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Temporal and Spatial Variation of *Stenoma cathosiota* Meyrick (Lepidoptera: Elachistidae) Caterpillar Abundance in the Cerrado of Brasilia, Brazil

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Variação Temporal e Espacial na Abundância das Lagartas de *Stenoma cathosiota* Meyrick (Lepidoptera: Elachistidae) no Cerrado de Brasília, DF

RESUMO - As lagartas da mariposa *Stenoma cathosiota* Meyrick alimentam-se de folhas de *Roupala montana* Aubl. (Proteaceae) em áreas de cerrado do Distrito Federal. Elas constroem abrigos juntando folhas da planta onde se alimentam e empupam. São parasitadas por uma vespa (Hymenoptera: Braconidae) que emerge da pupa. A abundância de lagartas de *S. cathosiota* e a frequência do parasitismo foram comparadas em duas áreas de estudo: uma com queimadas freqüentes (bienal) e a outra com queimadas esporádicas (1987 e 1994). Na área com baixa freqüência de queimada, a variação na abundância das lagartas entre anos foi significativamente diferente ($\chi^2 = 24,06$; gl. = 1; $P = 0,000$). No entanto, a variação na abundância de lagartas entre áreas, para o mesmo período de tempo, não diferiu estatisticamente ($\chi^2 = 3,45$; gl. = 1; $P = 0,063$). A freqüência do parasitismo foi alta, ocorrendo em 29% das lagartas coletadas e não diferiu entre as áreas. A grande variação temporal na abundância de lagartas no cerrado dificulta a determinação dos efeitos do fogo sobre essa fauna.

PALAVRAS-CHAVE: Braconidae, Stenomatinae, fogo, parasitismo, planta hospedeira

ABSTRACT - The caterpillars of *Stenoma cathosiota* Meyrick feed on *Roupala montana* Aubl. (Proteaceae) in the cerrado of the Distrito Federal, Brazil. They construct shelters by joining leaves of the plant where they feed and pupate. The caterpillars are parasitized by a wasp (Hymenoptera: Braconidae), which emerges from the pupae. Caterpillar abundance and parasitism frequency were associated in an area of frequently burned cerrado (biennial fire) and in another area that burns sporadically (1987 and 1994). For *S. cathosiota*, the variation among years in a single area, with sporadic fires, was greater than the variation among areas with different fire regimes. Caterpillar abundance among years was significantly different in the area that burns sporadically ($\chi^2 = 24.06$; df. = 1; $P = 0.000$). However, there were no significant differences on caterpillar abundance between areas for the same period ($\chi^2 = 3.45$; df. = 1; $P = 0.063$). Parasitism frequency was high, reaching 29% of the collected caterpillars, and did not differ among areas. The great temporal variation in abundance of lepidopteran caterpillars in the cerrado makes it difficult to determine the effects that fire exerts over this fauna.

KEY WORDS: Braconidae, Stenomatinae, fire, host plant, parasitism

Knowledge of the effects of fire over cerrado vegetation has grown quickly in recent years (Hoffman 1998; Miranda *et al.* 2002, 2004). However, its effects on the fauna are still poorly understood. In accidentally burned, protected areas, there has been a tendency for greater herbivory and greater abundance of some herbivorous insects during the first regrowth after the fire (Prada *et al.* 1995, pers. obs.). For example, the frequency of a gall insect was greater and they had higher survival in spite of a greater tendency of parasitism, in a recently burned area of cerrado, than in an unburned neighboring area (Vieira *et al.* 1996). On the

other hand, the effects of frequent fires compared to those of accidental, sporadic fires on protected areas have not been thoroughly investigated.

In the Cerrado of central Brazil the Proteaceae plant family comprises two genera but only *Roupala* occur in the cerrado *sensu stricto* (Mendonça *et al.* 1998). *Roupala montana* Aubl. is very common in this region and a rich caterpillar fauna feeds on this plant. In the Área de Proteção Ambiental Gama-Cabeça de Veado (DF, Brazil), 62 species of Lepidoptera associated with *R. montana* were identified (Bendicho-López *et al.* 2006). This is more than found on

other host plants already studied in the area (e.g. Diniz & Morais 1997; Diniz *et al.* 1999, 2001).

The Neotropical region is particularly rich in Stenomatinae (Elachistidae *sensu* Minet 1990). Of the 1,216 known species of this subfamily, 1,106 occur in the Neotropical region (Heppner 1991). Forty-eight species of *Stenoma* were found on host plants in the cerrado of Distrito Federal (Diniz *et al.* 2001, unpublished data). Two of these occur on *R. montana*: *Stenoma cathosiota* Meyrick and *Stenoma ferrocanella* (Walker). Another three species of the same family use *R. montana* as food, those being: *Cerconota sciaphilina* (Zeller), *Chlamydistis platyspora* (Meyrick), and one undescribed genus (V. O. Becker, pers. com.). *S. cathosiota*, *C. platyspora* and the new genus were found only on *R. montana* (Bendicho-López *et al.* 2006).

The biology of the rich lepidopteran fauna of cerrado region is still little known. In this work, information on the biology of the caterpillar of the moth *S. cathosiota*, which uses *R. montana* as its host, are presented, along with information on variation in the abundance and parasitism of these caterpillars in biennially and sporadically burned areas.

Material and Methods

This study was carried out in the Área de Proteção Ambiental Gama-Cabeça de Veado (15° 55'S 47° 51'W) in the Distrito Federal of Brazil. This area, of about 10,000 ha, includes the Jardim Botânico de Brasília, the Reserva Ecológica do IBGE (IBGE) and the Fazenda Agua Limpa (FAL), the experimental farm of the Universidade de Brasília. The area is between 1,000 m and 1,100 m high, with an average annual temperature of 21.1°C, an average annual precipitation of 1,470 mm and a punctuated dry season from May to September, when the lowest temperatures also occur (average minimum of 15.6°C) (RECOR Meteorological Station).

R. montana is very common in this area. It is a bush that can reach up to 2 m of height, but in the IBGE area, tends to be lower due to the frequent fires. It is an evergreen plant that does not lose all of its leaves, but presents peak leaf production during the transition period between the dry and rainy seasons (September-October) (Franco 1998). Throughout the year, a small number of new leaves on different individuals may occur.

Caterpillars of *S. cathosiota* feed on mature leaves of *R. montana* as scrappers, in the cerrado areas of the Distrito Federal. These larvae are known as leaf-tying caterpillars because they construct shelter by binding together mature and old leaves with silk, the soft pupal cocoon is lined by silk inside the leaf shelter. Under laboratory conditions, the average pupal period was 17 days (mean standard error = 0.732; n = 41; min = 7 max = 25).

The caterpillars of *S. cathosiota* were parasitized by a braconid wasp. The adult parasites emerged from the pupae. Several wasps emerge from the same pupa (3 to 47), and the average time recorded between the formation of the moth's pupal cocoon and the emergence of the parasitoids was 18 days (mean standard error = 2.375; n = 35; min = 3 max = 64). Parasitoid attack occurs in the field, yet the development stage in which such attack occurs is unknown.

Inventories were made in two areas of cerrado *sensu stricto*, one in FAL (4 ha) and other in IBGE (10 ha), separating about 6 km of natural vegetation cover. The FAL study area was accidentally burned in 1987 and 1994. The IBGE area is an experimental portion of the "Fire Project", which has had biennial August fires since 1990. In that area, inventories were made during a year without fire, in the period from April 1997 and April 1998. In FAL, inventories were made between May 1996 and October 1997.

All study areas were divided into four sub-areas that were visited weekly, in rotation. In each sub-area, 15 unmarked plants of *R. montana* were examined. Each plant was carefully examined for caterpillar presence. All *S. cathosiota* larvae were collected and raised without temperature or humidity control in the laboratory. They were kept in plastic pots, covered with paper towel and closed with fine cotton fabric held on by elastic bands. At least three times a week they received leaves of the host plant as food with the petioles wrapped in damp cotton to reduce drying. Dates of the pupal and of the emergence of the adult moth and/or parasitoids were recorded.

Frequencies sampling of *S. cathosiota* larvae between areas, and between years in the same area (FAL) were compared by Contingence table or by Fisher Exact Test when the expected valor for a cell was less than five (Sokal & Rohlf 1995), using the BioEstat 4.0. The same test was used to compare numbers of parasitized larvae between areas, and between years in the same area (FAL).

Results

The caterpillars of *S. cathosiota* were present in only 6.5% of the examined plants in FAL between May/96 and October/97. This proportion was similar to that observed in IBGE (5.8%) for the period from April/97 to April/98 (Fig.1, Table 1a). Comparing the period from April to October/97 in both areas, there was a tendency for greater caterpillar abundance in FAL (Fig.1), but this difference was not significant (Table 1b).

In FAL, the frequency of caterpillars differed in both years (May to October of 1996 and of 1997) (Table 1c). This period corresponds to the dry season and the beginning of the rainy season (October). A great variation of plants with caterpillars (abundance) was observed among consecutive years in the same area (FAL): in 1996 only 2% of the censuses presented caterpillars, while in 1997 this figure reached 13%.

The degree of parasitism was high, observed in 25% of the caterpillars collected in FAL and 34% of those collected in IBGE. In IBGE the peaks of parasitism (July-August and November) (Fig.1) were slightly off sync to the peak of caterpillar abundance (June-July and October-November), while in FAL this pattern was not clear (Fig.1). The frequency of parasitized caterpillars did not differ between the two sampling areas, even among the same periods of 1996 and 1997 in the FAL (Table 2). The great majority of the caterpillars collected were in the final phase of development. By removing the caterpillars from the field and raising them in the laboratory, having a relatively high mortality rates, resulted in a sub-estimate of the parasitism rates. Of 134 caterpillars collected 33.6% completed development, 29% were parasitized and 37.4% died from unknown causes.

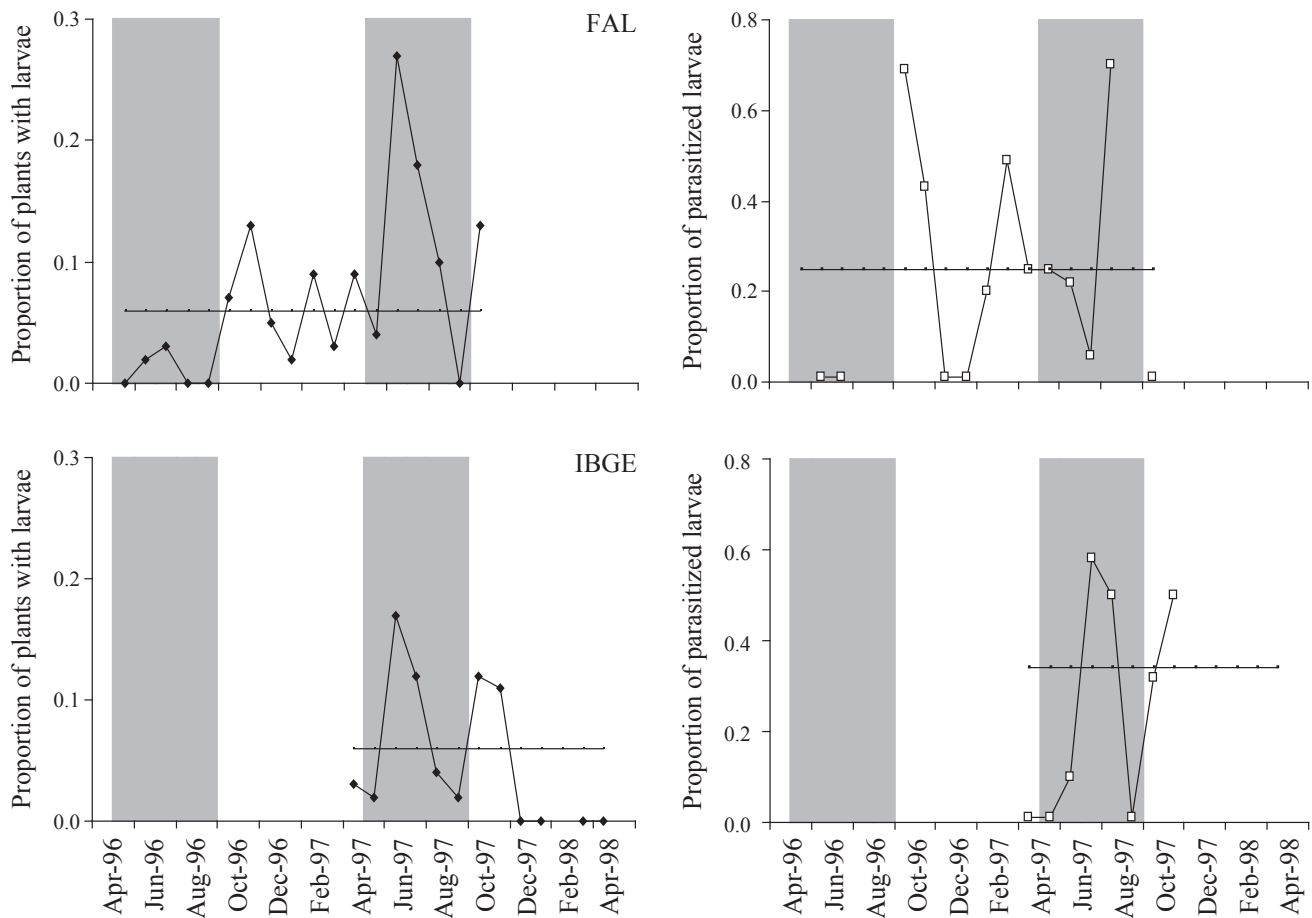


Fig. 1. Variation in the proportion of plants with *S. cathosiota* caterpillars (abundance) and the proportion of caterpillar parasitized by Braconidae (Hymenoptera) in cerrado areas of FAL, with low fire frequency, and IBGE, with biennial fires, in the Distrito Federal, Brazil. The shaded areas correspond to the dry season and the horizontal lines to the average proportion frequencies of caterpillars and of parasitism.

Discussion

The results indicate a low frequency of caterpillars of *S. cathosiota* on *R. montana*, which appears to be a pattern for the caterpillar fauna on plants in the cerrado (Price *et al.* 1995; Morais *et al.* 1996, 2005; Bendicho-López *et al.* 2003). The rarity of caterpillars may be partially related to the high rates of parasitism, which affected at least 29% of the *S. cathosiota* larvae. The greatest caterpillar abundance in the cerrado occurred during the first half of the dry season, when the vegetation still has old leaves and the lowest abundance occurred in the beginning of the rainy season when leaves are younger (Morais *et al.* 1999). This means that they eat leaves with low nitrogen and high fiber contents (Marquis *et al.* 2001), which can be another factor that partially explain the rarity of caterpillars. In the case of *S. cathosiota*, whose larvae fed on mature leaves (Bendicho-López *et al.* 2006), the peaks of caterpillar frequencies occurred in the dry season (June-July), but there was a relative high frequency of caterpillars in the beginning of the rainy season (October-November).

Caterpillar's abundance variation, among years, is

relatively common in cerrado areas (Andrade *et al.* 1995; Diniz *et al.* 2000a, b; Bendicho-López *et al.* 2003). This temporal variation (seasonal and annual) in caterpillar abundance makes it difficult to distinguish the possible effects of fire on this fauna. In general fire appears to affect insect population in the cerrado increasing the abundance of some orders (Diptera, Homoptera, Hymenoptera and Lepidoptera), and decreasing others like Collembola and Isoptera (I.R. Diniz, unpublished data). Sweep net samples on three regimes of the Kapalga fire experiment (Australia) showed an increase of abundance in caterpillars after fire. This is likely to be the result of nutritious canopy regrowth after the intense late fire (Braithwaite 1996). The frequent fires compared to those of accidental, sporadic fires apparently affect the *S. cathosiota* population decreasing its abundance. However, invertebrate populations, in general, are extremely variable in time and space and this variability has the capacity to override changes in populations attributable to fire (Friend 1995).

Fires in the cerrado do not occur in a homogeneous manner and, usually, produce small vegetation islands that may stay green (Henriques *et al.* 2000). On the other hand, in the areas where fire passes, the leaves that do not combust

Table 1. Frequencies of caterpillars of *S. cathosiota* on *R. montana* among cerrado areas of the Distrito Federal with different fire regimes: FAL = accidentally burned in 1987 and 1994; IBGE = experimental biennial August fires since 1990. (A) Among areas, total censuses periods; (B) Among areas, same censuses periods; (C) Same area, between years at same months.

Comparison	Area	Period	N° of censuses	N° of censuses with caterpillars	Contingence table
A	FAL	May/96 - Oct./97	765	50	$\chi^2 = 0.33$
	IBGE	Apr./97 - Apr./98	555	32	$p = 0.567$
B	FAL	Apr./97 - Oct./97	255	31	$\chi^2 = 3.45$
	IBGE	Apr./97 - Oct./97	375	29	$p = 0.063$
C	FAL	May - Oct./96	300	6	$\chi^2 = 24.06$
	FAL	May - Oct./97	210	27	$p = 0.000$

Table 2. Comparison of the number of *S. cathosiota* caterpillars parasitized by Braconidae among cerrado areas of the Distrito Federal with different fire regimes: FAL = accidentally burned in 1987 and 1994; IBGE = experimental biennial August fires since 1990. (A) Among areas, total censuses periods; (B) Among areas, same censuses periods; (C) Same area, between years at same months.

Comparison	Area	Period	N° of caterpillars	N° of parasitized caterpillars	Contingence table
A	FAL	May/96 - Oct./97	84	21	$\chi^2 = 1.84$
	IBGE	Apr./97 - Apr./98	50	18	$p = 0.175$
B	FAL	Apr./97 - Oct./97	58	14	$\chi^2 = 1.02$
	IBGE	Apr./97 - Oct./97	42	14	$p = 0.312$
C	FAL	May - Oct./96	9	2	Fisher Exact Test
	FAL	May - Oct./97	54	9	0.904

soon will dry out and drop a few days later, due to the high temperatures. *S. cathosiota* pupate on the host plant and the caterpillars, as well as the pupae, should suffer a mortality rate close to 100% when fire passes. Thus, this moth should be recolonizing areas after the passage of fire, then being followed by the parasitoids. The experimental fire portion of this study (Fire project) is relatively small (10 ha) and is surrounded by cerrado that is protected from fire, which probably facilitates such recolonization. Larger areas have a delayed colonization by insect herbivorous on host plants (Marini-Filho 2000). So, in a more and more fragmented landscape, with a highest burn risk near human population, fire can have an important destructive power on this biota.

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