

Euglossina (Hymenoptera: Apidae) from an Araucaria Forest fragment in Southern Brazil

Euglossina (Hymenoptera: Apidae) em um fragmento de Floresta com Araucária no Sul do Brasil

Fernanda Viero Dias¹
Maria Luisa Tunes Buschini^{2(*)}

Abstract

Bees of the subtribe Euglossina (Hym. Apidae) are Neotropical and are characterized by interaction with species of Orchidaceae. The objective of this study was to investigate the occurrence of Euglossina's species in a fragment of Araucaria Forest in Southern Brazil. Were determined eight sampling points in the Parque Municipal das Araucárias, which installed a set of traps containing odoriferous substances used as attractive (eugenol, eucalyptol, and vanillin). We collected 35 male specimens belonging to two species: *Eulaema nigrita* (n = 34) and *Euglossa fimbriata* (n = 1). Our findings add important information about the activity of Euglossina in the Araucaria Forest, since the occurrence of these bees is unprecedented for the region of Guarapuava.

Key words: Araucaria forest; euglossina; fragments; pollination.

Resumo

As abelhas da subtribo Euglossina (Hymenoptera: Apidae) são neotropicais e se destacam pela interação com espécies de Orchidaceae. O objetivo deste estudo foi investigar a ocorrência das espécies de Euglossina em um fragmento de Floresta Ombrófila Mista no Sul do Brasil. Foram coletados oito (8) pontos de amostragem no Parque Municipal das Araucárias nos quais foi instalado um conjunto de armadilhas contendo substâncias odoríferas utilizadas como atrativo (eugenol, eucaliptol e vanilina). Nós coletamos 35 exemplares machos pertencentes a duas espécies: *Eulaema nigrita* (n = 34) e *Euglossa fimbriata* (n = 1). Nossos resultados

1 MSc.; Bióloga; Professora na Faculdade Campo Real; Endereço: Rua Barão de Capanema, 721, CEP: 85015-420, Guarapuava, Paraná, Brasil; E-mail: fernanda.bioses@hotmail.com

2 Dra.; Bióloga; Professora do Departamento de Biologia e do Programa de Mestrado em Biologia Evolutiva da Universidade Estadual do Centro-Oeste do Paraná, UNICENTRO; Bolsista Produtividade da Fundação Araucária de Apoio ao Desenvolvimento Científico e Tecnológico do Paraná; Endereço: Rua Simeão Varela Camargo de Sá, 03, CEP 85040-080, Guarapuava, Paraná, Brasil; E-mail: mbuschini@unicentro.br E-mail: isatunes@yahoo.com.br (*) Autora para correspondência.

agregam informações importantes sobre a atividade de Euglossina na Floresta com Araucária, visto que a ocorrência destas abelhas é inédita para a região de Guarapuava.

Palavras-chave: floresta com Araucária; euglossina; fragmentos; polinização.

Introduction

Bees are considered the main group of flower visitors and pollinators, especially in tropical regions (BAWA, 1990). They are the most adapted pollinators for angiosperm flowers with a great variability of specialization. There is therefore a variety of skills on the part of the bees and, because of the structure of the plants, there is a complex chain of interrelationships (ZANELLA; MARTINS, 2003) that are related to a system of mutual dependence, where the plants provide food for bees, mainly pollen and nectar, and in return receive the benefits of pollen transfer (KEVAN and BAKER 1983; PROCTOR et al., 1996). The pollination process is one of the strongest relationships between plants and animals, often for both parties (BARTH, 1991).

Bees from Euglossina subtribe are considered to be the “orchids bees” and are neotropical and widely distributed in Tropical America from central Argentina to the south of the United States (SILVEIRA et al., 2002). Almost 200 species were described and they are distributed in five genera: *Euglossa* Latreille, *Eufriesea* Cockerell, *Eulaema* Lepeletier, *Aglae* Lepeletier and Serville and *Exaerete* Hoffmannsegg (MOURE, 1967; KIMSEY, 1982; CAMERON, 2004). They are solitary or have different levels of sociality (GARÓFALO, 1994; AUGUSTO

and GARÓFALO, 2004) with very peculiar morphology of medium to large size, brightly coloured iridescent body and a long proboscis (MICHENER, 1990). These bees comprise one of four tribes of the family Apidae whose members have the posterior tibiae extended, which is smooth and concave externally, where they carry pollen and materials to build nests (MICHENER, 2000).

These bees can fly long distances, reaching 23 km (JANZEN, 1971) and they repeatedly visit the same plants during the collection of pollen or nectar, assigning these insects the important role of pollinators in Neotropical forests (OLIVEIRA and CAMPOS, 1995; CARVALHO and MACHADO, 2002; STORCK-TONON et al., 2009). Thus, plant species that provide resources exclusively to these bees can exchange genetic material with each other, even when reproductively compatible individuals are separated by long distances (PERUQUETTI et al., 1999).

Considering the importance of these bees in the pollination process and the scarcity of information about their presence in Araucaria forests, this study aimed to investigate the occurrence of Euglossina in a fragment of Araucaria forest in Southern Brazil, quantifying their abundances and evaluating the influence of some climatic variables on its activities.

Material and Methods

Study area

This study was carried out from October 2008 to November 2009 in the Parque Municipal das Araucárias, located in the municipality of Guarapuava, Paraná (25°21'06"S, 51°28'08"W). The park comprises an area of approximately 104 ha. The vegetation is composed of Mixed Ombrophilous Forest (42.75%), gallery forest (10.09%), fields (6.8%), swamps (7.13%) and altered areas (33.23%). According to Köoper's classification the climate is humid mesothermic with no dry season and mild summers due to the altitude. The winter is moderate with frequent occurrence of frost. Annual mean temperature stays around 16 °C to 17.5 °C. Average monthly rainfall is above 100 mm and annual 1961 mm, being uniform throughout the year (MAACK, 1981).

Sampling program

These were determined randomly at eight sampling points in the studied fragment

(Mixed Ombrophilous Forest). It was later defined by the sequential order of monthly visits (from P1 to P8) to each of these points, so that only one of the points was evaluated in each sampling day. After the fourth sampling, the visits were fortnightly to increase the sampling effort. Thus, 24 samples were done, three from each sample point, from October 2008 to November 2009, 9:00 a.m to 2:00 p.m.

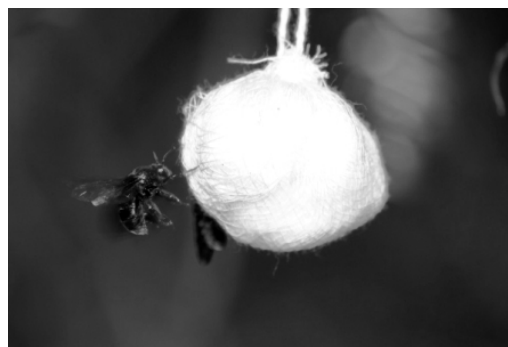
For each sample we used a set of eighteen traps. Of these, nine were made with plastic bottles and nine with "bait waiting", divided into three traps for each type of essence (eucalyptol, eugenol and vanillin). The traps were made with four 2 litre plastic bottles of (Figure 1) where one of the bottles was used as base containing absorbent cotton coated with the chemical essence. The top of the other three bottles were inserted into the base as a funnel allowing the bees to enter. The "bait waiting" comprises coated cotton gauze and is attached by a string (Figure 2). The collection is made with the aid of an insect net. All traps were distributed within 4m of each other, approximately 1.5m above the soil (STORCK-TONON, 2007). After each collection, traps were removed and

Figure 1- Trap made from plastic bottles



Fonte: Autores (2012).

Figure 2 - Bait waiting with males of *Euglossina Eulaema nigrita* attracted by the essence



Fonte: Autores (2012).

reused on the next collection in the next sample point.

Abiotic data

The abiotic data (air temperature, precipitation, relative humidity and insolation rates) regarding to the period of collections, were provided by the Department of Agronomy of the UNICENTRO.

Simple linear correlations were calculated between the abundance of these bees and abiotic variables using the program Bioestat 2009 Professional 5.8.1, considered only in those months in which the occurrence of bees was recorded.

Results

We collected over a year, 35 male specimens of the subtribe Euglossina, belonging to two species: *Eulaema nigrita* Lepeletier and *Euglossa fimbriata* Rebêlo and Moure. *E. nigrita* was more frequent (34 individuals) than *E. fimbriata* (one individual).

Eucalyptol was the essence that attracted the greatest number of individuals (34) compared with vanillin (1) and eugenol

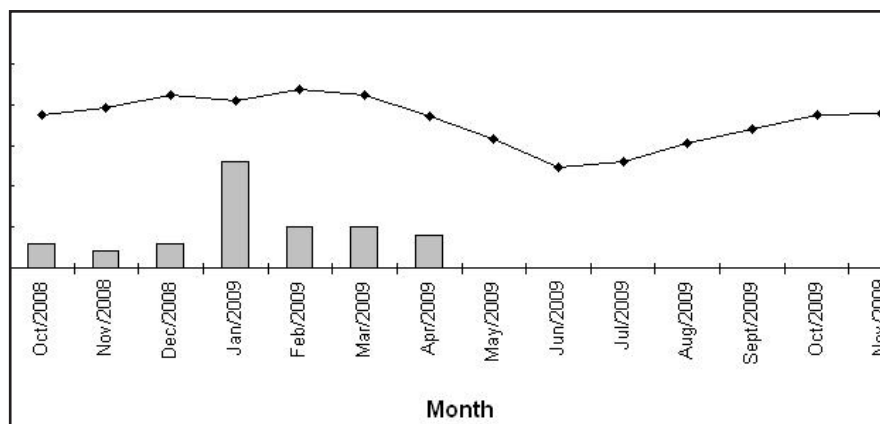
(0). With regard to the species types, the eucalyptol attracted both *E. nigrita* and *E. fimbriata* and vanillin attracted only one individual and that was from *E. nigrita*.

Regarding the type of bait used, the vast majority of bees (34 individuals) were collected with the bait waiting, while only one individual of *E. nigrita* was collected with a plastic bottle.

The month of greatest activity of Euglossina was January, while not one was collected from mid-April to late October. During the sampling period, monthly average temperatures ranged from 12.3 °C to 21.8 °C, with the lowest temperature recorded in June 2009 and the highest temperature in February 2009. It is noted that all individuals were collected in the months when the monthly average temperature was less than 18 °C (Figure 3) and they were captured between 09:15a.m and 01:47p.m., and the period of greatest activity was recorded between 11:00a.m and 01:00p.m.

It was not possible to infer a relation of climate variables with the activity of Euglossina, because there was no correlation between the number of individuals and average monthly temperature ($R = 0.1425$;

Figure 3 - Relationship between the number of bees and mean monthly temperature (Co)



Fonte: Autores (2012).

$p = 0.7877$) or between the number of individuals and the average monthly rainfall ($R = 0.7967$; $p = 0.0578$). The number of individuals captured correlated only negatively with the average monthly insolation ($R = -0.8238$; $p = 0.0438$).

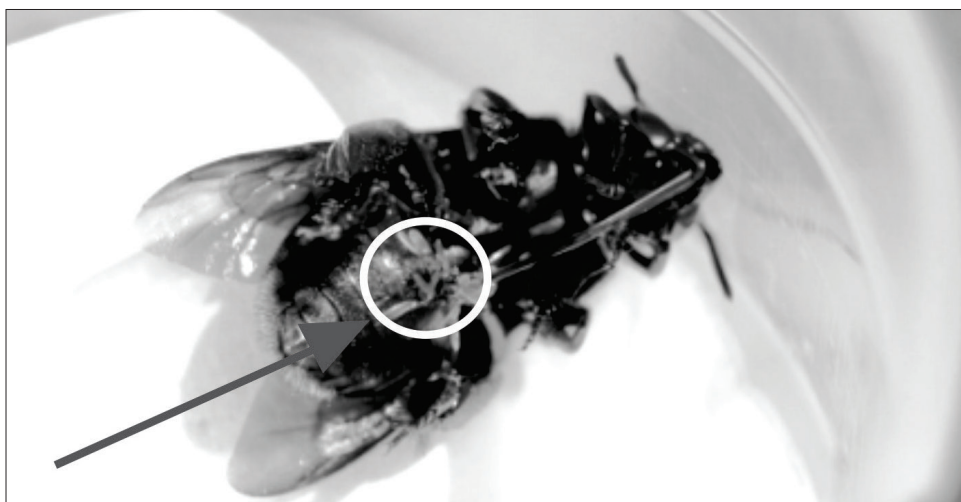
One male of *E. nigrita* contained pollen of Apocynaceae, subfamily Asclepiadoideae,

adhered to the mouthparts and mid legs (Figure 4). This male was attracted by eucalyptol essence.

Discussion

Comparing the present data with those records from other locations in Brazil,

Figure 4 - Male of *E. nigrita* with pollen on its mouthparts



Fonte: Autores (2012).

both the number of Euglossina species was very low in the Araucarias Park. Sofia et al. (2004), in the northern area of Paraná, collected 434 individuals of nine species and Essinger (2005) in the south of Santa Catarina, 126 individuals of four species. In northeastern Brazil Souza et al. (2005), in Paraíba, collected 2314 individuals of 11 species were collected, and northern Brazil in Acre Storck-Tonon (2007), collected 3675 individuals of 36 species. In southeastern Brazil these numbers varied considerably since Aguiar and Gaglianone (2008) in Rio de Janeiro collected 4069 individuals of 13 species and Cardoso Junior (2007) in Minas Gerais collected 366 individuals of 8 species. Considering all these regions,

with the exception of Santa Catarina, Guarapuava (in Paraná state) is one that has the highest latitude. Probably this could be one of the factors accounting for low Euglossina diversity in this region since in most taxonomic groups the number of species increases towards the equator. As Euglossina is typical of neotropical regions with warm climates (NEMÉSIO, 2008) and Guarapuava is a subtropical region, with low temperatures in winter. This could explain the low number of Euglossina species in this region. According to Giangarelli et al. (2009) these bees have a low diversity and abundance in Araucaria forest, being markedly smaller compared to semideciduous forest.

In this study, *E. nigrita* was the most frequent species, as well as in studies conducted by Sofia e Suzuki (2004); Storck-Tonon (2007); Souza et al. (2005); Aguiar and Gaglianone (2008) and Cardoso Junior (2007). It should be noted that these studies were conducted in disturbed areas with different levels of disturbance (from urban areas to secondary vegetation). According to Cordeiro (2005), in the past there was some selective cutting of plants species in this Park, which characterizes the study area as secondary forest. However, there is no specific study to quantify the degree of conservation of remaining forest.

Several authors consider *E. nigrita* as an indicator of degraded areas, indicating a higher degree of disturbance of the environment (MORATO et al., 1992; NEVES and VIANA, 1997; REBÊLO and CABRAL, 1997; PERUQUETTI et al., 1999; SILVA and REBÊLO, 2002; TONHASCA et al. 2002; VIANA et al., 2002; RAMALHO, 2006; RAMALHO et al., 2009). On the other hand, Alvarenga et al. (2007) stated that this species is often observed in open areas, and was abundant in a study conducted in the savannah (cerrado), with areas of open vegetation not necessarily degraded. Faced with these information, it is possible that these bees, are able to cross the agricultural matrix, where the Park is inserted, and transfer pollen from one fragment to another, since, according to Janzen (1971), they have a great ability to fly and can travel up to 23 km away.

The eucalyptol was the most attractive essence to the Euglossina at the Araucaria's Park, both for number of individuals as to the number of species. This essence also proved very efficient in collecting these bees in other regions of Brazil, as evidenced in

the work carried out by Neves and Viana (1997), Rebêlo and Garófalo (1991), Rebêlo and Cabral (1997), Silva and Rebêlo (2002), Bezerra e Martins (2001), Oliveira and Campos (1995), Brito and Rêgo (2001), Sofia and Suzuki (2004), Sofia et al. (2004), Morato et al. (1992), Aguiar and Gaglianone (2008) and Cardoso Junior (2007). However, Peruquetti et al. (1999) observed a higher number of species attracted by eugenol and ESSINGER (2005) by eugenol and also by vanillin. For Cardoso Junior (2007), the volatility of the substance had an effect on the attraction of bees. According to Silva and Rebêlo (2002) the eucalyptol is more volatile than the eugenol, with a better dispersion, attracting individuals over long distances.

Regarding the type of trap, bait waiting was more efficient than plastic bottles, which attracted only one individual from *E. nigrita*. This result confirms those obtained in the western Amazon (Acre) by Nemésio and Morato (2004), and by Essinger (2005) in Santa Catarina, which recorded a higher number of species and individuals in collections made with an insect net. On the other hand, Storck-Tonon (2007) collected the largest number of individuals in the traps made with bottles, which remained on site during all days of collection. These traps collected a large amount of individuals belonging to the genus *Eulaema*, whereas in collections with an insect net most of the specimens collected were *Euglossa*. The author suggests that this may be related to the smaller size of *Euglossa*, allowing them to escape more easily through the openings of the traps made with bottles, while the *Eulaema*, with larger size, cannot escape through the openings. This author also states the

ability of males of the species to be more aggressive which may have prevented other species entering the traps.

The times of activity of these bees are very similar, regardless of which region of Brazil (BRITO and RÊGO, 2001; SANTOS and SOFIA, 2002). In this study, the bees were caught between 9:15 a.m. and 01:47 p.m., with the peak of activity recorded between 11:00 a.m. and 01:00 p.m. Santos and Sofia (2002), like Farias et al. (2007) found a sharp decline in activity of these bees from 01:00 p.m. According to Oliveira (1999), the time of highest activity for most species of *Euglossina* in the Central Amazon in Brazil takes place between 09:00 a.m. and 04:00 p.m. (with temperature ranging between 24.5 ° and 27.0 °C), with a peak in abundance and diversity of individuals at 11:00 a.m. To this author several factors influence the activity of these insects such as the local temperature and supply of floral resources.

An important piece of information recorded in this study was the presence of pollinia in one male of *E. nigrita*. In the work performed by Tostes et al. (2003), *Euglossina* males (*Ef. violacea* Blanchard) also had pollinias adhered to their bodies. Essinger (2005) collected *Ef. violacea*, with pollinaria of flowers of Orchidaceae, *Catasetum cernuum* (Lindl.) Rchb.f. (Catasetinae) and *Macradenia multiflora* (Kraenzl.) Cogn (Oncidiinae). Storck-Tonon (2007) sampled 31 individuals belonging to six species of *Eulaema* and four species of *Euglossa* with pollinaria attached to their bodies. While Aguiar and Gaglianone (2008), did not collect any male with pollinaria, despite the large number of *Euglossina* specimens

sampled (n = 4,069). According Dressler (1982), the presence of pollinaria attached to the body of *Euglossina* is not sufficient evidence to characterize the local flora since these bees fly long distances and may be carrying pollen from other regions. However, the quantity of records of individuals carrying pollinaria indicates the importance of these bees for pollination of plants in forest fragments (STORCK-TONTON, 2007).

Conclusion

Considering the results of this study and that the record of *Euglossina* in Guarapuava is unprecedented, it is necessary to invest in larger studies in this region and in other fragments of Araucaria Forest, also in open areas, to confirm the occurrence of these bees on the third plateau of Brazil, Parana State, as well as the interaction between local flora and *Euglossina*. Studies of this nature will bring important information about the ecological and evolutionary processes involved in these relationships, which will outline the best strategies relating to the conservation of regional biodiversity.

Acknowledgements

Parcial support was provided by CAPES (from Ministry's Education of Brazil), Fundação Araucária (The State of Paraná Research Foundation) and UNICENTRO (Universidade Estadual do Centro-Oeste do Paraná). We thank the Professora Dra. Silvia Helena Sofia for valuable suggestions, Professor MSc. Samuel Boff for bees identification and Francisco Alberto Putin for technical support.

References

AGUIAR, W. M.; GAGLIANONE, M. C. Comunidade de abelhas Euglossina (Hym. Apidae) em remanescentes da Mata Estacional Semidecidual sobre Tabuleiro no Estado do Rio de Janeiro. **Neotropical Entomology**, Londrina, v. 37, p.118-125, 2008.

ALVARENGA, P. E. F.; FREITAS, R. F.; AUGUSTO, S. C. Diversidade de Euglossini (Hymenoptera: Apidae) em áreas de Cerrado do Triângulo Mineiro, Uberlândia, MG. **Bioscience Journal**, Uberlândia, v. 23, p. 30-37, 2007.

AUGUSTO, S. C.; GARÓFALO, C. A. Nesting biology social structure of *Euglossa* (*Euglossa*) *townsendi* Cockerell (Hymenoptera, Apidae, Euglossini). **Insectes Sociaux**, v. 51, p. 400-409, 2004.

BARTH, F. G. **Insects and flowers** - the biology of partnership. Princeton: Princeton University Press, 1991. 408 p.

BAWA, K. S. Plant-pollinator interactions in tropical rain forests. **Annual Review of Ecology and Systematics**, v. 21, 399-422, 1990.

BEZERRA, C. P.; MARTINS, C. F. Diversidade de Euglossinae (Hymenoptera, Apidae) em dois fragmentos da Mata Atlântica localizados na região urbana de João Pessoa, Paraíba, Brasil. **Revista Brasileira de Zoologia**, Curitiba, v. 18, p. 823-835, 2001.

BRITO, C. M. S.; RÊGO, M. M. C. Community of male Euglossina bees (Hymenoptera: Apidae) in a secondary forest, Alcântara, MA, Brazil. **Brazilian Journal of Biology**, São Carlos, v. 61, p. 631-638, 2001.

CAMERON, S. A. Phylogeny and biology of neotropical orchid bees (Euglossina). **Annual Review of Entomology**, v. 49, p. 377-404, 2004.

CARDOSO JUNIOR, C. S.; CAMPOS, M. J. O.; GOMIG, E. M. Estudo da fauna de Euglossini (Hymenoptera, Apidae) em paisagem fragmentada na região do sul de Minas Gerais (Brasil). In: CONGRESSO DE ECOLOGIA DO BRASIL, 8., 2007, Caxambu. **Anais...** Rio Claro: Universidade Estadual Paulista (UNESP), Instituto de Biociências, Departamento de Ecologia, 2007. p.1-2.

CARVALHO, R.; MACHADO, I. C. Pollination of *Catasetum macrocarpum* (Orchidaceae) by *Eulaema bombiformis* (Euglossini). *Lindleyana*, London. **Revista Brasileira de Zoologia**, Curitiba, v. 17, p. 85-90, 2002.

CORDEIRO, J. **Levantamento florístico e caracterização fitossociológica de um remanescente de Floresta Ombrófila Mista em Guarapuava – PR**. 2005. 138 f. Dissertação (Mestrado em Botânica) – Setor de Ciências Biológicas, Universidade Federal do Paraná, Curitiba, 2005.

DRESSLER, R. L. Biology of the orchid bees (Euglossina). **Annual Review of Ecology, Evolution and Systematics**, v.13, p. 373-394, 1982.

ESSINGER, L.N. **Euglossini (Apidae, Hymenoptera) no Sul de Santa Catarina**. 2005. 63 f. Dissertação (Mestrado em Ciências Ambientais) – Universidade do Extremo Sul Catarinense, Criciúma, 2005.

FARIAS, R. C. A. P.; MADEIRA-DA-SILVA, M. C.; PEREIRA-PEIXOTO, M. H.; MARTINS, C. F. Horário de atividade de machos de Euglossina (Hymenoptera: Apidae) e preferência por fragrâncias artificiais em mata e dunas na Área de Proteção Ambiental da Barra do Rio Mamanguape, Rio Tinto, PB. **Neotropical Entomology**, Londrina, v. 36, p. 863-867, 2007.

GARÓFALO, C. A. Biologia da nidificação dos euglossinae (Hymenoptera, Apidae). In: ENCONTRO SOBRE ABELHAS DE RIBEIRÃO PRETO, 1., 1994, Ribeirão Preto. **Anais... Ribeirão Preto: [S.I.]**, 1994. v.1, p. 17-26.

GIANGARELLI, D. C. Riqueza, abundância e diversidade de Euglossini (Hymenoptera, Apidae) em dois ecossistemas de Mata Atlântica no Estado do Paraná. In: CONGRESSO DE ECOLOGIA DO BRASIL, 9., São Lourenço. **Anais... São Lourenço: SEB**, 2009. p.1-4.

JANZEN, D. H. Euglossine bees as long-distance pollinators of tropical plants. **Science**, v. 171, p. 203-205, 1971.

KEVAN, P. G.; BAKER, H. G. Insects as flower visitors and pollinators. **Annual Review of Entomology**, v. 28, p. 407-53, 1983.

KIMSEY, L. S. Systematics of bees of the genus *Eufriesea* (Hymenoptera, Apidae). University California. **Neotropical Entomology**, Londrina, v. 95, p.1-125, 1982.

MAACK, R. **Geografia física do Estado do Paraná**. 2. ed. Rio de Janeiro: José Olympio. Secretaria da Cultura e do Esporte do Governo do Estado do Paraná, 1981. 450 p.

MICHENER, C. D. Classification of the Apidae (Hymenoptera). **University of Kansas Science Bulletin**, v. 54, p. 75-164, 1990.

MICHENER, C. D. **The bees of the world**. Baltimore and London: The Johns Hopkins University Press, 2000. 913 p.

MORATO, E. F.; CAMPOS, L. A. O.; MOURE, J. S. Abelhas Euglossina (Hymenoptera, Apidae) coletadas na Amazônia Central. **Revista Brasileira de Entomologia**, Curitiba, v. 36, p. 767-771, 1992.

MOURE, J. S. A check-list of the known euglossine bees (Hymenoptera, Apidae). **Atas do Simpósio sobre a Biota Amazônica**, v. 5, p. 395-415, 1967. (Catalog, distribution (as *Euplusia andina*, *E. fulvohirta* and *E. magretti*)).

NEMÉSIO, A. Orchid bee community (Hymenoptera, Apidae) at an altitudinal gradient in a large forest fragment in southeastern Brazil. **Revista Brasileira de Zoologia**, Curitiba, v. 10, p. 251-258, 2008.

NEMÉSIO, A.; MORATO, E. F. Euglossina (Hymenoptera: Apidae) of the Humaitá Reserve, Acre state, Brazilian Amazon, with comments on bait trap efficiency. **Revista Tecnologia e Ambiente**, v. 10, p. 71-80, 2004.

NEVES, E. L.; VIANA, B. F. Inventário da fauna de Euglossinae (Hymenoptera, Apidae) do Baixo Sul da Bahia, Brasil. **Revista Brasileira de Zoologia**, Curitiba, v. 14, p. 831-837, 1997.

OLIVEIRA, M. L. Sazonalidade e horário de atividade de abelhas Euglossinae (Hymenoptera, Apidae), em florestas de terra firme na Amazônia Central. **Revista Brasileira de Zoologia**, Curitiba, v. 16, p. 83-90, 1999.

_____; CAMPOS, L. A. O. Abundância, riqueza e diversidade de abelhas euglossinae (Hymenoptera, Apidae) em florestas contínuas de terra firme na Amazônia central, Brasil. **Revista Brasileira de Zoologia**, Curitiba, v. 12, p. 547-556, 1995.

PERUQUETTI, R. C.; CAMPOS, L. A. O.; COELHO, C. D. P.; ABRANTES, C. V. M.; LISBOA, L. C. O. Abelhas Euglossina (Apidae) de áreas de Mata Atlântica: abundância, riqueza e aspectos biológicos. **Revista Brasileira de Zoologia**, Curitiba, v. 16, p. 101-118, 1999.

PROCTOR, M.; YEO, P.; LACK, A. **The natural history of pollination**. London: Harper Collins Publishers, 1996. 479 p.

RAMALHO, A. V. **Comunidades de abelhas Euglossini (Hymenoptera; Apidae) em remanescentes de Mata Atlântica na bacia do Rio São João, RJ**. 2006. 69 f. Dissertação (Mestrado em Ecologia e Recursos Naturais) – Universidade Estadual do Norte Fluminense Darcy Ribeiro, Rio de Janeiro, 2006.

RAMALHO, A. V.; GAGLIANONE, M. C.; OLIVEIRA, M. L. Comunidades de abelhas Euglossina (Hymenoptera, Apidae) em fragmentos de Mata Atlântica no Sudeste do Brasil. **Revista Brasileira de Entomologia**, Curitiba, v. 53, p. 95-101, 2009.

REBÊLO, J. M. M.; CABRAL, A. J. Abelhas Euglossinae de Barreirinhas, zona do litoral da Baixada Oriental Maranhense. **Acta Amazônica**, Manaus, v. 27, p. 145-152, 1997.

REBELO, J. M. M.; GARÓFALO, C. A. Diversidade e sazonalidade de machos de Euglossina (Hymenoptera, Apidae) e preferências por iscas-odores em um fragmento de floresta no sudeste do Brasil. **Revista Brasileira de Biologia**, v. 51, p. 787-799, 1991.

SANTOS, A. M.; SOFIA, S. H. Horário de atividade de machos de Euglossinae (Hymenoptera, Apidae) em um fragmento de floresta semidecídua no Norte do estado do Paraná. **Acta Scientiarum**, Maringá, v. 24, p. 375-381, 2002.

SILVA, F. S.; REBÊLO, J. M. M. Population dynamics of Euglossinae bees (Hymenoptera, Apidae) in a early second-growth forest of cajual island, in the State of Maranhão, Brazil. **Brazilian Journal of Biology**, São Carlos, v. 62, p. 15-23, 2002.

SILVEIRA, F. A.; MELO, G. A. R.; ALMEIDA, E. A. B. **Abelhas brasileiras**. Sistemática e identificação. Fundação Araucária, Belo Horizonte, 2002. 253 p.

SOFIA, S. H.; SANTOS, A. M.; SILVA, C. R. M. Euglossine bee (Hymenoptera, Apidae) in a remnant of Atlantic Forest in Paraná State, Brasil. **Iheringia. Série Zoológica**, v. 94, p. 217-222, 2004.

SOFIA, S. H.; SUZUKI, K. M. Comunidades de machos de abelhas Euglossina (Hymenoptera: Apidae) em fragmentos florestais no Sul do Brasil. **Neotropical Entomology**, Londrina, v. 33, p. 693-702, 2004.

SOUZA, A. K. P.; HERNANDÉZ, M. I. M.; MARTINS, C. F. Riqueza, abundância e diversidade de Euglossina (Hymenoptera: Apidae) em três áreas da reserva Biológica Guaribas, Paraíba, Brasil. **Revista Brasileira de Zoologia**, Curitiba, v. 22, p. 320-325, 2005.

STORCK-TONON, D. **Efeitos da fragmentação florestal sobre a Abundância e diversidade de abelhas euglossina (Hymenoptera: Apidae: Apinae: Euglossina)** na amazônia ocidental. 2007. Dissertação (Mestrado em Ecologia e Manejo de Recursos Naturais) – Universidade Federal do Acre, 2007.

_____; MORATO, E. F.; OLIVEIRA, M. L. Fauna de Euglossina (Hymenoptera: Apidae) da Amazônia Sul-Occidental, Acre, Brasil. **Acta Amazônica**, Manaus, v. 39, p. 693-706, 2009.

TONHASCA, A. J. R.; BLACKMER, J. L.; ALBUQUERQUE, G. S. Abundance and Diversity of Euglossine Bees in the Fragmented Landscape of the Brazilian Atlantic Forest. **Biotropica**, v. 34, p. 416-422, 2002.

TOSTES, R. B.; VIEIRA, M. F.; CAMPOS, L. A. O. Polinização de *Peltastes peltatus* (Vell.) Woodson (Apocynoideae, Apocynaceae) por abelhas euglossíneas. In: MELO, G. A. R.; ALVES-DOS-SANTOS, I. (Ed.). **Apoidea Neotropica: Homenagem aos 90 anos de Jesus Santiago Moure**. Editora UNESCO: Criciúma, 2003. p. 297-302.

VIANA, B. F.; KLEINERT, A. P. E.; NEVES, E. L. Comunidade de Euglossini (Hymenoptera: Apidae) das dunas litorâneas do Abaeté, Salvador, Bahia, Brasil. **Revista Brasileira de Entomologia**, Curitiba, v. 46, p. 539-545, 2002.

ZANELLA, F. C. V.; MARTINS, C. F. **Abelhas da caatinga: Biogeografia, ecologia e conservação**. In: LEAL, I. R.; TABARELLI, M.; SILVA, J. M. C. (Ed). **Ecologia e conservação da Caatinga**. Recife: Editora Universitária, 2003. p. 75-134.