LEPIDOPTERAN CATERPILLAR FAUNA ON LACTIFEROUS HOST PLANTS IN THE CENTRAL BRAZILIAN CERRADO

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ABSTRACT

Nine lactiferous plants of five families were examined for caterpillars in a 4 ha cerrado *sensu stricto* (savanna-like vegetation) area of the University of Brasília Experimental Farm (DF, Brazil), from August 1995 to May 1997. In 5,540 censuses, less than 5% of the plants hosted caterpillars. All the caterpillars found, a total of 55 species in 15 families were reared under laboratory conditions. Pyralidae, Geometridae, Elachistidae, Megalopygidae, and Limacodidae were the richest caterpillar families recorded. Of the 55 species, more than 40% were polyphagous, feeding on different host plant families, while 21 were considered rare species with less than four records during the study period. The species' rareness did not permit any analysis of diet breadth. The presence of latex in the host plants seems to affect both the proportion of host plants with caterpillars (abundance) and the caterpillar species richness. The habit of eating plants that characteristically produce latex occurs in several distantly-related lepidopteran families. The results support the argument that specific behaviors to circumvent plant latex defense may have arisen independently many times in the Lepidoptera.

Key words: latex, Lepidoptera, host-plants, cerrado, diet.

RESUMO

Fauna de Lepidoptera associada a plantas lactíferas do cerrado

Nove espécies de cinco famílias de plantas hospedeiras lactíferas foram examinadas, a procura de lagartas, em uma área de cerca de 4 ha de cerrado *sensu stricto* na Fazenda Água Limpa da Universidade de Brasília, DF, Brasil, de agosto de 1995 a maio de 1997. Foram realizados 5.540 censos e em menos de 5% das plantas hospedeiras foram encontradas lagartas. Todas as lagartas encontradas foram criadas em condições de laboratório. No laboratório emergiram 55 espécies de 15 famílias de Lepidoptera. As famílias mais comuns foram Pyralidae, Geometridae, Elachistidae, Megalopygidae e Limacodidae. Do total de 55 espécies mais de 40% são certamente polífagas. Entretanto, 21 espécies podem ser consideradas raras com menos de quatro ocorrências, o que impede uma análise de dieta. De um modo geral a presença de látex nas plantas hospedeiras parece afetar a abundância e a riqueza de espécies de Lepidoptera. Espécies de Lepidoptera de famílias distantes filogeneticamente foram encontradas alimentando-se dessas plantas lactíferas, o que corrobora a sugestão de que comportamentos específicos desenvolvidos para alimentar-se de plantas com látex tenham evoluido várias vezes entre os lepidópteros.

Palavras-chave: látex, Lepidoptera, plantas-hospedeiras, cerrado, dieta.

INTRODUCTION

Latex may be defined as any amount of whitish or colored plant secretion (Gentry, 1993). Many plant species have latex canals in their leaves; the latex is contained internally under pressure (Bernays & Chapman, 1994). When the leaves are damaged, these channels break and the latex flows out.

Lactiferous plants are common in the Brazilian cerrado vegetation. Evidence has shown that they suffer less from herbivory than other plant species (Lewinsohn, 1991). Latex may work as a plant defense mechanism against insect herbivores. Many lactiferous plants have secondary compounds in the latex, such as alkaloids and terpenes, functioning to deter foliage-eaters. Latex might also cause other adverse effects on insects, as it is sticky and hardens when exposed to air (Bernays & Chapman, 1994; Farrell *et al*., 1991). However, insect herbivores have ways of circumventing this defense mechanism. For example, insect herbivores may show specific behavior to sabotage latex defense, such as cutting latex canals in the most distal part of the leaves and then feeding on these leaves (Dussourd, 1993; Bernays & Chapman, 1994).

Insect herbivores have the ability to recognize the chemical relationship between host plants. A high proportion of these species feed on related plants (same family) (Forbes, 1958). The presence of some allelochemicals, common to several taxonomically distant plant species, is frequently referred to as a possible explanation for an increase in the number of host plants accepted (Dussourd, 1993). Nevertheless, very little is known concerning which factors determine the breadth of insect herbivore food niches (Fowler, 1996).

Very little is known concerning the proportion of monophagous, oligophagous and polyphagous insects in the tropics (Marquis & Braker, 1994). The cerrado *sensu lato* is rich in lepidopteran species with estimates of 1,000 butterfly species (Brown & Mielke, 1967) and 5,000 to 8,000 moth species (Becker, 1991), and information is available concerning caterpillar abundance and species richness related to different host plant species in the Brasília cerrado vegetation (Andrade *et al*., 1995; Price *et al*., 1995; Diniz & Morais, 1995, 1997; Morais *et al*., in press). The purpose of this study is to describe the lepidopteran species associated with lactiferous plants in the cerrado vegetation of Brasilia, providing information about the richness, abundance and dietary breadth of caterpillars found on these plant species.

MATERIAL AND METHODS

Study Area

This study was carried out at the Água Limpa Experimental Farm (FAL) (15° 55'S – 47° 53'W) of the University of Brasília (Brasília, DF) from August 1995 to May 1997, in a 4 ha area of cerrado *sensu stricto* (Goodland, 1971). The climate of FAL is characteristic of the cerrado area with a mean average annual temperature of 22°C and mean average annual precipitation of 1,431 mm. The climate is markedly seasonal with five months of dry season (May to September), wherein only 7% of the annual mean precipitation occurs (Espinoza *et al*., 1982). Overall aspects of the site location, soil, climate and vegetation are described in Felfili & Silva (1993) and Felfili *et al*. (1993, 1994). The vegetation of FAL is thoroughly described in Ratter (1991).

Host plant species

The plant species utilized in this study were: *Aspidosperma tomentosum* Mart., *A. macrocarpon* Mart., *Himatanthus obovatus* (M. Arg.) R. E. Woodson (Apocynaceae), *Maprounea guianensis* (Aubl.) M. Arg. (Euphorbiaceae), *Kielmeyera coriacea* (Spreng) Mart., *K. abdita* Saddi, *K. variabilis* Mart. (Clusiaceae), *Brosimum gaudichaudii* Tréc. (Moraceae) and *Pouteria ramiflora* (Mart.) Radlk. (Sapotaceae). Other latex plant species, though in low densities, are present in the survey area, and include *Barjonia erecta* (Vell.) K. Schum. (Asclepiadaceae), and *Hancornia speciosa* Gomez (Apocynaceae).

Previous studies have already recorded 40 Angiosperm plant families as latex producers (Lewinsohn, 1991). This study thus includes approximately 12% of the lactiferous plant families. All examined species presented a milky white latex, except *M. guianensis*, which had a whitish and watery latex.

Aspidosperma spp. are plants that have abundant milky white to reddish or orange latex in the leaves, absent or in small amounts in the

tree trunks (Gentry, 1993). The two arboreal species examined in the study site have a white and abundant latex. *Aspidosperma macrocarpon*, rarer in the survey site, has large leaves whose upper surface presents a glabrous epidermis, and whose inferior surface is pubescent. *Aspidosperma tomentosum*, a deciduous species that flushes its leaves at the end of the dry season (September), has new leaves densely pubescent on both surfaces, but which are almost glabrous on the upper surface when mature.

Eight species of *Kielmeyera* are listed for the Federal District (Barros, 1989). *Kielmeyera coriacea* is the most common species in the Brazilian cerrado (Ratter, 1991). The shrubby *K. coriacea* and *K. abdita* have seasonally deciduous glabrous leaves, while *K. variabilis* is evergreen.

Brosimum gaudichaudii has a large amount of milky latex, especially in its leaves and branches. It is a shrubby plant species, evergreen, with tough glabrous leaves.

Pouteria ramiflora also has abundant milky latex in its leaves. It is mainly an arboreal plant species, deciduous, with very flexible leaves pubescent in the upper surface.

METHODOLOGY

The 4 ha study area was divided into quarters, surveyed in rotation. Fifteen unmarked plants from each species, between 0.5-2.0 m in height, were examined every week for external leaf-feeding caterpillars. In each census, the host plant and caterpillar data were recorded on standard forms including the following information: estimated plant height, estimated percent of new foliage, numbers of caterpillars, relative age of leaves used, and other traits of caterpillars.

All caterpillars found were collected, identified to morphospecies and reared to the adult stage in the laboratory. During their laboratory development, the dates of pupation, emergence of adults, and the presence and development of parasitoids were recorded. Adults were identified by Vítor O. Becker (moths) and Keith S. Brown Jr. (butterflies). Voucher specimens were deposited in the Entomological Collection of the Department of Zoology, University of Brasilia.

An assessment of niche breath was made, using data already obtained for the cerrado vegetation in the Federal District (Diniz & Morais, 1997 and unpublished data), distinguishing monophagous (restricted to one food plant genus), oligophagous (restricted to different genera belonging to the same family) and polyphagous species (host plants belonging to different families). Species found less than four times on only one plant species were considered rare, with insufficient data concerning dietary habits.

RESULTS

We made 5,490 censuses of the nine species of lactiferous host plants, yielding a low proportion of plants with caterpillars (4.6%). The presence of caterpillars per plant (from 0.7% to 16.2%) varied significantly among the studied plant species ($\chi^2 = 304.31$ $p \leq 0.001$), among the species belonging to Apocynaceae (1.2% to 4.5%; $\chi^2 = 8.03$ $p \leq 0.01$), and also among the ones belonging to the genus *Kielmeyera* (0.7% to 7.2%; $\chi^2 = 65.81$ $p \leq 0.001$). The plant with the smallest percentage of caterpillars was *Kielmeyera variabilis* (0.7%), and the one with the greatest percentage was *Pouteria ramiflora* (16.2%) (Table 1). Species richness was also a highly variable trait among host plants, from one species (*Isognathus caricae*) on *Himatanthus obovatus* to 40 (19 identified) on *Pouteria ramiflora* (Tables 1 and 2). The sampling effort varied according to the host plant species (Table 1) but no relationship was found between sampling effort and number of morphospecies ($F = 0.18$ $p \leq 0.68$).

From the nine examined host plants we obtained 55 species of adults belonging to 15 families reared in the laboratory. The most common families were Pyralidae (9 species), Elachistidae and Geometridae (7), and Megalopygidae and Limacodidae (6) (Table 2). Most morphospecies were identified to genus (Table 1). Twenty three (42%) of the 55 species found on these latex plants were polyphagous (Table 2). Of 30 species found on only one plant species (Table 2), 21 were very rare (only 1-3 records), preventing an analysis of dietary breath. Eleven caterpillar species were found a number of times on only one host plant genus and may be regarded as monophagous in this study site. However, *Isognathus caricae* is known from other Apocynaceae plant genera in other regions (Silva *et al*., 1968).

TABLE 1

Number of censuses carried out, number of censuses with caterpillars (%), and number of morphospecies and lepidopteran species identified on each lactiferous host plant species, from August 1995 to May 1997.

Family	Plant species	Nº of censuses	Nº of censuses with caterpillars (%)	Nº of morphospecies	Nº of species (adults reared in the laboratory)
Apocynaceae	Ato	697	08 (1.2)	09	09
	Ama	133	06 (4.5)	06	04
	Hob	498	14 (2.8)	01	01
Clusiaceae	Kab	755	10 (1.3)	04	04
	Kco	765	55 (7.2)	17	17
	Kva	753	05 (0.7)	04	04
Euphorbiaceae	Mgu	615	38 (6.2)	19	17
Moraceae	Bga	603	08 (1.3)	05	02
Sapotaceae	Pra	671	109 (16.2)	40	19

Abbreviations: Ama = *Aspidosperma macrocarpon*, Ato = A. *tomentosum*, Hob = *Himatanthus obovatus*, Mgu = *Maprounea guianensis*, Kab = *Kielmeyera abdita*, Kco = *K. coriacea*, Kva = *K. variabilis*, Bga = *Brosimum gaudichaudii*, Pra = *Pouteria ramiflora*.

TABLE 2

Lepidopteran species reared and emerged under laboratory conditions, and their host plants with latex (abbreviation as in Table 1), number of other known host plant families without latex (Others) and dietary breadth and/or rareness (Db/r). Pol = polyphagous, Mon = Monophagous.

Lepidopteran families and species	Host plant species								Others	Db/r
	Ato	Ama	Hob	Mgu	Kab	Kco	Kva	Bga Pra		
Arctiidae										
Cosmosoma cruenta (Perty, 1833)		X							–	Rare
Fregela semiluna (Walker, 1854)		X						X	>19	Pol.
Idalus carinosa (Schaus, 1905)								X	–	Rare
Paracles sp.	X								4	Pol.
Dalceridae										
Acraga ochracea (Walker, 1855)				X					2	Pol.
Dalcera abrasa H.-Schaeffer, 1854				X		X		X	5	Pol.
Dalcerina tijucana (Schaus, 1892)				X				X	2	Pol.
Elachistidae										
Chlamydastis sp. 1								X	–	Mon.
Chlamydastis sp. 2								X	–	Mon.
Chlamydastis sp. 3								X	–	Mon.
Chlamydastis sp. 4								X	–	Mon.
Inga phaeocrossa (Meyrick, 1912)	X								7	Pol.
Rectiostoma haemitheia (F. & R., 1875)								X	–	Rare
Stenoma annosa (Butler, 1877)				X					–	Rare
Gelechiidae										
Gelechiidae sp. 18				X					–	Rare

TABLE 2 (*cont.*)

Lepidopteran families and species	Host plant species									Others	Db/r
	Ato	Ama	Hob	Mgu	Kab	Kco	Kva	Bga	Pra		
Entogonia sp. 1									X	–	Rare
Glena demissaria Walker, 1860						X				–	Rare
Iridopsis sp.				X						–	Mon.
Oxydia saturniata Guenée,					X					3	Pol.
Phrudocentra eccentrica Prout, 1916				X						–	Rare
Pseudazelodes sp. n.	X									–	Rare
Geometridae sp. 2						X				–	Rare
Limacodidae											
Natada pucara (Dognin, 1893)						X				–	Rare
Phobetron hipparchia (Cramer, 1777)						X				7	Pol.
Platyprosterna pernambuconis (Dyar, 1905)				X						5	Pol.
Platyprosterna perpectinata (Dyar, 1905)				X						1	Pol.
Semyra incisa (Walker, 1855)						X	X		X	6	Pol.
Talima rufoflava (Walker, 1855)				X						2	Pol.
Lycaenidae											
Emesis russula Stichel, 1910	X			X					X	6	Pol.
Symmachia sp. 1									X	1	Pol.
Megalopygidae											
Megalopyge sp.	X									–	Rare
M. albicollis (Walker, 1855)		X		X		X			X	12	Pol.
M. lanata (Cramer, 1780)						X				–	Rare
Podalia albescens (Schaus, 1900)					X	X	X			17	Pol.
P. annulipes (Boisduval, 1833)					X	X	X			1	Pol.
Trosia sp.						X				–	Rare
Mimallonidae											
Lacosoma ludolpha Schaus, 1928									X	–	Rare
Notodontidae											
Malocampa satis (Druce, 1898)								X		–	Rare
Psychidae											
Oikiticus kirbyi Guilding, 1827						X				4	Pol.
Pyralidae											
Deuterollyta chrysoderas (Dyar, 1917)				X						–	Mon.
Incarcha aporalis (Dyar, 1910)									X	–	Rare
Mediavia sp.						X				–	Rare
Palpita sp. 1	X	X								–	Mon.
Palpita sp. 2	X									–	Mon.
Pessograptis thalamias Meyrick, 1923						X				–	Rare

TABLE 2 (*cont.*)

Lepidopteran families and species	Host plant species									Others	Db/r
	Ato	Ama	Hob	Mgu	Kab	Kco	Kva	Bga	Pra		
Epipaschiinae sp. 5					X	X	X			–	Mon.
Phycitinae sp. 5				X						–	Mon.
Saturniidae											
Automeris bilinea (Walker, 1855)	X									1	Pol.
Hylesia schuessleri Strand	X					X			X	>23	Pol.
Sphingidae											
Isognathus caricae (L., 1764)			X							–	Mon.
Tortricidae											
Clarkeulia sp.				X						5	Pol.
Cydia sp. 3				X						–	Rare
Episimus sp.						X				–	Rare
Platynota rostrana (Walker, 1863)				X				X	X	8	Pol.
Total species 55	9	4	1	17	4	17	4	2	19		
Exclusive species (on only one plant species) 30	3	1	1	7	0	8	0	1	9		

DISCUSSION

Generally speaking, the presence of latex in host plants may affect the abundance (number of plants with caterpillars) and species richness of herbivores. The abundance of caterpillars on three *Kielmeyera* species (with latex) were 4-7 times less than that found for three species each of *Byrsonima*, *Erythroxylum* and *Qualea* (species without latex); the same was found for species richness (Pinheiro *et al*., 1997). Nevertheless, *Pouteria ramiflora*, a species with abundant latex, showed similar or higher levels of caterpillars abundance and species richness when compared to other examined species without latex (I. R. Diniz & H. C. Morais, unpublished data).

Kielmeyera coriacea and *Maprounea guianensis* showed half as many morphospecies as *P. ramiflora* (Table 1). All three species are deciduous; *Pouteria* is larger and has a much lower density in the study site than the other species. Euphorbiaceae has the highest number of plant species, six times more than Clusiaceae (=Guttiferae) (11), and Sapotaceae (10) in the Federal District (Filgueiras & Pereira, 1994). The other six host plant species show low levels of richness and caterpillar abundance (Table 1). There is no comparable data on secondary chemical substances and leaf nutrients of these plant species. None of the traits of the plants studied could explain the difference in lepidopteran richness.

More than 90% of the lepidopteran species found on the lactiferous plants had free-living caterpillars, externally exposed on the leaves. This contrasts with the high proportion of caterpillars in cerrado areas living inside shelters made by tying, rolling and folding leaves, and other materials (Andrade *et al*., 1994).

At least 40% of the caterpillars associated with these plants are polyphagous, feeding on more than one host plant family. Twelve species of caterpillars have a broad dietary range (more than four host plant families), which includes species with and without latex. Nevertheless, at the study site, even the most polyphagous species, such as *Fregela semiluna*, *Megalopyge albicollis* and *Hylesia schuessleri*, were not found on all lactiferous plant species (Table 2).

Hylesia schuessleri was found feeding on 23 plant families in a small area of cerrado (approximately 10 ha) at the FAL. Similarly, polyphagy was also found in *Hylesia lineat*a, whose caterpillars feed on at least 17 plant families at Santa Rosa National Park, Costa Rica (Janzen,

1984). *Hylesia schuessleri* is a gregarious species, frequently found in groups of more than 100 individuals, especially in early instars; in the final instars, the caterpillars tend to disperse into smaller groups. The larvae eat the leaf from the apex to the base, always leaving intact the midrib of both lactiferous and non-lactiferous plants (unpublished data). An analogous gregarious behavior, at least in the early instars, seems to be an important strategy for *Noorda esmeralda* (Pyralidae) using the seeds of its Apocynaceae host plant, in that the energy required to break through the tough latescent fruit skin of the host plant is shared, and thus each caterpillar is exposed to less toxicity (Benavides & Monteiro, 1996).

A small proportion of the caterpillars collected on *Pouteria ramiflora* was identified (Sapotaceae) (Table 1) but approximately half of these were polyphagous. Janzen (1988) found a rather different result while studying other plant species of the same family; he considered *Manilkara chicle* as a host plant rich in caterpillars (17 species in a six-year survey). From these, only one sphingid species was found on three or more plant species having latex, and one arctiid species was found in other Sapotaceae, while the other 15 species seemed to be monophagous. On the other hand, Andrade & Benson (1997) described the use of *Mimosa laticifera* (Mimosaceae) by caterpillars of *Eurema dina leuce* (Pieridae) and suggested that the specific complex behavior against latex plants may easily appear even in taxa not normally associated with lactiferous plants during most of their evolutionary history.

It is difficult to draw conclusions about a specialized fauna occurring on lactiferous plants due to the low frequency of caterpillars found. Nevertheless, our results show that several species seem to be monophagous; more than half the species were found on only one genus of plants having latex (see exclusive species in Table 2). At the study site *Isognathus caricae* is specific to *Himatanthus obovatus*, *Deuterollyta chrysoderas* to *Maprounea guianensis*, Epipaschiinae sp. to *Kielmeyera* spp., and four species of *Chlamydastis* to *Pouteria ramiflora*. The available data show that species belonging to the genus *Palpita* seem to use only plants belonging to the family Apocynaceae. *Palpita flegia*, for instance, feed upon *Thevetia* by disabling the lactiferous canals (Dussourd & Denno, 1991). The results presented by Janzen (1985) showed a tendency to mono- or oligophagy among the sphingids (49 species) in the Santa Rosa National Park (Costa Rica); many of them (22%) feed on plants with latex. Surprisingly, in our study we only found one species of Sphingidae on the nine host plant species.

With relation to *Kielmeyera* spp. we found, over a year, 71% of morphospecies less than five times, and almost 80% of the caterpillars found belonged to only three species (*Podalia albescens*, *Podalia annulipes* and Epipaschiinae sp.), one of them being highly polyphagous. Moreover, the records were concentrated during a short period, the second half of the rainy season (Pinheiro *et al*., 1997). The low proportion of plants with caterpillars and their limitation to a specific period of the year may explain the absence of lepidopteran caterpillars on *K. coriacea* in surveys made by Loyola & Fernandes (1993).

Polyphagous caterpillars draw attention for being common among lepidopteran species associated with plants having latex. Nevertheless, the 60% of monophagous species may represent a typical fauna of latex plants in this cerrado area, even though they occur at very low frequencies.

Caterpillars feeding on the plants with latex show specific behavior for circumventing the lactiferous canals. This was already described for other insect groups such as Orthoptera, Coleoptera and Symphyta (Bernays & Chapman, 1994). According to the phylogenetic cladogram for Lepidoptera proposed by Minet (1991), species feeding on plants with latex in the cerrado area belong to different branches of superfamilies, phylogenetically distantly related: the micro-lepidopteran groups Gelechoidea (Elachistidae), Zygaenoidea (Dalceridae, Limacodidae and Megalopygidae), Tortricoidea (Tortricidae), Pyraloidea (Pyralidae), and the macrolepidopteran groups Mimallonoidea (Mimallonidae), Bombycoidea (Saturnidae, Sphingidae), Papilionoidea (Lycaenidae), Geometroidea (Geometridae), and Noctuoidea (Arctiidae, Notodontidae). This fact corroborates the suggestion that specific behavior related to feeding on plants with latex evolved many times in the Lepidoptera.

Arctiidae, Hypsidae, Noctuidae, Nymphalidae, Pyralidae, and Sphingidae have species that

can circumvent or sabotage lactiferous canals of their host plants (Dussourd, 1993; Dussourd & Denno, 1994). We may add to these seven other families that have species feeding upon plants with latex in the cerrado area of Brasilia: Dalceridae, Elachistidae, Geometridae, Limacodidae, Lycaenidae, Megalopygidae, and Notodontidae.

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