

# Floral biology of *Stachytarpheta maximiliani* Scham. (Verbenaceae) and its floral visitors

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**ABSTRACT.** Floral biology of *Stachytarpheta maximiliani* Scham. (Verbenaceae) and its floral visitors. This study describes the reproductive system of *Stachytarpheta maximiliani* (Verbenaceae), including its floral biology, nectar and pollen availability and insect foraging patterns, identifying whose species act as pollinators. It was carried out in a Brazilian Atlantic rain forest site. Observations on the pollination biology of the Verbenaceae *S. maximiliani* indicate that their flowering period extends from September through May. Anthesis occurs from 5:30 a.m. to 5:00 p.m. and nectar and pollen are available during all the anthesis. Many species of beetles, hemipterans, flies, wasps, bees and butterflies visit their flowers, but bees and butterflies are the most frequent visitors. The flowers are generally small, gathered in dense showy inflorescences. A complex of floral characteristics, such as violet-blue color of flowers, long floral tubes, without scents, nectar not exposed, high concentration of sugar in nectar (about 32%), allowed identification of floral syndromes (melittophily and psicophily) and function for each visitor. The bees, *Bombus morio*, *B. atratus*, *Trigonopedia ferruginea*, *Xylocopa brasilianorum* and *Apis mellifera* and the butterflies *Corticea mendica mendica*, *Corticea* sp., *Vehilius clavícula*, *Urbanus simplicius*, *U. teleus* and *Heraclides thoas brasiliensis*, are the most important pollinators.

**KEYWORDS.** Apoidea; floral ecology; Lepidoptera; pollination.

**RESUMO.** Biologia floral de *Stachytarpheta maximiliani* Scham. (Verbenaceae) e seus visitantes florais. Este estudo descreve alguns aspectos do sistema reprodutivo de *Stachytarpheta maximiliani* (Verbenaceae), incluindo características da flor, disponibilidade de néctar e pólen e o padrão de forrageio dos insetos visitantes florais, em uma área de Floresta Atlântica, no sul do Brasil. Observações sobre sua biologia floral indicam que esta espécie tem um período de floração que se estende de setembro a maio, antese diurna (das 5:30h às 17:00h) e oferta de néctar e pólen praticamente durante todo o período de antese. Suas flores são visitadas por diferentes espécies de coleópteros, dípteros, hemípteros, himenópteros e lepidópteros, em busca de néctar e pólen, sendo que abelhas e lepidópteros são os mais frequentes. Um complexo de características florais, em que se incluem flores de cor violeta-azulada, sem odor perceptível, corola infundibuliforme (longa e afilada), néctar não exposto, com alta concentração de açúcar (cerca de 32%), acumulado na porção inferior do tubo da corola, constitui um elemento selecionador de visitantes. Tais características se enquadram nas síndromes de melitofilia e psicofilia, sendo as abelhas *Bombus morio*, *B. atratus*, *Trigonopedia ferruginea*, *Xylocopa brasilianorum* e *Apis mellifera* e os lepidópteros *Corticea mendica mendica*, *Corticea* sp., *Vehilius clavícula*, *Urbanus simplicius*, *U. teleus* e *Heraclides thoas brasiliensis* seus mais importantes polinizadores.

**PALAVRAS-CHAVE.** Apoidea; ecologia floral; Lepidoptera; polinização.

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The genus *Stachytarpheta* Vahl (Verbenaceae), known commonly in Brazil by “gervão”, includes about 100 species widely distributed in tropical and subtropical America, with few members in tropical Asia, Africa and Oceania. In Brazil, there are nearly 40 species, with diversity center in the high fields in the states of Minas Gerais, Bahia and Goiás (Atkins *et al.* 1996). They are shrubs or herbaceous plants, with whole alternate or opposite leaves. The flowers are generally small, gathered in dense showy inflorescences, of varied colours, from intense purple to a pale rose (Atkins *et al. op. cit.*).

Although some species are considered ornamental or medicinal, such as *S. jamaicensis* (L.) Vahl and *S. cayennensis* (Rich.) Vahl (Hirschmann & Rojas de Arias 1990; Rodríguez & Castro 1996), they occur usually as weed in crops and pasture.

There are a few studies about *Stachytarpheta* reproductive

system, standing out some studies on floral rewards to the visitors and syndrome of pollination of sandbank plants, including *S. cayennensis* (Ormond *et al.* 1993). Evaluation of the pollen nutritive and attractive qualities of flowering plants includes two species of *Stachytarpheta* (Pinheiro *et al.* 1991); and observations about the foraging pattern of pollinators of *S. mutabilis* (Stone *et al.* 1988). Weather influence on abundance of floral visitors of *S. glabra* was investigated by Antonini *et al.* (2005). In the other groups in Verbenaceae, there are studies on floral biology and ecology of pollination of *Lantana camara* L. and *L. trifolia* L. (Schemske 1976); *Verbena stricta* Vent., *V. hastata* L. and *V. urticifolia* L. (Cruden *et al.* 1990); *Vitex negundo* L. (Reddy & Reddi 1994); *Duranta repens* L. (Reddy & Reddi 1996) and *Gmelina asiatica* L. (Reddi *et al.* 1996).

This work describes the reproductive biology of *S. maximiliani* Scham., including its floral biology, nectar and pollen availability and insect foraging patterns, identifying whose species act as pollinators. This plant was chosen because it is very common in secondary vegetation areas and it has a long blooming period. Besides, some morphological characteristics of the flower, such as the tiny tubular corolla with non-exposed nectar accumulated in the basis of the corolla, permit to establish close relationships between flower and different pollinators, especially bees and butterflies.

#### MATERIALS AND METHODS

The study was carried out at the Instituto Agronômico do Paraná (IAPAR) Experimental Station, located in the city of Morretes (25°30' S; 48°49' W), in a Brazilian Atlantic rain forest area.

The station is situated in a coluvio-aluvional plain area, about 200 m high. According to Klein (1979), the phytocological region is Tropical Ombrofilous Forest in the Atlantic Slope of Southern Brazil, or Dense Ombrofilous Forest (Veloso *et al.* 1991). It presents thick forest vegetation, pluristratified, with epiphytes and vines.

The climate is pluvial tropical, in a transition tropical zone, ever humid, with the minimum temperature around 18°C, without night frost in winter (Paraná 1987).

Nowadays, part of the area has been suffering modifications in its original vegetation due to agricultural and livestock researches of IAPAR, and to the illegally “palmito” (heart of palm) extractivism. Native forest is endangered too by cultures of rice and pasture, frequent land clearings and a buffalo’s trampling. Near to the pickets for the cattle and barns it is observed a variety of shrub or herbaceous weed plants including *S. maximiliani*.

Research was carried out from April of 1995 to December

of 1997, in two areas bordering the forest, next to a pasture. Voucher specimens of *S. maximiliani* are housed in the Herbarium of the State University of Ponta Grossa, Paraná (HUPG).

To understand the floral biology of “gervão”, many experiments were carried out, among them: record of anthesis and flowering period, evaluation of the intensity of blooming, evaluation of pollen and nectar availability and observation on the visitors behaviour, following Faegri & van der Pijl (1979) and Dafni (1992).

Measurements of the flower size were made concerning to the diameter of the corolla (in its wider part), its depth and form (circular, elliptical, etc.).

Twenty five plants were marked and their floral phenology recorded. The beginning peak and end of flowering, as well as the relative flowering intensity (= average number of flowers/inflorescence x average number of inflorescences/individual) were registered (following Dafni 1992). The flowering magnitude was measured from the percentage of simultaneously open flowers in the time (a day, in this case, due to anthesis time of “gervão”).

During anthesis, it was evaluated nectar availability (by volume) and sugar concentration (using a light refractometer Bausch & Lomb). Due to flower damage during nectar collection, it was impossible to quantify this parameter precisely. So, the nectar volume was estimated according to the space occupied into the corolla tube: just traces, a quarter, or almost half of the corolla. To analyze this, the inflorescences with buds were put on bags at evening; in the following day, hour by hour (all day long) the inflorescences was pulled out from the bags and the nectar amount and sugar concentration were measured, from at least 20 flowers of different marked individuals. The nectar amount produced by the flowers was measured from the average volume produced by flower, using a 10 µl micropipette.



Fig. 1. *Stachytarpheta maximiliani* habit (A); details of the inflorescence (B) and flower (C).

Table I. Flower measurements (in mm) in *Stachytarpheta maximiliani* (Verbenaceae), collected at Experimental Station II, IAPAR, Morretes, PR. (N = 20; average  $\pm$  standard error).

	Corolla depth	Tube diameter	Flower diameter
amplitude	6.9 - 9.5	1.1 - 1.9	8.1 - 9.9
average	8.2 $\pm$ 1.2	1.4 $\pm$ 0.3	8.7 $\pm$ 1.3

The availability and viability of the pollen grain were tested in field and in the laboratory. The grains, collected hour by hour, all day long, since anthesis until senescence, were tested with acetic carmin 15% and observed at the microscope.

Floral insects visitors on “gervão” were observed to settle their potential as pollinators. We recorded their behaviour on the flower, flying pattern across inflorescences, time of visit and kind of resource collected. Captured individuals were pinned and identified. Measures of body size and tongue length (mm) were obtained from estereomicroscope (Zeiss), with micrometric ocular.

## RESULTS AND DISCUSSION

**Floral morphology of *S. maximiliani*.** *S. maximiliani* is a perennial shrub plant, 1,5 m tall. Flowers are tubular (according with classification of Faegri & van der Pijl, 1979), small (medium 8,2 mm long), actinomorphic, pentamer, formed by a long and narrow tube (Table I), blue-violet (Fig. 1). They are inserted in a long inflorescence with staggered blooming.

**Floral Phenology.** In Morretes, “gervão” presents a relatively long flowering period from September to May, peaking between November and January, when insect activity is high. After February there is a decline in the number of open flowers per plant and from June to August flowers are almost completely absent. They possess non-exposed nectar, accumulated in the inferior portion of the corolla tube. Another shrub of this genera, *Stachytarpheta glabra* presents more brief period of flowering, from January to June at ferruginous fields of Minas Gerais, with flowering peak between February to April (Antonini *et al.* 2005).

Regarding to relative intensity of blooming, each bloom produces about 504 flowers/individual (from 24 to 1,100 flowers/plant). This value comprises the total number of flowers produced by each individual of “gervão” during the flowering period and represents the mean number of flowers by inflorescence (42 flowers/inflorescence) multiplied by average number of inflorescences by individual (12 inflorescences/individual). At peak blossom period, it was observed from 2 to 14 open flowers simultaneously by inflorescence by day, that represents *ca.* 12% of flowers in anthesis by plant.

These values represents a measure of the spatial distribution of the floral resource that can influence the patterns of pollen flow was evaluated e, together with the blooming

type, synchronous or sequential, allows to estimate the offer of floral resources (nectar and pollen) to visitors and to determine, in part, the reproductive strategy of a plant. In *S. maximiliani*, the blooming type is part sequential part synchronous, and the anthesis in the inflorescence, occurs in parcels from the basal portion towards the apex. However, a great number of flowers could open simultaneously in the different individuals. Their clumped distribution is very attractive to visitors. The positive relationship between flower and inflorescence abundance and the number of floral visitants has been discussed by many authors, among them, Schmitt (1983), Klinkhamer & de Jong (1993), Salimanta-Pires & Giulietti (1998) and Antonini *et al.* (2005) concerning that higher inflorescences number provide greater advertising area to the plant, and this added to the high number of open flowers simultaneously, attract more attention of visitants and potential pollinators.

**Anthesis.** The flowers begin opening at dawn, between 4:30 and 5:30 a.m. They open from 2 to 14 flowers by each blossom every day (the more common were 3 or 4). Fading occurs from the 3:00 up to the 5:00 p.m. Flower longevity is approximately 12 hours, which was also observed by Bawa *et al.* (1985) for other tropical species.

**Nectar:** the low quantity of nectar secreted (less than 10,0  $\mu$ l/flower during anthesis), forces pollinators to visit many flowers from different plants. Since the beginning of anthesis until almost 8:00 a.m. there is no nectar availability (or just traces); from 8:00 to noon it was observed a quarter of corolla tube of nectar; from 12:00 until 2:30 p.m., half tube was filled.

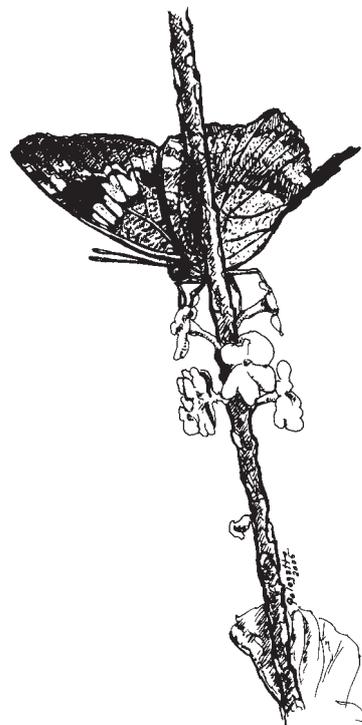


Fig. 2. *Stachytarpheta maximiliani* visited by *Anartia amathea roeselia* (Nymphalidae).

Table II. Insect visitors in flowers of *Stachytarpheta maximiliani* (Verbenaceae), at Experimental Station II - IAPAR, Morretes, PR, from April 1995 to December 1997. Visit frequency: R (for less than 10 visits), M (uncommon, from 10 to 20 visits), C (common, more than 20 visits); r (restrict to a specific period in the year, or even just one collect), f (frequent for a longer period, more than two month). Resource collected: N (nectar), P (pollen), petal (eating petals), nt (nectar thieves, perforating the corolla basis), (\*) presence of another pollen over the body, (?) uncertain.

Order	Family Specie	pollen deposition on insect body	visit frequency	Resource collected
<b>COLEOPTERA</b>				
	Chrysomelidae sp.1	(*)	Rr	P/petal
	Coleoptera sp.2		Rr	N
<b>DIPTERA</b>				
	Acroceridae sp.1	torax (ventral)	Rr	N
	Acroceridae sp.2		Rr	N
	Bombyliidae sp.1	buccal apparatus	Mr	N
	Bombyliidae sp.2		Mr	N
	Syrphidae sp.1	(*)	Rr	N P
<b>HEMIPTERA</b>				
	Hemiptera sp.1	fore legs	Mr	N (nt)
	Hemiptera sp.2	fore legs	Mr	N
	Hemiptera sp.3	(*)	Mr	N (nt)
<b>HYMENOPTERA</b>				
	Andrenidae			
	<i>Psaenythia chrysorhoea</i> (Holmberg, 1884)	buccal apparatus (*)	Rr	N P
	Anthophoridae			
	<i>Centris tarsata</i> Smith, 1874	(*)	Rr	N
	<i>Ceratina asuncionis</i> Strand, 1910	(*)	Mr	N P
	<i>Ceratina</i> sp.2	?	Rr	N
	<i>Ceratina</i> sp.3	?	Rr	N
	<i>Lophopedia</i> sp.2		Rr	N P
	<i>Melissodes nigroaenea</i> (Smith, 1854)	(*)	Rr	N P
	<i>Monoeca</i> sp.	Head (*)	Mr	
	<i>Nomada</i> sp.3	?	Rr	N
	<i>Exomalopsis aff. vernoniae</i>	buccal apparatus	Rf	N P
	<i>Thygater analis</i> (Lepelletier, 1841)	buccal apparatus (*)	Rr	N P
	<i>Thygater paranaensis</i> Urban, 1967	buccal apparatus	Rr	N P
	<i>Trigonopedia ferruginea</i> Moure, 1941	buccal ap., antenna, head, scopa and torax (*)	Cf	N P
	<i>Xylocopa brasilianorum</i> (Linnaeus, 1767)	scopa	Mr	N P
	Apidae			
	<i>Apis mellifera</i> Linnaeus, 1758	previous legs (*)	Cf	N P
	<i>Bombus atratus</i> Franklin, 1913	torax (ventral)	Cf	N P
	<i>Bombus brasiliensis</i> Lepelletier, 1836	?	Cf	N P
	<i>Bombus morio</i> (Swederus, 1787)	buccal ap., torax (*)	Cf	N P
	<i>Euglossa ignita</i> Dressler, 1982	?	Rr	N P
	<i>Eulaema nigrita</i> Lepelletier, 1841	(*)	Rr	N
	<i>Partamona helleri</i> (Friese, 1900)	buccal apparatus	Rr	N P
	<i>Trigona spinipes</i> Fabricius, 1793		Rr	N (nt)
	Halictidae			
	<i>Augochlora esox</i> (Vachal, 1911)	buccal ap., scopa (*)	Rf	NP
	<i>Augochloropsis brachycephala</i> Moure, 1943	(*)	Rf	N (nt)
	<i>Pseudaugochloropsis graminea</i> (Fabricius, 1804)	(*)	Rf	N (nt)
	Megachilidae			
	<i>Megachile nudiventris</i> Smith, 1853	buccal ap., head (*)	Rr	N P
	Vespidae sp.1	buccal apparatus	Rr	N P
	Scoliidae sp.1	torax (ventral)	Rr	N P?
<b>LEPIDOPTERA</b>				
	Hesperiidae			
	<i>Anthoptus epictetus</i> Fabricius, 1793		Cf	N
	<i>Callimormus</i> sp.1	(*)	Cf	N
	<i>Corticea mendica mendica</i> Mabilde, 1897	buccal apparatus	Cf	N
	<i>Corticea noctis</i> Plötz, 1883		Cf	N

Table II. Cont.

Order	Family Specie	pollen deposition on insect body	visit frequency	Resource collected
	<i>Corticea</i> sp.1	buccal apparatus	Cf	N
	<i>Epargyreus</i> sp.1	?	Cf	N
	<i>Eutyche olimpia</i> Plötz		Cf	N
	<i>Moris geisa geisa</i> Möschil., 1878		Cf	N
	<i>Panosquina sylvicola</i> Schaffer, 1865	?	Cf	N
	<i>Pirgus oileus orcus</i> Stoll, 1780		Cf	N
	<i>Pompeius pompeius</i> Latreille, 1824		Cf	N
	<i>Urbanus simplicius</i> Stoll, 1790	?	Cf	N
	<i>Urbanus teleus</i> Hübner, 1821	buccal apparatus / (*)	Cf	N
	<i>Vehilius clavícula</i> Plötz	buccal apparatus / (*)	Cf	N
	<i>Vehilius stictomenes stictomenes</i> Butler, 1877		Cf	N
	<i>Zariaspes mys</i> Hübner, 1808		Cf	N
Nymphalidae				
	<i>Anartia amathea roeselia</i> Eschscholtz, 1821		Mf	N
	<i>Heliconius erato phyllis</i> Fabricius, 1775		Cr	N
	<i>Heliconius sara apseudes</i> Hübner, 1806	(*)	Cr	N
Papilionidae				
	<i>Heraclides thoas brasiliensis</i> Roimsch & Jordan, 1906	buccal apparatus	Cr	N
Pieridae				
	<i>Ascia monuste orseis</i> Godart, 1819	?	Mr	N

From 3:00 p.m. the availability declines, probably due to reabsorption by the plant or evaporation. The sugar concentration was  $32\% \pm 5$  ( $n = 50$ ).

According to Vicente *et al.* (2002) and Antonini *et al.* (2005), the anthesis of *S. glabra* keeps *ca.* 10 hours and wick flower produce until 25  $\mu$ l of nectar/day.

**Pollen viability:** in this study pollen viability is high (more than 90%) in the period from 9:00 a.m. to 1:00 p.m. In the first hours in the morning or in the afternoon, pollen viability decreases to 50% until wilting, although can be observed pollen grains in the flower.

**Scent:** “gervão” flowers do not have perceptible smell along the day. According with Antonini *et al.* (2005), *S. glabra* flowers do not have perceptible smell too. This odour absence, such as the color (intense bluish-violet) and the corolla shape indicate pollination by diurnal visitants.

**Floral visitors of *S. maximiliani*.** The flowers of *S. maximiliani* are intensively visited by different insect groups since the first hours of the morning until the afternoon. The tubular flower requires specialized nectar-feeding insects (Faegri & van der Pijl 1979; Ormond *et al.* 1993; Antonini *et al.* 2005). So, visitors with long thin tongues could collect nectar at the corolla basis more easily, and pollen as well, when compared to short-tongue insects.

Table II lists visitors and Table III presents the measures of the body and the tongue of the most frequent species. *S. maximiliani* attracts a great number of insects (59 species were captured on the flowers), with variable body size and tongue length, with certain predominancy of long-tongue

insects. Bees and butterflies were the most abundant in species number and individuals. These groups, having long slender tongues, are capable to reach nectar and pollen, generally showing pollen grains in the buccal apparatus, head or even the ventral portion of thorax due to the position of the anthers on the inner surface of corolla.

Beetles presented few individuals of two small-sized body and short-tongue species visiting the flowers, without pollen on their bodies. In Diptera, some Bombyliidae showed pollen in the buccal apparatus, visiting briefly, in general, just one flower for plant. Only one individual of Acroceridae showed pollen in the ventral portion of thorax, while the two Syrphidae individuals captured had varied pollen over their bodies. Adults and nymphs of Hemiptera remained over the flowers for a long time, probably collecting nectar; sometimes it was observed individuals perforating the corolla basis and were found pollen grains deposited in the forelegs.

In one occasion, several individuals of a small long-beaked hummingbird, were observed collecting nectar of several flowers along the day.

By the data, one could analyze the role of several visitors in “gervão” flowers, at Morretes, as follows:

Coleoptera, Diptera (Acroceridae and Syrphidae) and Hymenoptera (Scoliidae), can be considered nectar thieves due to low frequency of visits and because they do not reach the reproductive structures of the flowers.

Hemiptera and the bees *A. brachycephala*, *T. spinipes* and specially *P. graminea*, due to their behaviour and abundance, are nectar thieves, perforating the corolla basis without touching the anthers and stigma.

Table III. Measurements of the body and tongue length of some insect visitors in flowers of *Stachytarpheta maximiliani* (Verbenaceae), at Experimental Station II - IAPAR, Morretes, PR, collected from April 1995 to December 1997. (~ points approximate length).

Insect species	Body length (mm)	Tongue length (mm)	Insect species	Body length (mm)	Tongue length (mm)
Diptera			Hymenoptera		
Acroceridae sp.1	8,0	5,6	<i>Apis mellifera</i>	14,0	4,7
Bombyliidae sp.1	21,0	9,0	<i>Augochlora esox</i>	11,0	4,2
Lepidoptera			<i>Augochloropsis brachycephala</i>	12,0	2,9
<i>Anartia amathea roeselia</i>	19,0	9,2	<i>Bombus atratus</i>	18,0	10,0
<i>Ascia monuste orseis</i>	23,0	~15,0	<i>Bombus morio</i>	23,0	10,4
<i>Corticea mendica mendica</i>	14,0	12,0	<i>Ceratina asuncionis</i>	10,0	2,2
<i>Corticea</i> sp.1	12,0	~ 9,0	<i>Lophopedia</i> sp.	10,0	5,0
<i>Eutychie olimpia</i>	18,0	~13,0	<i>Nomada</i> sp.	11,0	5,2
<i>Heraclides thoas brasiliensis</i>	31,0	~23,0	<i>Psaenythia chrysorhoea</i>	14,0	6,9
<i>Panosquina sylvicola</i>	17,0	14,0	<i>Pseudaugochloropsis graminea</i>	13,0	5,8
<i>Urbanus simplicius</i>	21,0	~17,0	<i>Thygater analis</i>	13,0	8,6
<i>Urbanus teleus</i>	20,0	15,0	<i>Xylocopa brasilianorum</i>	23,0	8,8
<i>Vehilius clavícula</i>	15,0	~11,0			

Some bee species (as *Psaenythia chrysorhoea*, *Centris tarsata*, *Thygater analis* and *Megachile nudiventris*), Vespidae and Bombyliidae, for their low frequency of visits, and for the usual absence of pollen over their bodies, would be just occasional pollinators. Some Lepidoptera, such as *Anthoptus epictetus*, *Epargyreus* sp.1 and *Anartia amathea roeselia*, (Fig. 2) also do not usually have pollen on their bodies and can be considered just occasional pollinators.

*B. morio*, *B. atratus*, *T. ferruginea*, *X. brasilianorum* and *A. mellifera*, for their high frequency and steadiness (specially *B. morio* and *T. ferruginea*), their behaviour of reaching reproductive structures of flowers and the great amount of pollen that they transport in their body in contact with stigma, can be considered important pollinators of "gervão". Among Lepidoptera, mainly the species *C. mendica mendica*, *Corticea* sp., *V. clavícula*, *U. simplicius*, *U. teleus* and *H. thoas brasiliensis*, for their high frequency and steadiness, their behaviour handling flowers and touching anthers and stigmas, although few pollen have been observed on their bodies, also are involved in the "gervão" pollination.

Psicophylly and mellitophyly seems to be usual in Verbenaceae. Stone *et al.* (1988), studying the floral visitants behaviour of *S. mutabilis*, in Papua New Guinea, identified two species of Papilionidae, *Ornithoptera priamus poseidon* and *Papilio ulysses*, and one of Anthophoridae, *Amegilla sapiens* as the main pollinators of the shrub.

Ormond *et al.* (1993), evaluating the kind of pollination among several species in a sand bank vegetation in Itaipuaçu (RJ - Brazil), suggest the occurrence of psychophylly (pollination by lepidopterans) in *S. canescens* HBK and *S. cayennensis*, supported by a set of morphological characteristics presented.

Antonini *et al.* (2005) recorded 28 species of flower-visiting insects of *S. glabra*, with two bee species, *Eulaema nigrata* e *Apis mellifera* and some Lepidoptera were considered as potential pollinators, whereas *Bombus atratus*, *Oxaea*

*flavescens*, some Vespidae e Halictidae were recognized as nectar thieves.

In other Verbenaceae, different authors found bees, wasps, butterflies and moths as their primary pollinators. Schemske (1976) observed several species of Hesperidae (specially *Urbanus* spp. and *Pyrgus* spp.), Pieridae, Papilionidae, Nymphalidae (mainly *Anartia jatrophae*), Danaidae and Lycaenidae visiting *Lantana camara* and *L. trifolia*. Reddy & Reddi (1994) have found 22 insect species visiting *Vitex negundo*, being the bees *Apis cerana indica*, *Amegilla* sp. and *Ceratina* sp., and the wasps *Sphex* sp., *Delta* sp. and *Ropalidia spatulata* their principal pollinators. Studying the reproductive system of *Clerodendrum infortunatum*, Reddy & Reddi (1995) identified three pollinator species of Papilionidae: *Papilio polytes*, *P. polymnestor* and *Atrophaneura hector*. These two authors, in 1996, observed 30 insect species visiting flowers of *Duranta repens*, of which bees, wasps, butterflies and moths were effective pollinators. Reddi *et al.* (1996) considered the flowers of *Gmelina asiatica* pollinated by large bees of the genus *Xylocopa*, although other insect species also visit them.

The results of the current study in the Atlantic Forest are in conformity with the observations for the Verbenaceae, in which several diurnal species of insects, mainly bees and lepidopterans, visit their flowers searching for nectar and pollen. A set of characteristics in this plant, such as bluish-violet flowers, no perceptible smell, long tubular corolla, and non-exposed nectar deposited at the bottom of the corolla tube, strongly select the visitors and pollinators, demanding a more elaborated intrafloral behaviour. Bees and lepidopterans, with their long tongues, are able to reach the bottom of the corolla and take the nectar (and pollen, in the case of the bees). At the same time, they could reach the anthers and stigma using several parts of their bodies, being the more important visitors pollinating this species.

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