>	11	30	2.7 \pm 0.19	0.71 \pm 0.05
<i>T. atopovirilia</i>	11	25	2.3 \pm 0.19	0.70 \pm 0.06
<i>T. lasallei</i>	3	6	2.0 \pm 0.58	0.89 \pm 0.11

¹Sex-ratio = n° de fêmeas/n° de machos + n° de fêmeas

²Means did not differ statistically for the number of adults emerged/host egg (F=1.28; d.f.=4; p<0,05) and for the sex-ratio (F=0.68; d.f.=4; p<0,05).

parasitoid in eggs of Lepidoptera (Zucchi & Monteiro 1997), while *T. acacioi* has not been previously cited in eggs of *A. gemmatalis*.

Parasitoids were present in the crop since the first sampling date in January in the vegetative stage of the crop (Figs. 3, 4). Natural oviposition by adults of *A. gemmatalis* lasted until the end of March at pod-filling, when no more eggs were found in the crop. However eggs laid by caged moths in April were found parasitized, indicating that adults of *Trichogramma* were still present in the crop after the period of natural incidence of the host. Parasitism rates increased as the soybean season progressed, reaching the highest percentages during the development and filling of the pods in all seasons.

The mean number of adult parasitoids emerged per host egg and the sex-ratio of each species are shown in Table II. More adults of *T. rojasi* emerged from *A. gemmatalis* eggs in comparison to the other species, but the differences were not significant. Also, no statistical differences were recorded in the sex-ratio of the *Trichogramma* species collected in the field, which ranged from 0.69 in *T. pretiosum* to 0.89 in *T. lasallei*.

The high rates of parasitism observed in 2000/01 show that egg parasitoids may have a significant impact on the natural control of the velvetbean caterpillar, provided selective insecticides are used judiciously against soybean insect pests. From the results, it is concluded that *T. pretiosum* and *T. acacioi* are the most promising species to be considered in mass-rearing programmes for the biological control of VBC in Brazil.

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