

*Journal of the Lepidopterists' Society*  
59(4), 2005, 212–218

## THE HIGHLY SEASONAL HAWKMOTH FAUNA (LEPIDOPTERA SPHINGIDAE:) OF THE CAATINGA OF NORTHEAST BRAZIL: A CASE STUDY IN THE STATE OF RIO GRANDE DO NORTE

JOSÉ ARAÚJO DUARTE JÚNIOR

Programa de Pós-Graduação em Ciências Biológicas, Departamento de Sistemática e Ecologia, Universidade Federal da Paraíba, 58059-900, João Pessoa, Paraíba, Brasil. E-mail: duarte@dnonline.com.br

AND

CLEMENS SCHLINDWEIN

Departamento de Botânica, Universidade Federal de Pernambuco, Av. Prof. Moraes Rego, s/n, Cidade Universitária, 50670-901, Recife, Pernambuco, Brasil. E-mail: schlindw@ufpe.br

**ABSTRACT:** The *caatinga*, a thorn-shrub succulent savannah, is located in Northeastern Brazil and characterized by a short and irregular rainy season and a severe dry season. Insects are only abundant during the rainy months, displaying a strong seasonal pattern. Here we present data from a yearlong Sphingidae survey undertaken in the reserve *Estação Ecológica do Seridó*, located in the state of Rio Grande do Norte. Hawkmoths were collected once a month during two subsequent new moon nights, between 18.00h and 05.00h, attracted with a 160-watt mercury vapor light. A total of 593 specimens belonging to 20 species and 14 genera were collected. *Neogene dynaeus*, *Callionima grisescens*, and *Hyles euphorbium* were the most abundant species, together comprising up to 82.2% of the total number of specimens collected. These frequent species are residents of the *caatinga* of Rio Grande do Norte. The rare Sphingidae in this study, *Pseudosphinx tetrio*, *Isognathus australis*, and *Cocytius antaeus*, are migratory species for the *caatinga*. Ninety percent of specimens and 75% of species were collected during the rainy season. With the arrival of the dry season, when bushes and trees lose their leaves and the herbaceous layer disappears, Sphingidae abundance decreases rapidly. Richness and abundance of species through the year is highly seasonal and correlated with rainfall. *Erinnyis alope alope*, *Eumorphia fasciatus*, *E. vitis vitis*, and *Manduca brasiliensis* were recorded for the first time in NE-Brazil.

**Additional keywords:** *Callionima grisescens*, dry savannah, *Hyles euphorbium*, *Neogene dynaeus*, Northeastern Brazil, Sphingidae.

### INTRODUCTION

Sphingidae are widely distributed and comprise approximately 1200 species, which occur predominantly in tropical regions (Lemaire & Minet 1999). Sphingidae are generally among the first Lepidoptera to be surveyed in a region. Despite this, studies related to the taxonomy, geographical distribution, relationship with host plants, and adult food sources are scarce for Sphingidae (Kitching & Cadiou 2000).

In Brazil to date, 180 species of Sphingidae have been recorded in regional surveys (Brown 1986), more than half in the Amazon basin: 61 species in the state of Amazonas (Motta 1998) and 90 in the state of Pará (Moss 1920). Seventeen species were recorded in the state of São Paulo (Coelho et al. 1979), 55 in the state of Paraná (Laroca & Mielke 1975), and 65 in the state of Rio Grande do Sul (Biezanko 1982; Corseuil et al 2001).

In Northeastern Brazil the Sphingidae fauna is still poorly studied. The only published data concern a community of Sphingidae and associated plants from an area of *tabuleiro nordestino* (a kind of *cerrado*, isolated from the Central Brazilian *Cerrado*) on the coast of the state of Paraíba (Darrault & Schlindwein 2002); this study recorded 24 species of Sphingidae for the area. A preliminary list for the *caatinga* region, based on

sporadic visits to the field counts 14 species (Duarte & Motta 2001). Both surveys add up to a total of 32 species for NE - Brazil.

The *caatinga*, a 834,666km<sup>2</sup> thorn-shrub succulent savannah (Andrade-Lima 1981), is the predominant vegetation in Northeastern Brazil (Fig. 1). The region is characterized by seasonal rainfall that defines the phenophases of the vegetation. During the dry season, which lasts approximately eight months (May–December), the vegetation loses its leaves. Sporadically there are years with almost no rain and drought can be severe (Andrade-Lima 1981, Sampaio et al. 1991, Machado et al. 1997). Therefore, the seasonal characteristics of the *caatinga's* climate and vegetation must influence the seasonality of Sphingidae and the development from an immature stage to adult (Janzen 1983, Haber & Frankie 1989, Darrault & Schlindwein 2002). The annual development cycle of the Sphingidae is not known for the *caatinga* region.

Generally, the relationships between larvae of Sphingidae and their host plants are highly specific. In many cases, the larvae accumulate toxic compounds from the plants that protect the larvae against predators. Such host plants include species of Apocynaceae, Euphorbiaceae, Solanaceae, and Rubiaceae (Biezanko

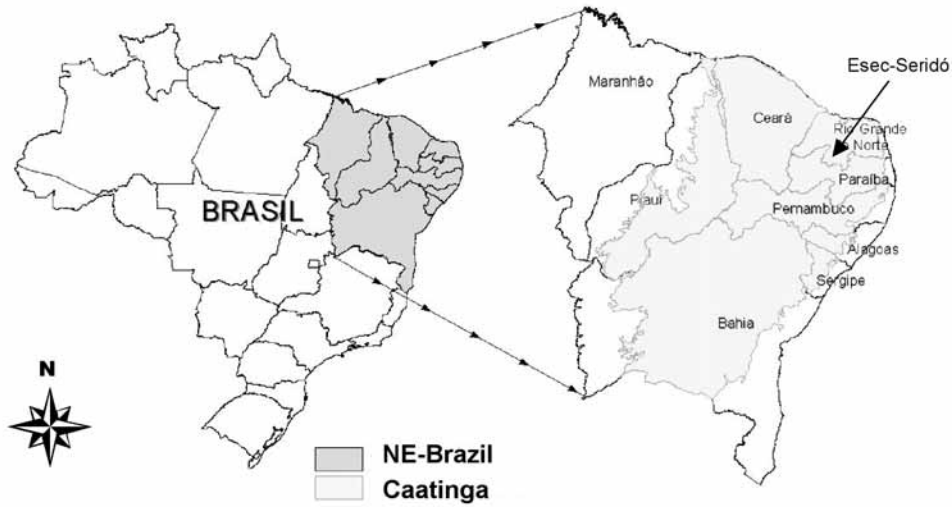


FIG.1. Map of Brazil indicating Northeastern Brazil, the distribution of the *caatinga* and the location of the study site “Estação Ecológica do Seridó (ESEC - Seridó)”, state of Rio Grande do Norte. Source: FREIRE, 2003.

1982, Janzen 1983, Moss 1920). The relationships between adult Sphingidae and sphingophilous flowers, however, does not seem to be specific (Darrault & Schlindwein 2002, Haber & Frankie 1989).

Pittaway (1993) affirms that a species may be submitted to seasonal cycles of abundance and scarcity, or its occurrence throughout the year may be constant for an area. According to this author, species abundance may also decline or increase in response to environmental conditions and to the degree of migration.

Here we present data for the composition, species richness and abundance of Sphingidae through the year in the *caatinga* in the nature reserve *Estação Ecológica do Seridó* in the state of Rio Grande do Norte, NE-Brazil.

MATERIALS AND METHODS

**Study area**

The study was undertaken in the nature reserve *Estação Ecológica do Seridó* (ESEC-Seridó) in the municipality of Serra Negra do Norte, state of Rio Grande do Norte, NE - Brazil (Fig.1). The reserve covers an area of 1,166.38 ha located between 06°35' and 06°40'S and 37°20' and 37°39'W, at an altitude of approximately 170 m. The climate is hot and dry (mean annual temperature of 28°C), with a rainy season that varies from January/February to April/June (mean annual rainfall of 497 mm). The rest of the year is characterized by a severe drought (IBAMA 1989) (Fig.

2). The temperature and rainfall data were obtained from the climate station in the reserve.

The vegetation is an arbustive to arboreous *caatinga*, with an herbaceous stratum that is only well-developed during the rainy period (Prado 2004).

**Sampling**

Sphingidae were collected between March 2002 and May 2003 (with the exception of May 2002). The moths were attracted by a 160-watt mercury light source positioned against a white wall. The light dispersed over an extensive area. Specimens were collected during two consecutive new moon nights per month from 18.00h to 05.00h on the following day. The moths were killed with an injection of ethyl acetate between the thorax and abdomen. The specimens were then placed in entomological envelopes and prepared in the laboratory.

The identification of the material collected was based on D’Abrera (1986) and Kitching & Cadiou (2000). Specimens were deposited in the entomological collection of the Federal University of Pernambuco (UFPE, Recife), the entomological collection of the Department of Systematics and Ecology of the Federal University of Paraíba (UFPB, João Pessoa), and in the Museum of Natural History of Seridó (located in the ESEC Seridó reserve).

Three abundance criteria were established using Rabinowitz et al. (1986), based on the number of specimens collected per species: rare (1 to 2 specimens), common (3 to 19 specimens), and abundant (20 to 50 specimens).

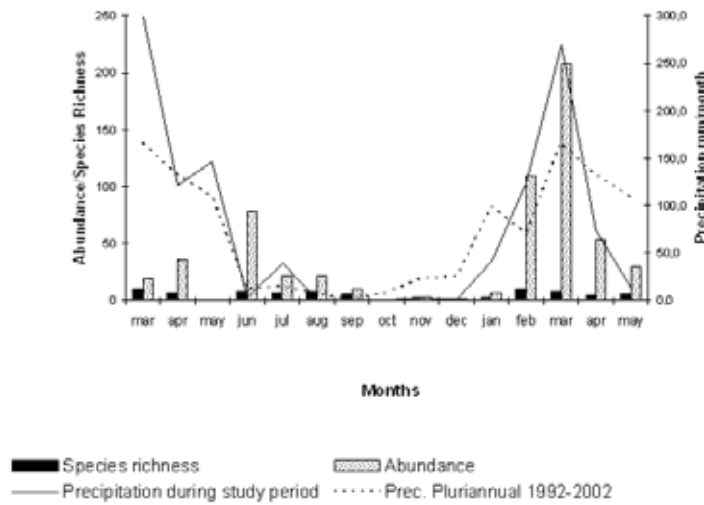


FIG. 2. Annual and pluriannual precipitation and abundance and richness of species of Sphingidae of the Estação Ecológica do Seridó between March 2002 and May 2003 (May 2002 was not sampled).

The following indices were calculated: Shannon-Wiener, Spearman's correlation coefficient and Pearson's correlation coefficient. The indices were calculated using the BioStat version 2.0 (Ayres *et al* 2000) and Krebs version 5.1. (Krebs 1999).

In contrast, correlations for both rainfall and species richness versus temperature, calculated using Pearson's coefficient, were negative. The accumulated species curve was representative, showing no increase during the last months (Fig.5).

RESULTS

**Sphingidae species richness and abundance**

In the nature reserve Esec-Seridó, 593 specimens of 20 species were recorded (Table 1). From this total, 90% of specimens and 75% of species were collected during the rainy months (February to June) (Fig.2). From October to December, only three specimens of two species were recorded, *Erinnyis ello ello* and *Xylophanes tersa tersa* (Fig. 2). In October, no hawkmoths appeared at the light traps.

*Neogene dynaeus* (38%), *Callionima grisescens elegans* (28%), and *Erinnyis ello ello* (8.8%) were the predominant species, accounting for over two-thirds of all Sphingidae collected (Fig. 3). The six most abundant species comprised 91.7% of the total of specimens, while the six least abundant summed to only 1.7% (Fig.3).

*Neogene dynaeus* occurred during the rainy season, from February to June, and *Callionima grisescens elegans* from February to September (Fig.4). The rare species *Cocytius antaeus*, *Isognathus australis*, and *Pseudosphinx tetrio*, were recorded only in the dry months (Table 1).

Spearman's correlation index was 0.6196 for species abundance versus rainfall and 0.5913 for species richness versus rainfall, showing significant correlations.

DISCUSSION

**Species richness, abundance and seasonality**

Our results show that species abundance and richness of Sphingidae are highly seasonal in the *caatinga* region. This seasonality is influenced by the distinct

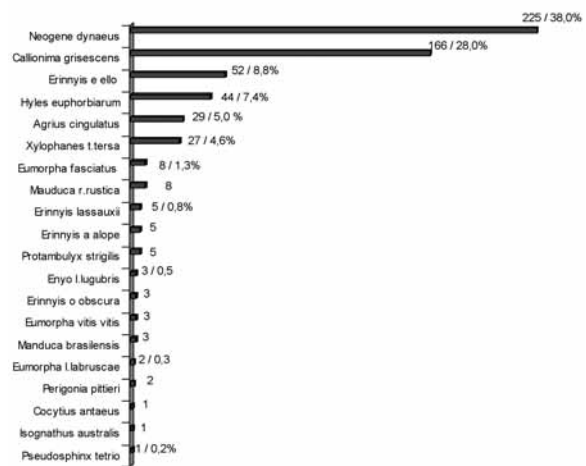


FIG.3. Number of specimens and relative abundance of species of Sphingidae recorded between March 2002 and May 2003 at the Estação Ecológica do Seridó.

TABLE 1. Species of Sphingidae recorded in the Estação Ecológica do Seridó, municipality of Serra Negra do Norte, state of Rio Grande do Norte, Northeast Brazil, between March 2002 and May 2003.

Species	Month	Rare*	Common*	Abundant*
<b>Macroglossinae</b>				
Macroglossini				
<i>Hyles euphorbiarum</i> (Guérin & Percheron, 1835)	Feb - Mar, Aug			X
<i>Xylophanes tersa tersa</i> (Linnaeus, 1771)	Apr, Jun-Sep, Dec			X
Dilophonotini				
<i>Callionima grisescens elegans</i> (Rothschild, 1894)	Feb-Sep			X
<i>Erinnyis lassauxii</i> (Boisduval, 1859)	Mar		X	
<i>Erinnyis obscura obscura</i> (Fabricius, 1775)	Jan, Apr-May		X	
<i>Erinnyis alope alope</i> (Drury, 1773)	Feb, May, Jul-Aug		X	
<i>Erinnyis ello ello</i> (Linnaeus, 1758)	Jan-Mar, May-Aug, Dec			X
<i>Enyo lugubris lugubris</i> (Linnaeus, 1771)	Mar-Apr		X	
<i>Isognathus australis</i> Clark, 1917	Sep	X		
<i>Perigonia pittieri</i> Lichy, 1962	Feb	X		
<i>Pseudosphinx tetrio</i> (Linnaeus, 1771)	Sep	X		
Philampelini				
<i>Eumorpha fasciatus</i> (Sulzer, 1776)	Feb, Apr		X	
<i>Eumorpha labruscae labruscae</i> (Linnaeus, 1758)	Mar, Aug	X		
<i>Eumorpha vitis vitis</i> (Linnaeus, 1758)	Feb-Mar		X	
Smerinthinae				
Ambulycini				
<i>Protambulyx strigilis</i> (Linnaeus, 1771)	Jun-Jul		X	
Sphinginae				
Acherontiini				
<i>Agrius cingulatus</i> (Fabricius, 1775)	Feb-Ago			X
Sphingini				
<i>Cocytius antaeus</i> (Drury, 1773)	Aug	X		
<i>Manduca brasiliensis</i> Jordan, 1911	Feb-Mar, Jun		X	
<i>Manduca rustica rustica</i> (Fabricius, 1775)	Mar-Apr, Sep		X	
<i>Neogene dynaeus</i> (Hübner, [1827]-[1831])	Feb-Jun			X

\*The abundance categories follow Rabinowitz *et al* (1986).

phenophases of the vegetation as well as by the rainy period. Most Sphingidae occurred only during two months (March and April) of the rainy season; 65% of species occurred in these months. Other insect groups are probably also influenced by biotic and abiotic factors in the *caatinga* to the same degree. In the rainy season, leaves of host plants are available to larvae.

The species *Erinnyis ello ello* showed an even distribution of abundance throughout the year. This was probably related to the existence of leaves of the host plants of native and cultivated species of Euphorbiaceae like *Manihot* for the larvae and sphingophilous flowers for the adults. No species occurred continuously throughout the entire year.

The high seasonality of the Sphingidae was expected as, during the leafless dry season, the *caatinga* offers no food for the larvae and no nectar sources for the adults. Almost all perennial plants that flower during the dry season in the *caatinga* are melithophilous, ornithophilous or chiropterophilous (Machado & Lopes 2004).

other states of NE-Brazil. The species may show sporadic occurrence in the contact zone of *caatinga* with neighboring ecosystems. *Hyles euphorbiarum* and *Erinnyis ello ello*, like most of the other species recorded, are widely distributed in the Neotropical region (D'Abrera 1986, Biezanko 1982, Hodges 1971, Kitching & Cadiou 2000).

Nevertheless, rare species like *Pseudosphinx tetrio*, *Isognathus australis*, and *Cocytius antaeus* were found exclusively during the dry period, when there were no host plants for the larvae in the leafless environment. Therefore, we suppose that these Sphingidae migrated from adjacent regions, such as the non-seasonal Atlantic rain forest with its evergreen vegetation. These hawkmoths probably do not reproduce in the *caatinga*. *P. tetrio* and *C. antaeus* are widely distributed. *Isognathus. australis* was considered endemic to NE-Brazil (Schreiber 1978). Our survey shows the occurrence of four species not previously recorded for NE-Brazil (*Erinnyis alope alope*, *Eumorpha fasciatus*, *E. vitis vitis*, and *Manduca brasiliensis*), increasing to 36

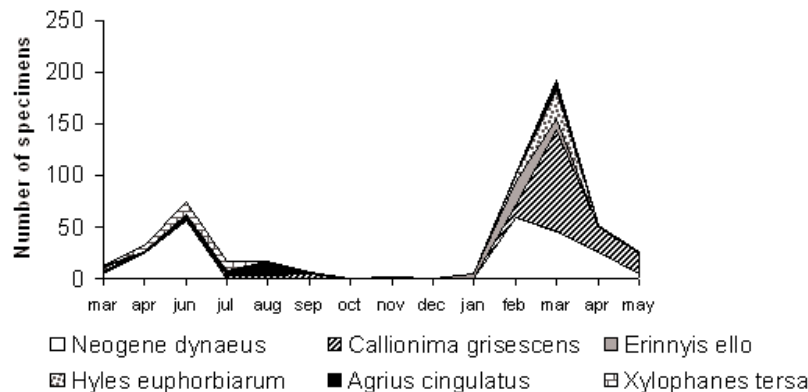


FIG.4. Seasonality of the six most frequent species of Sphingidae at the Estação Ecológica do Seridó between March 2002 and May 2003.

#### **Caatinga- resident and migratory Sphingidae**

The abundant Sphingidae in the *caatinga* occur exclusively during the rainy season. Therefore, *Neogene dynaeus* (Fig.7a), *Callionima grisescens elegans* (Fig.7b), *Hyles euphorbiarum*, and *Erinnyis ello ello* are *caatinga*-resident species closing the whole ontogenetic cycle during the short period of rainfall. The host plants for their larvae, as well as sphingophilous flowers for the adults, thus should be plants of the *caatinga* vegetation.

Schreiber (1978) considered *Neogene dynaeus* and *Callionima grisescens elegans* to be endemic to the state of Pernambuco, one of the neighbor states of Rio Grande do Norte. Yet the author did not specify with which vegetation types these species are associated. Based on our data, they are endemic to the *caatinga* region, and they probably also occur in *caatinga* of the

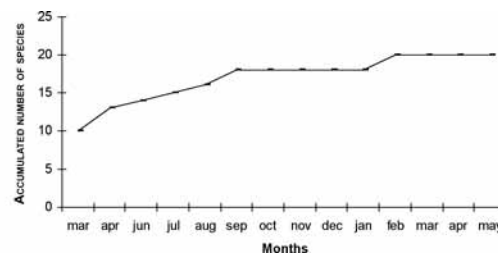


FIG.5. Accumulated number of species of Sphingidae recorded between March 2002 and May 2003 at the Estação Ecológica do Seridó.

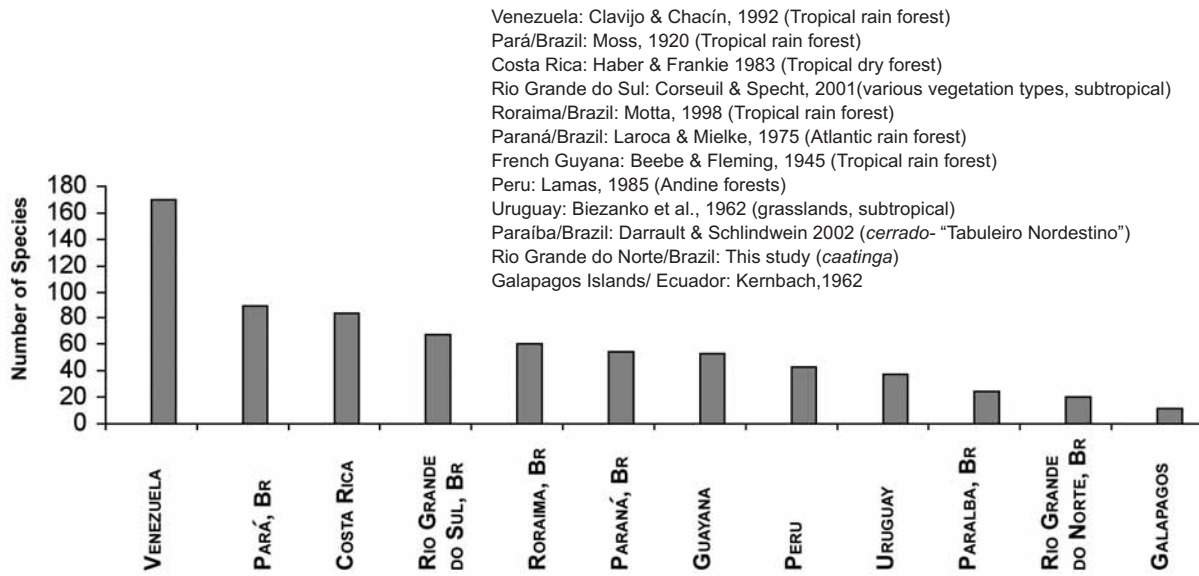


FIG. 6. Number of species of Sphingidae recorded in surveys undertaken in the Neotropical region.



FIG. 7. The most common hawkmoths of the *caatinga*. a) *Neogene dynaeus* b) *Callionima griseascens elegans*

the number of Sphingidae in this region. When compared to Northern, Southern, and Southeastern Brazil and to other countries of the Neotropical region, the species richness recorded here was low (Fig.6). The abundance, on the other hand, was high. The accumulated species curve shows that the number of species in this locality is representative and probably may not or only slightly be increased in a prolonged survey.

ACKNOWLEDGEMENTS

We thank the staff of the nature reserve *Estação Ecológica do Seridó*: Adson Borges de Macedo, Armênio Araújo, Rivalvo Medeiros, George Araújo, and Manuel Irmão for their support. Dr. Olaf H. H. Mielke (Federal University of Paraná, Curitiba), Catarina Motta (National Research Institute of Amazonas, INPA, Manaus) and Dr. I.J. Kitching (The Natural History Museum, London), kindly confirmed the identification of some

specimens. Furthermore, we thank and André Mauricio Melo Santos for support in statistics, Arthur C.D. Maia for his help with the photos, Dr. Celso Feitosa Martins (Federal University of Paraíba, João Pessoa), Reisla Oliveira Darrault for valuable suggestion on the manuscript, and Scott Heald (Cornell University) for revising the English.

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*Received 18 October 2004; revised and accepted 12 May 2005*