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The orchid bees (Hymenoptera, Apidae, Euglossina) in a forest fragment from western Paraná state, Brazil

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Abstract

An orchid bee inventory was carried out in Parque Estadual São Camilo, Palotina, Paraná (Brazil); conservation unit with about 400 hectares of Semidecidual Seasonal forest. Three bait traps were installed at the border of the fragment, each one containing the following fragrances: 1,8-cineole, eugenol, and vanilin. Sampling was carried out from 09 am to 03 pm, October 2011 to June 2012, summing up nine sampling days. A total of 186 specimens distributed among seven species were sampled. Eufriesea violacea *with 140 specimens was the most common species, followed by* Euglossa fimbriata *(31),* Euglossa annectans *(9),* Eulaema nigrita *(4),* Euglossa cordata *(1),* Euglossa pleosticta *(1), and* Exaerete smaragdina *(1). According to qualitative and NMDS analysis, the orchid bee fauna of Parque Estadual São Camilo is representative of Semidecidual Seasonal forest, with richness comparable with other assemblages in the southern distribution of Euglossina. The sampled bee richness indicates that forest fragments, even small and isolated, are important in the conservation of this bees.*

Key-Words: Euglossini; Apinae; Survey; Sinecology.

INTRODUCTION

Orchid bees (Euglossina) are known for males who collect aromatic compounds from different plant families (mainly Orchidaceae) and store them in highly modified hind tibia to further attract females (Roubik & Hanson, 2004). There are about 200 species of orchid bees, distributed among five monophyletic genera (Moure *et al.,* 2007; Nemésio, 2007; Ramírez *et al.,* 2010) and the group occurs from southern United States to northern Argentina, but most of its diversity is concentrated in Neotropical forests (Dressler, 1982; Roubik & Hanson, 2004). Much of the knowledge about the group, especially that generated by structured inventories, was enhanced by the discovery and use of synthetic chemical compounds to attract males for sampling (Dodson *et al.,* 1969). After this, many structured inventories of Euglossina fauna were carried out in many Neotropical areas (*p. ex.,* Becker *et al.,* 1991; Morato *et al.,* 1992; Nemésio & Faria, 2004; Storck-Tonon *et al.,* 2009). Although the most studies use hand-netting, an alternative methodology to collect orchid bees is the bait trap which retains the males attracted to scent (Campos *et al.,* 1989).

Most Euglossina inventories are concentrated on the Atlantic side of South America (*p. ex.,* Bonilla-Gómez, 1999; Bezerra & Martins, 2001; Nemésio

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& Silveira, 2004), with some scattered studies in the Amazon (*e.g.,* Pearson & Dressler, 1985; Oliveira & Campos, 1995; Nemésio & Morato, 2006) and Central America (*e.g.,* Janzen *et al.,* 1982; Ackerman, 1983). In the Atlantic forest, inventories are scattered in both main forest formations: Dense Ombrophylous (DOF) and Semidecidual Seasonal (SSF) forests (Mattozo *et al.,* 2011; Silveira *et al.,* 2011). Inventories on southern portions of Semidecidual Seasonal forests were conducted in Londrina, Paraná (Sofia & Suzuki, 2004; Sofia *et al.,* 2004), Telemaco Borba, Paraná (Giangarelli *et al.,* 2009), and two areas of São Paulo (Rebêlo & Garófalo, 1997; Silveira *et al.,* 2011).

Orchid bee diversity is negatively related to latitude as discussed by Sydney *et al.* (2010), but inventories of southern portions of their distribution are important for biogeographical and conservation purposes. As for coastal areas of Atlantic forest, inland areas are very fragmented, and even small fragments can contribute to the conservation of pollinators such as orchid bees (Sofia & Suzuki, 2004). The objective of this study is to present the species list from the first survey of orchid bee fauna of western Paraná - an important contribution to the knowledge of this group in the region. An additional effort to compare the present assemblage with those from other localities of the same forest formation is made in order to contextualize our results.

MATERIAL AND METHODS

The study was conducted in Parque Estadual de São Camilo (PRPA), located at Palotina municipality, western Paraná state, Brazil (-24.312998, -53.917491). PRPA is a 385.34 ha conservation unit, under a submontane Seasonal Semideciduous forest, Atlantic Forest biome (IAP, 2006). The area is surrounded by alternate soybean and corn crops, and is one of the few forest fragments under conservation in western Paraná.

Sampling was carried out between 09 am and 03 pm, from October 2011 to June 2012, summing nine diary samples (Table 1). For sampling method we opted to use bait traps that were installed on the border of the fragment. The selection of only one sampling point is justifiable under evidence of large home ranges of male orchid bees (*p. ex.,* Wikelski *et al.,* 2010) and complies with the objective of this study. Bait traps were made with commercial 500 ml plastic bottles; the scents, 1-8 cineol, eugenol and vanillin were available on top, and the bottom was filled with 10 cm of ethanol 70%. Two lateral funnel openings with diameter equal to a commercial bottle opening served as a lane and entrance for the bees; these funnels were manually abraded with sandpaper. The bait traps were placed in tree branches, about one meter from each other and about 1.5 meters from the soil. Sampled bees were pinned, databased, identified and deposited at the Laboratório de Hymenoptera do Campus Palotina, Universidade Federal do Paraná (PAUP) and Departamento de Zoologia, Universidade Federal do Paraná (DZUP).

For each sample we performed diversity analysis to access both dominance (D) and the Simpson index (S = D-1) for a measure of evenness, and the Shannon diversity index (H). To represent the assemblage of PRPA and orchid bee assemblages from other selected localities (Table 1) we performed nonmetric multidimensional analysis (NMDS), utilizing the Jaccard index for a matrix of presence/absence of species. The included studies were selected using the following criteria: geographical proximity with PRPA; Semidecidual Seasonal (SSF) or Dense Ombrophylous (DOF) forest formation; and the utilization of cineol, eugenol, and vanillin. All the included studies used only active sampling, except Mattozo *et al.* (2011), which also used bait traps in one locality (Sete Barras, SP) and Ramalho *et al.* (2009), which only used bait traps. All analyses were carried out with Past (Hammer *et al.,* 2001).

RESULTS

A total of 186 specimens distributed among seven species and four genera were sampled in PRPA (Table 2). The most common species was *Eufriesea violacea* with 140 sampled specimens, followed by *Euglossa fimbriata* with 31, *Euglossa annectans* with nine, *Eulaema nigrita* with four, *Euglossa cordata, Euglossa pleosticta*, and *Exaerete smaragdina* with only one sampled individual each. The higher abundance was observed from November to January, especially for *Eufriesea violacea* and *Eu. fimbriata.* Therefore, these samples present higher dominance values and consecutively lower evenness. Regarding diversity among the samples, the Shannon index was very low throughout the year, except in the February sample (Table 2). About two species were collected in traps on each sampling day. The most attractive scent was cineole, which sampled 88% of individuals; followed by vanilin 11%, and the eugenol scent which attracted only three individuals (less than 1%).

TABLE 1: Euglossina assemblages included in the ordenation analysis. N = number of individuals, S = species number. Scent legends: ab = benzil acetate, bi = beta-ionona, cm = metyl cinamate, eg = eugenol, eu = eucaliptol/cineol, ni = not informed, sc = escatol, sm = metil salicilate, va = vanilin.

Code	Municipality, State	N	S	Vegetation	Latitude	Longitude	Scents	Reference
ESLI	Linhares, Espírito Santo	16.177	31	FOD	-19.12	-40.27	eg, eu, sm, sc, va	Bonilla-Gómez (1999)
PRAN	Antonina, Paraná	254	6	FOD	-25.32	-48.65	eg, eu, sm, va	Mattozo *et al.* (2011)
PRLO	Londrina, Paraná	245	7	FES	-23.28	-51.17	eg, eu, va	Sofia *et al.* (2004)
PRPA	Palotina, Paraná	186	7	FES	-24.31	-53.91	eg, eu, va	this study
PRTB	Telemaco Borba, Paraná	246	6	FES	-24.29	-50.59	bi, eg, eu, sm, va	Giangarelli *et al.* (2009)
RJCA	Casimiro de Abreu, Rio de Janeiro	1923	17	FOD	-22.43	-42.03	ab, cm, eg, eu, sm, va	Ramalho *et al.* (2009)
RSOS	Osório, Rio Grande do Sul	639	5	FOM	-30	-50.5	eu, sc, va	Wittmann *et al.* (1988)
SPCA	Cajuru	736	14	FES	-21.13	-47.98	eg, eu, va	Rebêlo & Garófalo (1997)
SPPP	Patrocínio Paulista, São Paulo	859	13	FES	-20.77	-47.24	eg, eu, va	Silveira *et al.* (2011)
SPSA	Salesópolis, São Paulo	691	13	FOD	-23.65	-45.88	ni	Wilms (1995)
SPSE	Sertaozinho, São Paulo	906	10	FES	-21.4	-47.27	eg, eu, va	Rebêlo & Garófalo (1997)
SPSB	Sete Barras, São Paulo	39	8	FOD	-22.37	-47.97	eg, eu, sm, va	Mattozo *et al.* (2011)

TABLE 2: Euglossina species bait-trapped in Parque Estadual de São Camilo (Palotina, Paraná, Brazil) from October 2011 to June 2012. All specimens sampled with cineol except by [a] vanilin, [b] 20 sampled with vanilin, [c] three with vanilin, [d] two with eugenol and two with vanilin. N = number of individuals, D = dominance, H = Shannon diversity index.

	05/X/11	07/XI/11	14/XII/11	16/I/12	23/II/2012	29/III/12	05/IV/12	29/V/12	14/VI/12
Eufriesea violacea (Blanchard, 1840)	0	117[b]	23[c]	0	0	0	0	0	0
Euglossa annectans Dressler, 1982	1[a]	0	0	0	0	0	1	3	3
Euglossa cordata (Linnaeus, 1758)	0	1	0	0	0	0	0	0	0
Euglossa fimbriata Moure, 1968	0	0	4	17	4[d]	1	1	3	1e
Euglossa pleostica Dressler, 1982	0	0	0	0	0	1	0	0	0
Eulaema nigrita Lepeletier, 1841	0	0	0	2	2	0	0	0	0
Exaerete smaragdina (Guérin, 1844)	0	0	0	0	1	0	0	0	0
N	1	118	27	19	7	2	2	6	4
D	1	0,98	0,75	0,81	0,49	0.5	0.5	0,5	0,63
H	0	0,05	0,42	0,34	0,96	0,69	0,69	0,69	0,56

The first two axes on the graph of NMDS are presented in Figure 1; a total of 41 Euglossina species were used, according to the original species list of the selected studies. The study area (PRPA) is plotted on the center of the graph, surrounded by other SSF localities (PRLO, PRTB, SPCA, SPSE, SPPP). Dense Ombrophylous forest areas (ESLI, PRAN, RJCA, SPSB, SPSA) are not grouped, but all of them have positive values on NMDS2. Finally, the included southern locality (RSOS) shows an isolated position with very low NMDS1 value.

DISCUSSION

The orchid bee richness sampled here (seven species) is similar to that from the SSF areas of Paraná (Sofia & Suzuki, 2004; Sofia *et al.,* 2004, Giangarelli *et al.,* 2009), but not similar to areas from São Paulo that are comparatively richer with more than ten species commonly sampled. Comparing the PRPA assemblage with assemblages from DOF, it has similar richness to southern areas (Mattozo *et al.,* 2011), but has less species when compared with northern areas (RJCA, ESLI) of this forest formation. These minor observations can be supported by the hypothesis of a strong latitudinal effect in Atlantic Forest biome orchid bee assemblages (Sydney *et al.,* 2010; Mattozo *et al.,* 2011), rather than a strong effect of the kind of forest formation - DOF or SSF - on Euglossina communities.

The species composition of PRPA is similar to those of Semidecidual Seasonal forest, especially with localities sampled in the municipality of Londrina (Sofia & Suzuki, 2004; Sofia *et al.,* 2004); and some species are also shared with other localities of this vegetation cover. *Euglossa cordata* is a common element of the Atlantic Forest biome (Nemésio & Silveira, 2004; Mattozo *et al.,* 2011), *Euglossa annectans* is particularly abundant in coastal areas of the region (Bonilla-Gómez, 1999; Nemésio & Faria, 2004; Sofia & Suzuki, 2004), *Eulaema nigrita* and *Exaerete smaragdina*

are found along the Neotropical region (Nemésio & Silveira, 2004; Sydney *et al.,* 2010). The species *Eufriesea violacea* (Sofia & Suzuki, 2004; Sofia *et al.,* 2004; Nemésio & Silveira, 2004; Nemésio, 2007) and *Euglossa pleosticta* (Nemésio & Silveira, 2004) are considered typical species of Semidecidual inland areas. Another species, *Euglossa truncata* Rebêlo & Moure, 1996, is a common species in SSF areas, including Paraná areas (Sofia & Suzuki, 2004, Sofia *et al.,* 2004, personal observation), and was not sampled in PRPA bait traps.

Regarding the efficiency of bait traps, the assemblage of PRPA is similar to others from southern Brazil, surely not excluding the possibility that bait traps underestimate diversity when compared with a putative active sampling. The studies using bait traps as methodological protocol to sample orchid bees have increased recently (Aguiar & Gaglianone, 2008; Ramalho *et al.,* 2009, Aguiar & Gaglianone, 2011, 2012; Andrade-Silva *et al.,* 2012), in spite of some conclusions that active sampling should be preferred in some situations (Nemésio & Morato, 2004, 2006; Justino & Augusto, 2006), or that both methods were comparable approaches (Morato, 1998).

The qualitative approach presented here is reinforced in NMDS analysis. The PRPA is surrounded by other SSF assemblages, a cohesive group when compared with DOF areas. This result has two important interpretations in our view: first that PRPA is representative of SSF; and second that the dataset is not complete enough to find a cohesion of DOF areas that have many more recorded species, and therefore greater heterogeneity. Orchid bees are related to latitudinal gradient, and a gradient from Amazon Forest and Atlantic Forest fauna is also discussed in the literature (Sydney *et al.,* 2010). The Atlantic Forest orchid bee fauna itself has a latitudinal gradient with impoverished assemblages in southern portions, as well as species composition patterns in inland and coastal areas (Mattozo *et al.,* 2011). This differentiation of assemblages from areas of the Atlantic Forest biome correspond in some degree to Semidecidual Seasonal forest. This is typical of inland, Dense Ombrophylous forest, and coastal areas.

Among the compared studies, only Rebêlo & Garófalo (1997) and Sofia & Suzuki (2004) provide data from phenology. These studies, as well as other references on Euglossina, point out that most of the species collected in PRPA are known to take flight throughout the entire year - *Euglossa annectans, Euglossa fimbriata, Euglossa pleosticta, Eulaema nigrita,* and *Exaerete smaragdina.* The two latter species were sampled only once in the present study, possibly due to a small population or inefficient sampling. *Eufriesea* species are known as seasonal (Roubik & Hanson, 2004), with *Eufriesea violacea* being collected in spring (Peruquetti & Campos, 1997; Sofia & Suzuki, 2004). This species was the most common with a massive capture rate in two samples, similar to data from Londrina and Osório (Wittmann *et al.,* 1988; Sofia & Suzuki, 2004; Sofia *et al.,* 2004). As pointed out by Sofia *et al.* (2004), the higher abundance of

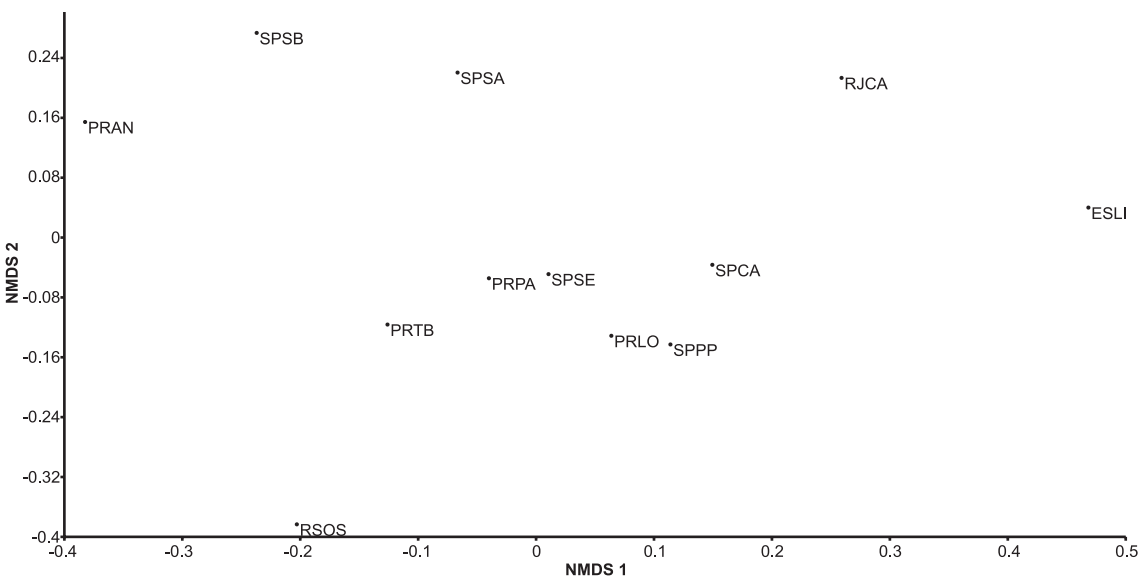

FIGURE 1: NMDS graph for the selected assemblages of orchid bees from Atlantic Biomes. Locality codes as listed in Table 1. Stress 0.1731, R2 NMDS1: 0.3555, NMDS 2: 0.3367.

Eufriesea violacea is uncommon among Semidecidual Seasonal forest and, for example, species like *Eulaema nigrita* and *Euglossa pleosticta* are relatively more abundant in other studies (*e.g.,* Rebêlo & Garofalo, 1997; Giangarelli *et al.,* 2009). We cannot affirm that the prevalence of *Eufriesea violacea* over other species is the reflection of a higher natural abundance of this species in spring, or is because of an underestimation of abundance of other species due to bait trap sampling.

According to our results, the orchid bee assemblage of Parque Estadual São Camilo presents a typical fauna composition of Semidecidual Seasonal forest when compared to other sampled areas (Sofia & Suzuki, 2004; Sofia *et al.,* 2004; Giangarelli *et al.,* 2009), and has a richness compatible with the southern portion of the distribution of the group (Wittmann *et al.,* 1988; Mattozo *et al.,* 2011). The sampled bee diversity indicates that a forest fragment such as the conservation unit of Parque Estadual de São Camilo, even being a small and isolate area, is important for the conservation of this bee group.

RESUMO

Abelhas das orquídeas (Hymenoptera, Apidae, Euglossina) em um fragmento florestal do oeste do Paraná. Um inventário de abelhas das orquídeas foi conduzido no Parque Estadual São Camilo, Palotina, Paraná, uma unidade de conservação de cerca de 400 hectares de Floresta Estacional Semidecidual. Três garrafas-armadilha foram instaladas na borda do fragmento, cada uma contendo uma das seguintes essências: 1,8-cineol, eugenol e vanilina. A amostragem foi realizada entre 09 e 15 horas, entre outubro de 2011 e junho de 2012, somando nove dias amostrais. Um total de 186 espécimens distribuídos em sete espécies foram amostrados, Eufriesea violacea *com 140 indivíduos foi a mais comum, seguida de* Euglossa fimbriata *com 31,* Euglossa annectans *com nove,* Eulaema nigrita *com quatro,* Euglossa cordata, Euglossa pleosticta *e* Exaerete smaragdina *com apenas um indivíduo amostrado cada. De acordo com análise qualitativa e de NMDS a fauna de Euglossina de Parque Estadual São Camilo é representativa de Floresta Estacional Semidecidual, com riqueza comparável a outras áreas no sul da distribuição do grupo. A riqueza de espécie amostrada indica que fragmentos florestais, mesmo que pequenos e isolados, são importantes na conservação destas abelhas.*

Palavras-Chave: Euglossini; Apinae; Inventário; Sinecologia.

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REFERENCES

Ackerman, J.D. 1983. Diversity and seasonality of male euglossine bees (Hymenoptera: Apidae) in central Panamá. *Ecology,* 64:274-283.

Aguiar, W.M. & Gaglianone, M.C. 2008. Comunidade de abelhas Euglossina (Hymenoptera: Apidae) em remanescentes de mata estacional semidecidual sobre tabuleiro no estado do Rio de Janeiro. *Neotropical Entomology,* 37:118-125.

Aguiar, W.M. & Gaglianone, M.C. 2011. Euglossine bees (Hymenoptera: Apidae: Euglossina) at an inselberg of Atlantic Forest domain in Southeastern Brazil. *Tropical Zoology,* 24:107-125.

Aguiar, W.M. & Gaglianone, M.C. 2012. Euglossine bees communities in small forest fragments of the Atlantic Forest, Rio de Janeiro state, southeastern Brazil. *Revista Brasileira de Entomologia,* 56:130-139.

Andrade-Silva, A.C.R.; Nemésio, A.; Oliveira, F.F. & Nascimento, F.S. 2012. Spatial-Temporal Variation in Orchid Bee Communities (Hymenoptera: Apidae) in Remnants of Arboreal Caatinga in the Chapada Diamantina Region, State of Bahia, Brazil. *Neotropical Entomology,* 41:296-305.

Becker, P.; Moure, J.S. & Peralta, F.J.A. 1991. More about euglossine bees in Amazonian Forest fragments. *Biotropica,* 23:586-591.

Bezerra, C.P. & Martins, C.F. 2001. Diversidade de Euglossinae (Hymenoptera, Apidae) em dois fragmentos de Mata Atlântica localizados na região urbana de João Pessoa, Paraíba, Brasil. *Revista Brasileira de Zoologia,* 18:823-835.

Bonilla-Gómez, M.A. 1999. *Caracterização da Estrutura Espaço-temporal da Comunidade de Abelhas Euglossinas (Hymenoptera,Apidae) na Hiléia Bahiana.* (Ph.D. Dissertation). Campinas, Universidade Estadual de Campinas.

Campos, L.A.O.; Silveira, F.A.; Oliveira, M.L.; Abrantes, C.V.M.; Morato, E.F. & Melo, G.A.R. 1989. Utilização de armadilhas para a captura de machos de Euglossini (Hymenoptera, Apoidea). *Revista Brasileira de Zoologia,* 6:621-626.

Dodson, C.H.; Dressler, R.L.; Hills, H.G.; Adams, R.M. & Williams, N.H. 1969. Biologically active compounds in orchid fragrances. *Science,* 164:1243-1249.

Dressler, R.L. 1982. Biology of the orchid bees (Euglossini). *Annual Review of Ecology and Systematics,* 13:373-394.

Giangarelli, D.C.; Freiria, G.A.; Alves, A.N.; Ferrari, B.R. & Sofia, S.H. 2009. Riqueza, abundância e diversidade de Euglossini (Hymenoptera, Apidae) em dois ecossistemas de Mata Atlântica no estado do Paraná. *In:* Congresso Brasileiro de Ecologia do Brasil, 9º. *Anais.* São Lourenço, MG, Sociedade de Ecologia do Brasil. 4p.

Hammer, O.; Harper, D.A.T. & Ryan, P.D. 2001. PAST: Paleontological statistics software package for education and data analysis. *Palaeontology Electronica,* 4:1-9

IAP (Instituto Ambiental do Paraná). 2006. *Plano de Manejo do Parque Estadual de São Camilo. Curitiba, Instituto Ambiental do Paraná.* Available from <www.uc.pr.gov.br/modules/conteudo/conteudo.php?conteudo=4> (Acessed 12 August 2012).

Janzen, D.H.; Devries, P.J.; Higgins, M.L. & Kimsey, L.S. 1982. Seasonal and site variation in Costa Rican Euglossine bees at chemical baits in lowland deciduous and evergreen forests. *Ecology,* 63:66-74.

Justino, D.G. & Augusto, S.C. 2006. Eficiência de Armadilhas no Levantamento de Machos de Euglossini (Hymenoptera, Apidae) em áreas de Cerrado. *In:* Santana, W.C.; Lobo, C.H. & Hartfelder, K.H. (Eds.). Encontro sobre Abelhas, 7º. *Anais.* Ribeirão Preto, SP, FFCLRP-USP/FMRP-USP. p. 33.

Mattozo, V.C.; Faria, L.R.R. & Melo, G.A.R. 2011. Orchid bees (Hymenoptera: Apidae) in the coastal forests of southern Brazil: diversity, efficiency of sampling methods and comparision with other Atlantic forest surveys. *Papéis Avulsos de Zoologia,* 51:505-515.

Morato, E.F. 1998. Estudos sobre comunidades de abelhas Euglossini. *In:* Camargo, J.M.F.; Michelette, E.R.M.; Gaglianone, M.C.; Zanella, F.C.V. & Oliveira, M.L. (Eds.). Encontro sobre Abelhas, 7º. *Anais.* Ribeirão Preto, SP, FFCLRP-USP/FMRP-USP. p. 135-143.

Morato, E.F.; Campos, L.A.O. & Moure, J.S. 1992. Abelhas Euglossini (Hymenoptera, Apidae) coletadas na Amazônia Central. *Revista Brasileira de Entomologia,* 36:767-771.

Moure, J.S.; Melo, G.A.R. & Faria, L.R.R. 2007. Euglossini Latreille, 1802. *In:* Moure, J.S.; Urban, D. & Melo, G.A.R. (Eds.). *Catalogue of Bees (Hymenoptera, Apoidea) in the Neotropical Region.* Curitiba, Sociedade Brasileira de Entomologia. p. 214-255.

Nemésio, A. 2007. The community structure of male orchid bees along the Neotropical Region. *Revista Brasileira de Zoociências,* 9:151-158.

Nemésio, A. & Faria, L.R.R. 2004. First assessment of orchid bee fauna (Hymenoptera: Apidae: Apini: Euglossina) of Parque Estadual do Rio Preto, a cerrado area in southeastern Brazil. *Lundiana,* 5:113-117.

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

Nemésio, A. & Morato, E.F. 2006. The orchid-bee fauna (Hymenoptera: Apidae) of Acre state (northwestern Brazil) and a re-evaluation of euglossine bait-trapping. *Lundiana,* 7:59-64.

Nemésio, A. & Silveira, F.A. 2004. Biogeographic notes on rare species of Euglossina (Hymenoptera: Apidae: Apini) ocurring in the Brazilian Atlantic rain forest. *Neotropical Entomology,* 33:117-120.

Oliveira, M.L. & Campos, L.A.O. 1995. Abundância, riqueza e diversidade de abelhas Euglossinae (Hymenoptera: Apidae) em florestas contínuas de terra firme na Amazônia central, Brasil. *Revista Brasileira de Zoologia,* 12:547-556.

Pearson, D.L. & Dressler, R.L. 1985. Two-year study of male orchid bee (Hymenoptera: Apidae: Euglossini) attraction to chemical baits in lowland south-eastern Perú. *Journal of Tropical Ecology,* 1:37-54.

Peruquetti R.C. & Campos, L.A.O. 1997. Aspectos da biologia de *Euplusia violacea* (Blanchard) (Hymenoptera, Apidae, Euglossini). *Revista Brasileira de Zoologia,* 14:91-97.

Ramalho, A.V.; Gaglianone, M.C. & Oliveira, M.L. 2009. Comunidades de abelhas Euglossina (Hymenoptera, Apidae) em fragmentos de Mata Atlântica no Sudeste do Brasil. *Revista Brasileira de Entomologia,* 53:95-101.

Ramírez, S.; Roubik, D.W.; Skov, C. & Pierce, N.E. 2010. Phylogeny, diversification patterns and historical biogeography of euglossine orchid bees (Hymenoptera: Apidae). *Biological Journal of Linnean Society,* 100:552-572.

Rebêlo, J.M.M. & Garófalo, C.A. 1997. Comunidades de machos de Euglossini (Hymenoptera: Apidae) em matas semidecíduas do nordeste do estado de São Paulo. *Anais da Sociedade Entomológica Brasileira,* 26:243-255.

Roubik, D.W. & Hanson, P.E. 2004. *Orchid bees of Tropical America. Biology and field guide.* San José, Costa Rica, INBio.

Silveira, G.C.; Nascimento, A.M.; Sofia, S.H. & Augusto, S.C. 2011. Diversity of the euglossine bee community (Hymenoptera, Apidae) of an Atlantic Forest remnant in southeastern Brazil. *Revista Brasileira de Entomologia,* 55:109-115

Sofia, S.H. & Suzuki, K.M. 2004. Comunidades de machos de abelhas Euglossina (Hymenoptera: Apidae) em Fragmentos florestais no Sul do Brasil. *Neotropical Entomology,* 33:693-702.

Sofia, S.H.; Santos, A.M. & Silva, C.R.M. 2004. Euglossine bees (Hymenoptera, Apidae) in a remnant of Atlantic Forest in Paraná state, Brazil. *Iheringia, Série Zoologia,* 94:217-222.

Storck-Tonon, D.; Morato, E.F. & Oliveira, M.L. 2009. Fauna de Euglossina (Hymenoptera: Apidae) da Amazônia Sul-Ocidental, Acre, Brasil. *Acta Amazonica,* 39:693-706.

Sydney, N.V.; Gonçalves, R.B. & Faria, L.R.R. 2010. Padrões espaciais na distribuição de abelhas Euglossina (Hymenoptera, Apidae) da região Neotropical. *Papéis Avulsos de Zoologia,* 50:667-679.

Wikelski, M.; Moxley, J.; Eaton-Mordas, A.; Lopez-Uribe, M.M.; Holland, R.; Moskowitz, D.; Roubik, D.W. & Kays, R. 2010. Large-Range Movements of Neotropical Orchid Bees Observed via Radio Telemetry. *PLoS ONE,* 5: e10738. doi:10.1371/journal.pone.0010738

Wilms, W. 1995. *Die Bienenfauna im Küstenregenwald Brasiliens und ihre Beziehungen zu Blütenplanzen: Fallstudie Boracéia, São Paulo.* (Tese de Doutorado), Universidade de São Paulo, São Paulo, Brasil / Fakultät für Biologie der Eberhard-Karls-Universität Tübingen, Germany. 219 p.

Wittmann, D.; Hoffmann, M. & Scholz, E. 1988. Southern distributional limits of euglossine bees in Brazil linked to habitats of the Atlantic- and Subtropical Rain Forest (Hymenoptera: Apidae: Euglossini). *Entomologia Generalis,* 14:53-60.

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