

***Eloria subapicalis* (Lepidoptera: Noctuidae: Lymantriinae): rare and specialist species on *Erythroxylum* (Erythroxylaceae) in the cerrado**

Ivone R. Diniz^{1, 3}; Cintia Lapesqueur¹; Michelle S. Milhomen¹;
Fabiana C. S. Bandeira¹ & Helena C. Morais²

¹ Departamento de Zoologia, Instituto de Ciências Biológicas, Universidade de Brasília. 70910-900 Brasília, DF, Brazil.

² Departamento de Ecologia, Instituto de Ciências Biológicas, Universidade de Brasília. 70910-900 Brasília, DF, Brazil.

E-mail: morais@unb.br

³ Corresponding author. E-mail: irdiniz@unb.br

ABSTRACT. *Eloria subapicalis* (Walker, 1855) is a rare species (61 individuals in four years of samplings) of Noctuidae (Lymantriinae) with a specific diet consisting of leaves of *Erythroxylum* P. Browne (Erythroxylaceae) species in Brasília's cerrado. Generally, the rarity of a caterpillar species may have many explanations such as a generalist diet, being restricted to a host plant that is scarce in the area, or occurring in a limited geographical area. However, all the above explanations do not apply to *E. subapicalis* because it shows specificity of diet, uses a common host plant in the cerrado areas, and has a large geographical distribution.

KEY WORDS. Abundance; diet specificity; folivorous caterpillar; host plants; moths.

Herbivorous insects may be generalists or specialists. Specialists feed on a few phylogenetically related species which generally have similar chemical compounds (BERNAYS & CHAPMAN 1994). The diets of lepidopterans living in the tropics are often more specialized than the diets of temperate species (DYER *et al.* 2007). When a caterpillar species in the cerrado feeds specifically on a genus or family of plants, it is generally also abundant on its hosts (e.g. PESSOA-QUEIROZ *et al.* 2008). However, a few specialized caterpillar species in the cerrado seem to be rare (e.g. MORAIS & DINIZ 2003).

Two decades of studies in the cerrado have revealed a low frequency of folivorous caterpillars and a prevalence of rare species on their host plants (PRICE *et al.* 1995, MORAIS *et al.* 1996, BENDICHO-LÓPEZ *et al.* 2003, MORAIS & DINIZ 2003, 2004). Because cerrado caterpillars are found in low frequencies and low densities on plants, data collection is very time consuming, resulting in rare or scarce species being overlooked by researchers.

The Lymantriinae were previously considered to be a separate family (Lymantriidae) but are presently recognized as a subfamily within Noctuidae (KRISTENSEN *et al.* 2007). They are found all over the world, except in Antarctica, and are particularly abundant in tropical Africa, India, Southeast Asia, and South America (EOL 2010). Lymantriinae are represented in the cerrado plants of Brasília by only four species: *Eloria subapicalis* (Walker, 1855), a relatively abundant species *Thagona tibialis* (Walker, 1955); and two unidentified species of *Caviria* (DINIZ *et al.* 2001). Adult Lymantriinae have a short lifespan, a reduced haustellum, and do not feed (COSTA LIMA 1949). Cater-

pillars are hairy, usually colorful, and remain in the cocoon (where they incorporate larval hairs) when pupating. Many Lymantriinae are known for being plant pests and some bear urticating hairs that can lead to mild skin irritation to serious dermatitis in man (SCOBLE 1992).

Eloria Hübner, 1819 recently contains 80 species (BECCALONI *et al.* 2010). However, host plant information is available for only four species: two in Brazil (SILVA *et al.* 1968), one in Peru (CHEN *et al.* 2006), and one in Costa Rica (JANZEN & HALLWACHS 2010). In cerrado, *E. subapicalis* is specialized on species of the plant genus *Erythroxylum* P. Browne (Erythroxylaceae) (DINIZ *et al.* 2001).

Ordinarily, studies on Lepidoptera concern the most common species, and data on rare species in any ecosystem are difficult to find. Because rare species in the tropics represent a high proportion of the species in insect communities, they are very important in biodiversity assessments. Furthermore, they may be crucial to understanding the maintenance of small populations in the ecosystem over the long-term (NOVOTNY & BASSET 2000, NOVOTNY *et al.* 2002, KEAN & BARLOW 2004). *Eloria subapicalis* is noteworthy because its host plants are fairly common in the cerrado (FELFILI & SILVA JR 1993) but their caterpillars are rare. In this paper, we present data on *E. subapicalis* caterpillars that feed on common species of *Erythroxylum* in a cerrado at Brazil Central. This information was collected for three consecutive years (1995 to 1997), and a decade later, during one year (September 2005 to August 2006), and aims to provide a backdrop for discussing cerrado lepidopteran rarity and restricted diets.

MATERIAL AND METHODS

This study was carried out in areas of cerrado *sensu stricto* (OLIVEIRA-FILHO & RATTER 2002) at the Experimental Station of the University of Brasília (FAL), 15°55'S, 47°55'W, Distrito Federal, Brazil. The region has an average annual temperature of 22°C and average annual precipitation of 1,431 mm, with a well-defined dry season lasting from May to September (IBGE 2009). Further information on the soil and vegetation in the area is available in RATTER (1991), FELFILI *et al.* (1994), and EITEN (2001).

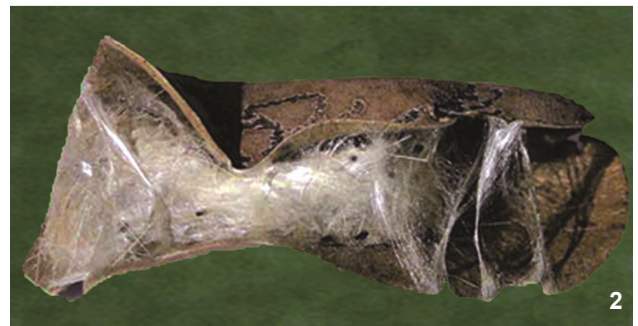
The four plant species monitored for caterpillars were: *Erythroxylum deciduum* St.-Hil., *E. tortuosum* Mart., *E. suberosum* St.-Hil., and *E. campestre* St.-Hil. *Erythroxylum* is represented by 10 species in the cerrado of the Distrito Federal (CAVALCANTI & RAMOS 2001) – four in gallery forests and six in the cerrado *sensu stricto*.

Surveys were carried out at the same 4 ha of cerrado *sensu stricto* in all three sampling periods, and using the same methodology. We monitored caterpillars weekly, covering the entire foliage of 15 to 25 individuals of each *Erythroxylum* species during three periods: 1) from February 1995 to September 1997, on 5,150 plants belonging to *E. deciduum*, *E. suberosum*, and *E. tortuosum*; 2) from September 1996 to August 1997 on 690 plants belonging to *E. campestre*; and 3) from September 2005 to August 2006 on 4,196 plants belonging to *E. deciduum* and *E. tortuosum*. Since the study site was partially and accidentally burned in August 2005, the third sampling event occurred on both burned and unburned areas with approximately 2 ha each; 2,065 individuals of *E. deciduum* and *E. tortuosum* were sampled in an unburned portion of the study site and 2,131 in a burned portion.

The caterpillars of *E. subapicalis* (Fig. 1), have long yellowish hairs, dark green tegument with a central yellow stripe and a reddish head; they attain a length of 4 cm in their final stage, and the pupal cocoon is built with leaves and silk (Fig. 2). All *E. subapicalis* caterpillars found were collected and reared in plastic jars in the laboratory without temperature, light or humidity control, and fed on leaves of the plant on which they were found. Observation on larval behavior was performed in the field and in the laboratory. Dates of pupation, emergence of the adult moth and/or of parasitoids were recorded. Dr Vitor O. Becker identified the genus or species, and adult (Fig. 3) voucher specimens were added to the 'Coleção Entomológica do Departamento de Zoologia da Universidade de Brasília (CEDZ/UnB)'.

RESULTS

The caterpillars cut marginal portions of the leaves and avoid the central vein. They were located exposed and isolated in the abaxial portion of mature and new leaves, and on trunks. The pupation occurs within a cocoon covered with a layer of silk and leaves (Fig. 2). The average pupation time in laboratory ($n = 8$) was 13 days ($sd = 10$) and parasitism was not recorded for either larvae or pupae.



Figures 1-3. *Eloria subapicalis*: (1) caterpillar on *Erythroxylum suberosum* in the cerrado area at Fazenda Água Limpa, Experimental Station, Distrito Federal, Brazil; (2) pupa cocoon; (3) adult.

A total of 54 *E. subapicalis* caterpillars were found on 5,150 plants examined during the first period of sampling, of which 50% were located on *E. tortuosum*, 46% on *E. suberosum* and 4% on *E. deciduum*. No caterpillar was found on *E. campestre* during the second period of sampling. In the third period of sampling (4,196 plants examined) only seven caterpillars were found between January and March 2006, all on mature leaves of *E. tortuosum* and only in the burned portion of the study site.

The abundance of *E. subapicalis* varied throughout the year, and between years. The caterpillars use *E. tortuosum* and

E. suberosum in a similar way (Fig. 4). Two generations of caterpillars appear to occur during a year, one during the dry season, beginning from April to July and extending until September, and another during the rainy season, from November to February.

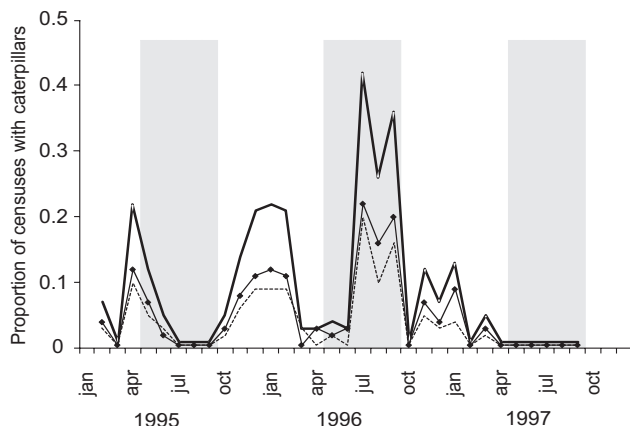


Figure 4. Monthly occurrence of *Eloria subapicalis* caterpillars on two species of *Erythroxylum* in the cerrado at Fazenda Água Limpa, Distrito Federal, Brazil. The gray bar indicates the dry season (May-September) in the region, black full line = proportion of caterpillars on the two species of hostplants, dotted line = proportion of caterpillars on *E. suberosum*, and gray full line = proportion of caterpillars on *E. tortuosum*.

DISCUSSION

Lymantriinae was seldom represented in the folivorous caterpillar surveys conducted in cerrado areas of the Distrito Federal (DINIZ *et al.* 2001). There is scant information in the literature about the host plants associated with *Eloria* (as summarized in Tab. I). All five species of *Eloria* for which we obtained

information from the literature also used *Erythroxylum* and three of them also used other plants as hosts (SILVA *et al.* 1968, CHEN *et al.* 2006, JANZEN & HALLWACHS 2010). However, specimens of *Eloria* were rarely found, or not found at all, on some species *Erythroxylum*. This is the case of *E. campestre* (no *Eloria* caterpillars found) and *E. deciduum* (only two caterpillars) in the present study. In another study, conducted at the restinga area in Rio de Janeiro (MONTEIRO *et al.* 2007), *Eloria* caterpillars were not found on *E. ovalifolium* Peyr. and *E. subsessile* (Mart.) O. E. Schulz Caterpillars belonging to *Eloria noyesi* Schaus, 1927 present detoxification and dopamine sequester mechanisms that allow them to use *E. coca* Lam. as a host plant (CHEN *et al.* 2006). The leaves of *E. campestre* and *E. deciduum* have cocaine, whereas the leaves of *E. suberosum* do not (BIERI *et al.* 2006); thus, it is possible that *E. subapicalis* selects its host plants according to the chemical constitution of their leaves.

Eloria subapicalis caterpillars seem to be local specialists on *Erythroxylum* occurring predominantly on *E. tortuosum* and *E. suberosum*. This hypothesis is based on our database obtained since 1991 for caterpillars in the cerrado vegetation of the Distrito Federal, on more than 30,000 plants of 100 species, and on more than 5,000 adults reared in the laboratory (DINIZ *et al.* 2001 and unpublished data). This database, far from complete due to the great plant diversity of the cerrado, is the largest for caterpillars and their host plants in the biome. It encompasses 76% of plant Index value of importance (IVI) (FONSECA & SILVA JR 2004), and to 80% of basal area (FELFILI *et al.* 2000). *Erythroxylum tortuosum* and *E. suberosum* represent the major biomass and densities of this genus in the cerrado *sensu stricto* (FELFILI & SILVA JR 1993). Despite the abundance of host plants in the area, caterpillars are rare. Usually, in the cerrado, caterpillars specialize on abundant host plants and use a small portion of the available resources (10% to 25% of the plants), but are abundant on these (BENDICHO-LÓPEZ *et al.* 2003, MORAIS *et al.* 2005). However, this is not the case of *E. subapicalis*, which is a rare species on *Erythroxylum* in the cerrado of the Distrito Federal.

Table I. Available information on host plants of *Eloria* species.

Eloria species	Host Plants		Location	Reference
	<i>Erythroxylum</i>	Others		
<i>E. moeonia</i>	<i>E. pelleterianum</i>	Apuleia (Fabaceae)	RS	SILVA <i>et al.</i> 1968
<i>E. noyesi</i>	<i>E. coca</i>	?	Peru	CHEN <i>et al.</i> 2006
<i>E. spectra</i>	<i>E. pelleterianum</i>	Apuleia (Fabaceae) Malvaceae	ES, RJ, RS	SILVA <i>et al.</i> 1968
<i>E. subapicalis</i>	<i>E. deciduum</i>			
	<i>E. suberosum</i>	–	DF	This study
	<i>E. tortuosum</i>			
<i>E. torrida</i>	<i>E. macrophyllum</i>	Polyphagous, mainly on species of <i>Eugenia</i>	Costa Rica	JANZEN & HALLWACHS 2010

States in Brazil: (DF) Distrito Federal, (ES) Espírito Santo, (RJ) Rio de Janeiro, (RS) Rio Grande do Sul.

There are several possible explanations for the rarity of these caterpillars in the cerrado. One could be population control by natural enemies. Even though egg parasitism and predators were not examined in this study, they are important factors affecting moth populations (KIDD & JERVIS 1997). Laboratory-reared *E. subapicalis*, however, were not parasitized. Another explanation would be the effect of the dry season, which lasts five months in the cerrado region. However, in the studied cerrado areas *E. subapicalis* caterpillars occur on *Erythroxylum* during both dry and wet seasons. Therefore, the long cerrado dry season does not constitute a limiting factor for these caterpillars.

Four other species of *Erythroxylum* are common in gallery forests of the Distrito Federal (CAVALCANTI & RAMOS 2001). Another possible explanation for the rarity of *E. subapicalis* caterpillars in their cerrado host plants would be the use of other *Erythroxylum* species in gallery forests. This hypothesis was proposed to explain the low densities of caterpillars of *Siderone galanthis galanthis* (Cramer) (Nymphalidae) in its cerrado host plant (MORAIS *et al.* 1996).

The distribution of some species may be considered sparse, with many small populations dispersed throughout a broad geographical region (KEAN & BARLOW 2004). Thus, a fourth possible explanation is that this species is locally rare (61 caterpillars in four years of research), but has a large geographical distribution. *Eloria subapicalis* is known to occur in Venezuela (local type) and also in the French Guiana (COLLENETTE 1950), but there is no additional published information on its phenology.

At least three species of *Eloria* are polyphagous (SILVA *et al.* 1968, JANZEN & HALLWACHS 2010) but *E. subapicalis* is restricted to *Erythroxylum* in this region. Another rare and specialized moth species found in the Cerrado, *Aucula munroei* Todd & Poole, 1981 (Noctuidae: Agarastinae), was found only on *Davilla elliptica* (Dilleniaceae) (see MORAIS & DINIZ 2003) in our limited Cerrado study area, but other agaristine species are found on several host species in a broad geographical distribution, feeding on Vitaceae and other 13 unrelated families, including Dilleniaceae (RAWLINS 1992). Most of these plant families are available in the cerrado.

The moth fauna of the Cerrado is clearly dominated by rare species with basically unknown natural histories (PRICE *et al.* 1995, MORAIS & DINIZ 2003, DINIZ & MORAIS 2005). Information on the biology, diet amplitude, and use of habitats by these species would provide a basic information network for decision making on the conservation of the cerrado biome. This study suggests that, in the cerrado, *E. subapicalis* caterpillars specialize on *Erythroxylum* species, occur seasonally, and do not occur in densities that reflect those of their host plant. This trend corroborates the prevalent pattern of the cerrado caterpillars, where they occur in low densities relative to resource availability (PRICE *et al.* 1995). Also, top-down pressure does not seem to be very important in regulating this caterpillar population because none of the caterpillars collected were attacked by parasitoids. However, we know little about egg parasitism and predation.

Further studies are needed to understand the underlying factors shaping our results, and to clarify the questions they raise. It is also necessary to investigate the presence of *E. subapicalis* on *Erythroxylum* species in gallery forests of other cerrado areas, and whether individuals of this species make better use of host plants in areas that have been burned previously, like other species in this cerrado area (DINIZ & MORAIS 2008).

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