



News from the west: the orchid bees from Parque Nacional do Iguauçu, Paraná, Brazil (Hymenoptera, Apidae, Euglossina)

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Abstract: Orchid bees were surveyed at Parque Nacional do Iguauçu, the largest remnant of Seasonal Semideciduous Forest in Brazil. Seven species were collected, and *Eufriesea violacea* (Blanchard) was the most common species, followed by *Euglossa annectans* Dressler. The observed species richness and species composition agree with what is known for the local euglossine faunas in fragments of Seasonal Semideciduous Forest of southern and southeastern Brazil. On the other hand, the abundance of individuals was remarkably low. The occurrence of a severe winter in 2013 and the collection of several males in other fragments suggest that this noteworthy low abundance can be fortuitous.

Keywords: inventory, species list, Iguazu, Euglossini, Seasonal Semideciduous Forest, Atlantic forest.

Notícias do oeste: as abelhas-das-orquídeas do Parque Nacional do Iguauçu, Paraná, Brasil (Hymenoptera, Apidae, Euglossina)

Resumo: Abelhas-das-orquídeas foram amostradas no Parque Nacional do Iguauçu, o maior fragmento de Floresta Estacional Semidecidual do Brasil. Sete espécies foram coletadas e *Eufriesea violacea* (Blanchard) foi a espécie mais comum, seguida por *Euglossa annectans* Dressler. A riqueza e composição de espécies observadas concordam com o que se conhece para as faunas locais de abelhas euglossinas em fragmentos de Floresta Estacional Semidecidual. Por outro lado, a abundância de indivíduos foi notavelmente baixa. A ocorrência de um inverno severo em 2013 e a coleta de muitos machos em outros fragmentos sugerem que tal baixa abundância pode ser fortuita.

Palavras-chave: inventário, lista de espécies, Iguauçu, Euglossini, Floresta Estacional Semidecidual, Mata Atlântica.

Introduction

Orchid bees are a primarily Neotropical and monophyletic group of bees (e.g. Ramírez et al. 2010) distributed from southern United States (Skov & Wiley 2005) to southern Brazil (Wittmann et al. 1988) and northern and central Argentina (Pearson & Dressler 1985; Cordoba, Central Argentina; FCVZ, personal observation). The importance of these bees in the dynamics of forestry ecosystems are fairly recognized for their role as pollinators of several plant clades, mainly Orchidaceae, Gesneriaceae, Araceae, Euphorbiaceae, Apocynaceae and Solanaceae (e.g. Ramírez et al. 2002, Cameron 2004). These bees are closely related to forests (e.g. Moure 1967) and are by far recognized as key elements in Neotropical forests (Dodson et al. 1969). Approximately 60 species are known to occur in the Atlantic Forest domain (Nemésio 2009, Moure et al. 2012). But, despite the considerable number of inventories carried

out in this region, most of these studies are concentrated in coastal areas of Brazil and neighboring sites (e.g. Sydney et al. 2010, see Gonçalves et al. 2014). This geographical caveat implies in a more limited appraisal of the patterns of species richness, diversity and composition of orchid bee faunas of interior forests, which seems even more relevant when one considers the existence of a significant distinction between the faunas of interior and coastal Atlantic Forest (Nemésio & Silveira 2007, Nemésio 2009, Sydney et al. 2010). Regarding the Semideciduous Seasonal forests (from now on, SSF) of southern Brazil, efforts in systematic inventorying orchid bees are quite punctual, restricted to studies in small fragments of up to 680 ha, in the region of Londrina (Santos & Sofia 2002, Sofia & Suzuki 2004, Sofia et al. 2004, Ferronato et al. 2018), Telêmaco Borba (Giangarelli et al. 2015) and Palotina (Gonçalves et al. 2014), all in Paraná state.

In this context, the Parque Nacional do Iguaçu (PNI) could be considered a key area, in view of its status as the largest fragment of Atlantic Forest in southern Brazil (see Ribeiro et al. 2009), encompassing ca. 185,000 ha in western Paraná state (Conforti & Azevedo 2003), and its position near the western boundaries of the hotspot (e.g. Paviolo et al. 2016). It is worth to mention that PNI, Iguazú National Park, Uruguá Provincial Park, and eight other smaller private and provincial reserves in Argentina correspond to a continuous protected area of 340,800 ha (Di Bitetti et al. 2003) separated only by the Iguaçu river. Previous studies in areas of SSF in southern Brazil have suggested that the local orchid bee richness ranges from seven to nine species; see Santos & Sofia 2002, Sofia & Suzuki 2004, Sofia et al. 2004, Giangarelli et al. 2015, Gonçalves et al. 2014, Ferronato et al. 2018). If we consider that fragmentation could be affecting the orchid bee species in the region (Sofia & Suzuki 2004, Giangarelli et al. 2009), it seems reasonable to assume that the chance of collecting the species naturally inhabiting seasonal forests in southern Brazil would be higher at this large-sized forest fragment. Herein, we present data from a survey of orchid bees carried out at the Parque Nacional do Iguaçu, Brazil.

Material and Methods

1. Study site

Fieldwork was carried out in the Parque Nacional do Iguaçu (PNI), located in the Triple Frontier (Argentina, Brazil and Paraguay) region. PNI is the largest national conservation unity of Brazil within the Atlantic Forest domain and comprises areas of SSF (most part of the Park) and Mixed Ombrophilous forests (restricted to areas with higher elevational quotas, at the western part of the park) (see Cervi & Borgo 2007).

The climate in the region is the Cfa of Köppen, subtropical, mesothermal, with average temperature in the hottest month >22°C, average temperature in the coldest month <18°C, hot summers, uncommon frosts, tendency of rainfall concentration in the summer months but without a defined dry season (IAPAR 1994). Annual average rainfall is about 1,700 mm and daily relative humidity is around 80% (Salamuni et al. 2002).

2. Data collection

Two sample points, separated from each other by ca. 50 m, were established near the Poço Preto trail (25°37'31.9" S, 54°27'12.9" W, inside the forest, and 25°37'28.2" S, 54°27'11.0" near the border of the 2 m wide trail), a 9 km long trail located near the park administration in Foz do Iguaçu. The region of the Poço Preto trail was a farm about 30 years ago (Rodolfo et al. 2008). At each point two monthly samples (one day per sample) were carried out from November/2013 to June/2014. Seven aromatic compounds, known to be attractive to male orchid bees, were employed during fieldwork: 1,8-cineole, β -ionone, benzyl acetate, eugenol, methyl salicylate, trans-methyl cinnamate and vanillin. Two collecting methods were employed, (i) hand nets, where the collector remains on sampling site inspecting the baits and collecting any bee approaching the chemical lures, and (ii) bait traps, where a given aromatic compound is offered to bees inside traps and

only the bees that enter and remain in the traps are actually collected. For active collection (hand nets), the seven aromatic baits, made of cotton waddings soaked with one of the presented substances, were placed ca. 1.5 m apart from each other and at ca. 1.5 m above the ground. Regarding scent traps, we used a modified version of traps previously presented (Mattozo et al. 2011, Gonçalves et al. 2014) and, in the same way, a single compound was placed at each trap. Traps were also arranged ca. 1.5 m apart from each other and ca. 1.5 m above the ground. These methods were alternated in the two monthly samplings carried out at each point, so that in the same month each point was assessed one way and the other. In all cases, daily sampling procedure was performed from 08:00 to 15:00 h. This way, a total sampling effort of 112 h was carried out considering both sampling points and methods.

A last relevant methodological detail regards that hourly replenishments have been made on 1,8-cineole baits due to its volatility.

Bees attracted to those lures were killed with ethyl acetate (in the case of traps after being gently removed from them) and kept apart in paper bags. Posteriorly, they were mounted in entomological pins for identification. Bees were identified with help of taxonomic keys (Rebêlo & Moure 1996, Faria & Melo 2007, Nemésio 2009) and by comparison with specimens previously identified by specialists. Taxonomy follows Moure et al. (2012) and the organization of the previous known distribution of species follows Zanella et al. (2000).

In the labels of examined specimens transcribed in the species list, quotations marks indicate distinct labels associated with a given specimen, and one inverted bar (\) indicates distinct lines in a label. When a label was very similar to other associated to a specimen, only the different information (e.g. date, scent, etc.) is presented. All the collected specimens are deposited in the entomological collection of the Universidade Federal da Integração Latino-Americana (UNILA), Foz do Iguaçu, Paraná, Brazil. The study was conducted under ICMBIO permit 41.140-1.

Results

A total of 60 specimens belonging to seven species was sampled in the Parque Nacional do Iguaçu (Table 1). The most common species was *Eufriesea violacea*, followed by *Euglossa annectans* and *E. pleosticta*.

The higher abundance of orchid bees, ca. 88% of the collected specimens, and all the seven species were collected from December to February. Moreover, the tripleton, the doubleton and all the singletons were recorded only in this period. *Eufriesea violacea*, the most common species, presented an even more restrict phenology, since it was only collected in November and December. On the other hand, only one species, *Euglossa annectans*, with only one individual, was collected between April and June (Table 2).

The most attractive scent was cineole, where ca. 53% of the specimens (32 individuals) were collected, followed by vanillin (21 specimens; 35%). All the species, excepting *Eufriesea* cfr. *auriceps*, were registered in cineole baits, and regarding the other employed attractants, two species were found in trans-methyl cinnamate and vanillin, and only one species at β -ionone and eugenol. The two remaining scents, benzyl acetate and methyl salicylate, were not visited by any orchid bee (Table 1).

Table 1. Number of individuals of each species at an area of Seasonal Semideciduous Forest, Parque Nacional do Iguaçu, according to attractive baits. BI: β -ionone; C: 1,8-cineole; E: eugenol; MC: trans-methyl cinnamate; and V: vanillin. Benzyl acetate and methyl salicylate are not included as no specimens were collected at these two scents.

Species	Attractant					Total
	BI	C	E	MC	V	
<i>Eufriesea violacea</i> (Blanchard, 1840)	0	5	0	0	19	24
<i>Euglossa (Glossura) annectans</i> Dressler, 1982	4	16	1	0	2	23
<i>Euglossa (Euglossa) pleosticta</i> Dressler, 1982	0	6	0	0	0	6
<i>Euglossa (Euglossa) cordata</i> (Linnaeus, 1758)	0	2	0	1	0	3
<i>Euglossa (Euglossa) fimbriata</i> Moure, 1968	0	2	0	0	0	2
<i>Euglossa (Euglossa) truncata</i> Rebêlo & Moure, 1996	0	1	0	0	0	1
<i>Eufriesea</i> cfr. <i>auriceps</i> (Friese, 1899)	0	0	0	1	0	1
Total individuals/attractant	4	32	1	2	21	
Grand total individuals						60

Table 2. Number of individuals of each species at an area of Seasonal Semideciduous Forest, Parque Nacional do Iguaçu, collected by month.

Species	Month								Total
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
<i>Eufriesea violacea</i> (Blanchard, 1840)	1	23	0	0	0	0	0	0	24
<i>Euglossa (Glossura) annectans</i> Dressler, 1982	2	0	9	8	3	0	1	0	23
<i>Euglossa (Euglossa) pleosticta</i> Dressler, 1982	0	0	1	5	0	0	0	0	6
<i>Euglossa (Euglossa) cordata</i> (Linnaeus, 1758)	0	1	0	2	0	0	0	0	3
<i>Euglossa (Euglossa) fimbriata</i> Moure, 1968	0	1	0	1	0	0	0	0	2
<i>Euglossa (Euglossa) truncata</i> Rebêlo & Moure, 1996	0	1	0	0	0	0	0	0	1
<i>Eufriesea</i> cfr. <i>auriceps</i> (Friese, 1899)	0	1	0	0	0	0	0	0	1
Total individuals/attractant	3	27	10	16	3	0	1	0	
Grand total individuals									60

Species list

1. *Eufriesea* cfr. *auriceps* (Friese, 1899)

Distribution (for *Eufriesea auriceps*, see additional comments below). Brazil: Tocantins, Goiás, Mato Grosso do Sul, Minas Gerais, Espírito Santo, Rio de Janeiro, São Paulo, Paraná, Santa Catarina; Paraguay; Argentina: Misiones (Moure et al. 2012). Sofia et al. (2004) presented a record of a melanic *Eufriesea*, named by them as *E. auriceps*, collected in a fragment of semideciduous forest in northern Paraná state.

Examined material. 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1A Arm Cinam. Met.\ 25°37'28.2” 54°27'11.0”\ 01/XII/2013 207 m\ Arce leg.”, “CE-UNILA\ HYEU 10025”.

Additional information. As stated by G.A.R. Melo (unpublished, in Moure et al. 2012), “The systematics of the melanic forms in the *musitans* group is far from being resolved (...) and the entire group needs a thorough revision, since many additional undescribed forms remain”. It does not seem too much to say that any black-bodied *Eufriesea* in this group has, at the moment, an uncertain identity. The single male was collected in methyl trans-cinnamate.

2. *Eufriesea violacea* (Blanchard, 1840)

Distribution. Brazil: Goiás, Minas Gerais, Espírito Santo, Rio de Janeiro, São Paulo, Paraná, Santa Catarina, Rio Grande do Sul; Paraguay; Argentina: Catamarca, Córdoba, Misiones, Tucumán (Moure et al. 2012).

Examined material. 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1A Arm Vanilina\ 25°37'28.2” 54°27'11.0”\ 15/XI/2013 207 m\ Clerici leg.”, “CE-UNILA\ HYEU 10019”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1B Rede Vanilina\ 25°37'31.9” 54°27'12.9”\ 1/XII/2013 194 m\ Faria & Neves leg.”, “CE-UNILA\ HYEU 10001”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1A Arm Vanilina\ 25°37'28.2” 54°27'11.0”\ 1/XII/2013 207 m\ Arce leg.”, “CE-UNILA\ HYEU 10002”; 1 male, idem, except “10003”; 1 male, idem, except “10004”; 1 male, idem, except “10005”; 1 male, idem, except “10006”; 1 male, idem, except “10007”; 1 male, idem, except “10008”; 1 male, idem, except “10009”; 1 male, idem, except “10011”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1A Arm Cineol\ 25°37'28.2” 54°27'11.0”\ 1/XII/2013 207 m\ Arce leg.”, “CE-UNILA\ HYEU 10013”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1B Rede Cineol\ 25°37'31.9” 54°27'12.9”\ 1/XII/2013 194 m\ Faria & Neves

leg.”, “CE-UNILA\HYEU 10010”; 1 male, idem, except “10012”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1A Rede Cineol\ 25°37'28.2” 54°27'11.0”\ 5/XII/2013 207 m\ Neves leg.”, “CE-UNILA\HYEU 10014”; 1 male, idem, except “10017”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1A Rede Vanilina\ 25°37'28.2” 54°27'11.0”\ 5/XII/2013 207 m\ Neves leg.”, “CE-UNILA\HYEU 10020”; 1 male, idem, except “10021”; 1 male, idem, except “10022”; 1 male, idem, except “10023”; 1 male, idem, except “10024”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1B Arm Vanilina\ 25°37'31.9” 54°27'12.9”\ 5/XII/2013 194 m\ Faria leg.”, “CE-UNILA\HYEU 10015”; 1 male, idem, except “10016”; 1 male, idem, except “10018”.

Additional information. *Eufriesea violacea* is regarded as a species typical of the semideciduous forests of the interior of the Atlantic forest (Nemésio 2009). Moreover, in some fragments of semideciduous forests of southern Brazil, this species appears as the dominant element of the local faunas (e.g. Sofia & Suzuki 2002, Gonçalves et al. 2014). A relevant characteristic of species of the genus *Eufriesea* regards the fact that most species has their activities restricted to some few months in the rainy season (e.g. Kimsey 1982). Males were collected in cineole and vanillin.

3. *Euglossa (Glossura) annectans* Dressler, 1982

Distribution. Brazil: Minas Gerais, Espírito Santo, Rio de Janeiro, São Paulo Paraná, Santa Catarina, Rio Grande do Sul; Paraguay; Argentina: Misiones (Faria & Melo 2007, Moure et al. 2012). Records in semideciduous forests of Paraná are provided by Giangarelli et al. (2015), Gonçalves et al. (2014) and Ferronato et al. (2018).

Examined material. 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1B Arm B-ionona\ 25°37'31.9” 54°27'12.9”\ 02/XI/2013 194 m\ Zanella leg.”, “CE-UNILA\HYEU 10046”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1A Arm Cineol\ 25°37'28.2” 54°27'11.0”\ 15/XI/2013 207 m\ Clerici leg.”, “CE-UNILA\HYEU 10047”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1B Rede Cineol\ 25°37'31.9” 54°27'12.9”\ 10/I/2014 194 m\ Faria leg.”, “CE-UNILA\HYEU 10040”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1B Rede Eugenol\ 25°37'31.9” 54°27'12.9”\ 10/I/2014 194 m\ Faria leg.”, “CE-UNILA\HYEU 10041”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1A Arm Cineol\ 25°37'28.2” 54°27'11.0”\ 10/I/2014 207 m\ Arce leg.”, “CE-UNILA\HYEU 10042”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1A Rede B-ionona\ 25°37'28.2” 54°27'11.0”\ 21/I/2014 207 m\ Arce leg.”, “CE-UNILA\HYEU 10037”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1A Rede Cineol\ 25°37'28.2” 54°27'11.0”\ 21/I/2014 207 m\ Arce leg.”, “CE-UNILA\HYEU 10038”; 1 male, idem, except “10035”; 1 male, idem, except “10039”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1A Rede Vanilina\ 25°37'28.2” 54°27'11.0”\ 21/I/2014 207 m\ Arce leg.”, “CE-UNILA\HYEU 10034”; 1 male, idem, except “10036”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1A Arm Cineol\ 25°37'28.2” 54°27'11.0”\ 18/II/2014 207 m\ Clerici leg.”, “CE-UNILA\HYEU 10031”; 1 male, idem, except “10033”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1B Rede Cineol\ 25°37'31.9” 54°27'12.9”\ 18/II/2014 194 m\ Arce leg.”, “CE-UNILA\HYEU 10032”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1A Rede B-ionona\ 25°37'28.2” 54°27'11.0”\ 19/II/2014 207 m\ Clerici leg.”, “CE-UNILA\HYEU 10026”; 1 male, idem, except “10030”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1B Arm Cineol\ 25°37'31.9” 54°27'12.9”\ 19/II/2014 194 m\ Clerici leg.”, “CE-UNILA\HYEU 10027”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1A Rede Cineol\

25°37'28.2” 54°27'11.0”\ 19/II/2014 207 m\ Clerici leg.”, “CE-UNILA\HYEU 10028”; 1 male, idem, except “10029”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1A Rede Cineol\ 25°37'28.2” 54°27'11.0”\ 16/III/2014 207 m\ Arce leg.”, “CE-UNILA\HYEU 10043”; 1 male, idem, except “10045”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1B Arm Cineol\ 25°37'31.9” 54°27'12.9”\ 16/III/2014 194 m\ Zanella leg.”, “CE-UNILA\HYEU 10044”; 1 male, “PNI Arm\ Cineol\ 18-05-2014\ Zanella\ (annectans)”, “CE-UNILA\HYEU 10048”.

Additional information. As stated by Faria & Melo (2007), available locality records indicate that *E. annectans* is restricted to the southern portion of the Atlantic forest in Brazil, including the inland forests of the Paraná basin, south to Misiones, in Argentina. The species can be found in coastal areas (from Rio de Janeiro to Santa Catarina states) and, regarding inland areas of southeastern Brazil, *E. annectans* have been found both in semideciduous forests and savannas (see Faria & Melo 2007 for details). Males were collected in β -ionone, cineole, eugenol and vanillin baits.

4. *Euglossa (Euglossa) cordata* (Linnaeus, 1758)

Distribution. Mexico; Guatemala; Honduras; Costa Rica; Panama; Jamaica; Trinidad and Tobago; Colombia; Venezuela; Guyana; Suriname; French Guiana; Ecuador; Brazil: Amapá, Pará, Amazonas, Maranhão, Ceará, Paraíba, Alagoas, Sergipe, Bahia, Goiás, Minas Gerais, Espírito Santo, Pernambuco, Rio de Janeiro, São Paulo, Paraná, Rio Grande do Sul; Paraguay (Moure et al. 2012). Besides these countries presented by Moure et al. (2012), Bembé (2007) also provided a record of the species in Bolivia. Records regarding specifically the semideciduous forests of Paraná are presented by Sofia & Suzuki (2004), Sofia et al. (2004), Giangarelli et al. (2015), Gonçalves et al. (2014) and Ferronato et al. (2018).

Examined material. 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1B Rede Cineol\ 25°37'31.9” 54°27'12.9”\ 1/XII/2013 194 m\ Faria & Neves leg.”, “CE-UNILA\HYEU 10057”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1A Rede Cineol\ 25°37'28.2” 54°27'11.0”\ 19/II/2014 207 m\ Clerici leg.”, “CE-UNILA\HYEU 10060”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1A Rede Cinam. Met.\ 25°37'28.2” 54°27'11.0”\ 19/II/2014 207 m\ Clerici leg.”, “CE-UNILA\HYEU 10053”.

Additional information. Males were collected in cineole and trans-methyl cinnamate.

5. *Euglossa (Euglossa) fimbriata* Moure, 1968

Distribution. Brazil: Maranhão, Bahia, Minas Gerais, Espírito Santo, Rio de Janeiro, São Paulo; Bolivia: Santa Cruz (Moure et al. 2012). Nemésio (2009) stated that the species also reaches Paraíba and Pernambuco states, northwards in the Brazilian Atlantic forest, and the Maranhão state. Records in the semideciduous forests of Paraná were provided by Sofia & Suzuki (2004), Sofia et al. (2004), Giangarelli et al. (2015), Gonçalves et al. (2014) and Ferronato et al. (2018).

Examined material. 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1A Arm Cineol\ 25°37'28.2” 54°27'11.0”\ 01/XII/2013 207 m\ Arce leg.”, “CE-UNILA\HYEU 10058”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1B Rede Cineol\ 25°37'31.9” 54°27'12.9”\ 18/II/2014 194 m\ Arce leg.”, “CE-UNILA\HYEU 10059”.

Additional information. The two males were collected in cineole.

6. *Euglossa (Euglossa) pleosticta* Dressler, 1982

Distribution. Brazil: Bahia, Minas Gerais, Espírito Santo, Rio de Janeiro, São Paulo (Moure et al., 2012). Nemésio (2012) have also presented records for the states of Maranhão, Alagoas, Sergipe and Paraná. Regarding specifically the Paraná state, the species was recorded both in semideciduous forests (Sofia & Suzuki 2004; Sofia et al. 2004; Giangarelli et al. 2015, Gonçalves et al. 2014 and Ferronato et al. 2018) and in coastal ombrophilous forests (Mattozo et al. 2011; Giangarelli et al. 2015).

Examined material. 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1B Rede Cineol\ 25°37'31.9” 54°27'12.9”\ 10/I/2014 194 m\ Faria leg.”, “CE-UNILA\ HYEU 10056”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1B Rede Cineol\ 25°37'31.9” 54°27'12.9”\ 18/II/2014 194 m\ Arce leg.”, “CE-UNILA\ HYEU 10054”; 1 male, idem, except “10055”; 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1A Rede Cineol\ 25°37'28.2” 54°27'11.0”\ 19/II/2014 207 m\ Clerici leg.”, “CE-UNILA\ HYEU 10051”; 1 male, idem, except “10050”; 1 male, idem, except “10052”.

Additional information. *Euglossa pleosticta* seems to be more common in areas in the drier portions of the interior of the Atlantic Forest (e.g. Rebêlo & Garófalo 1997). *Euglossa pleosticta* appears as the most common species in fragments of semideciduous forests in the interior of São Paulo state (Rebêlo & Garófalo 1997). The species is also very common in semideciduous forests of Paraná (Sofia & Suzuki 2004, Sofia et al. 2004). Nemésio (2007, 2009, 2012) have considered this species inhabiting the Amazon Basin (records for the Brazilian states of Amazonas and Acre). However, we follow here the interpretation of Moure et al. (2012) considering *E. pleosticta* as a species endemic to the Atlantic forest. Males were collected in cineole baits.

7. *Euglossa (Euglossa) truncata* Rebêlo & Moure, 1996

Distribution. Brazil: Maranhão, Bahia, Minas Gerais, São Paulo, Paraná (Moure et al. 2012). Nemésio (2009, 2012) have also considered the occurrence of this species in the states of Espírito Santo and Rio de Janeiro, in Brazil, and have presented records of the species in Argentina (province of Misiones). *Euglossa truncata* is also a very common element in the local faunas of orchid bees in inland areas of the Atlantic forest. In the Paraná state, *Euglossa truncata* was recorded by Sofia & Suzuki (2004), Sofia et al. (2004), Giangarelli et al. (2015) and Ferronato et al. (2018). It is noteworthy that Gonçalves et al. (2014) did not collect the species in nearby Palotina.

Examined material. 1 male “Brasil, PR, Foz do Iguaçu\ PNI 1A Rede Cineol\ 25°37'28.2” 54°27'11.0”\ 5/XII/2014 207 m\ Arce leg.”, “CE-UNILA\ HYEU 10049”.

Additional information. The single male was collected in a cineole bait.

Discussion

Data collected at the Parque Nacional do Iguaçu revealed an orchid bee species richness comparable to what have been found elsewhere in seasonal semideciduous areas in southern Brazil and, with regard to species composition, results also suggested that the local orchid bee fauna of PNI comprises elements that are very common in these areas (Sofia & Suzuki 2004, Sofia et al. 2004, Giangarelli et al. 2015, Gonçalves et al. 2014, Ferronato et al. 2018). On the other hand, the remarkably low abundance of orchid bees collected at PNI draws most attention.

An additional orchid bee species, *Euglossa (Euglossella) mandibularis* Friese, 1899 is known to inhabit Parque Nacional do Iguaçu (Faria & Zanella 2015), bringing the number of species found in PNI to eight. This value is comparable to the orchid bee richness assessed in other SSF fragments in southern Brazil (Paraná state), e.g. in the region of Londrina, where species richness ranged from five to nine (Sofia & Suzuki 2004, Sofia et al. 2004, Ferronato et al. 2018), Telêmaco Borba (seven species; Giangarelli et al. 2015) and Palotina (seven species; Gonçalves et al. 2014) (Table 3). When comparing these values to the species richness found in lower latitude sites of SSF in southeastern Brazil, where species richness ranges from ten up to 14 species (Rebêlo & Garófalo 1997, Silveira et al. 2011, Mateus et al. 2015) (Table 3), it is possible to perceive the alleged impoverishment of orchid bee faunas southwards in the SSF (see e.g. Sydney et al. 2010), which seems even more noticeable when considering the poor local faunas of areas farther south in Brazil (Wittmann et al. 1988).

Regarding species composition, it is possible to realize that the species found at PNI are, for the most part, the species commonly collected in assessments carried out in SSF areas in southern Brazil. The only species that was collected in PNI but is rare in other surveys employing aromatic attractants in the Atlantic forest is *Euglossa mandibularis* Friese. As far as we know, besides Faria and Zanella (2015), only Costa and Francoy (2017) report the attraction of this species to aromatic baits (even if the scent attracting the species was not identified in this latter case). However, *E. mandibularis* is widely distributed in southeastern and southern Brazil, southern Paraguay and in the provinces of Corrientes and Misiones in Argentina (see Faria & Zanella 2015). The occurrence of *E. mandibularis* at PNI seems to regard much more a spatial variation concerning the attractiveness of some aromatic compounds to males than any geographical restriction.

Some species that have commonly been found in the surveys carried out in SSF areas in Southern Brazil was not collected in PNI. The most noticeable case regards *Eulaema nigrita* Lepelletier, 1841 that was surveyed in all the other studies in SSF areas in Paraná state (Sofia & Suzuki 2004, Sofia et al. 2004, Giangarelli et al. 2015, Gonçalves et al. 2014, Ferronato et al. 2018) and is one of the most widespread euglossine species in the Neotropical region, whose distribution stands from Costa Rica to northern Argentina (e.g. Nemésio 2009). It is important to emphasize that this species is one of the most common elements in some local faunas in SSF areas in southern Brazil, the dominant species in a fragment in Telêmaco Borba (Giangarelli et al. 2015), and the second most common species in a 680 ha fragment in Londrina (Sofia et al. 2004).

Other three species recorded in these studies were also not collected in PNI, *Exaerete smaragdina* (Guérin, 1844), *Euglossa melanotricha* Moure, 1967 and *Euglossa townsendi* Cockerell, 1904 (see Sofia & Suzuki 2004, Sofia et al. 2004, Gonçalves et al. 2014 and Ferronato et al. 2018). But, unlike *E. nigrita*, these species have always been sampled with a very low number of individuals. Regarding *E. smaragdina*, nine and five individuals were assessed in two fragments in northern Paraná state, in the region of Londrina by Ferronato et al. (2018). In the other two studies where the species was recorded, it appears as a singleton in fragments in Londrina (Sofia & Suzuki 2004) and Palotina (Gonçalves et al. 2014). The other two species, *E. melanotricha* and *E. townsendi*, seem to be a common element in the local faunas of northern Paraná, although infrequent in the sites they occur (Sofia et al. 2004, Ferronato et al. 2018).

Table 3. Surveys of orchid bee assemblages carried out in Seasonal Semideciduous Forest areas in the states of Paraná and São Paulo.

Locality	Latitude (Degrees and minutes)	Area description	Sampling effort (h)/number of compounds employed	Species richness	References
Cajuru, SP	21°20' - 21°27' S	A fragment of ca. 99 ha	108/3	14	Rebêlo & Garófalo 1997
Patrocínio Paulista, SP	20°46' S	A fragment of 49 ha	48/3	13	Silveira et al. 2011
Pedregulho, SP	20°14' S	Parque Estadual Furnas do Bom Jesus, 2,070 ha	36/3	12	Mateus et al. 2015
Londrina, PR	23°27' S*	Parque Estadual Mata dos Godoy, ca. 680 ha*, a fragment of 86 ha, a fragment of 8.5 ha and a reforested area of 20 ha	276/8**	11	Sofia et al. 2004, Sofia & Suzuki 2004 and Ferronato et al. 2018
Sertãozinho, SP	21°8' S'	A fragment of ca. 75 ha	108/3	10	Rebêlo & Garófalo 1997
Alvorada do Sul, PR	22°49' S	A forest fragment of 128.1 ha and a reforested area of 11.3 ha	72/8	9	Ferronato et al. 2018
Primeiro de Maio, PR	22°46' S	A forest fragment of 32.1 ha and a reforested area with 33.3 ha	72/8	8	Ferronato et al. 2018
Rancho Alegre, PR	22°59' S	A forest fragment of 108.0 ha and a reforested area of 11.8 ha	72/8	8	Ferronato et al. 2018
Telêmaco Borba, PR	24°12' S	A fragment of ca. 217 ha	76/8	7	Giangarelli et al. 2015
Palotina, PR	24°18' S	Parque Estadual São Camilo, ca. 386 ha	54/3	7	Gonçalves et al. 2014
Foz do Iguaçu, PR	25°37' S	Parque Nacional do Iguaçu, ca. 185,000 ha; see methods	112/7	7	This study

* Latitude and total area of Mata dos Godoy according to Sofia et al. 2004; ** Combined sampling effort and number of scents.

Considering that in PNI most of species was also represented by few individuals, it seems reasonable to state that most of the difference regarding the local faunas in the SSF of southern Brazil regards the presence of these locally rare species. It seems also possible to hypothesize that many of these species have naturally low populations in southern Brazil, since the region is likely to represent the limit (or at least close to it) of their distributions (for a discussion on the population size towards species range limits see Gaston 2009). If this is the case, we could expect that a long-term survey in PNI could also reveal the occurrence of these nowadays unrecorded species in this large remnant.

With respect to species abundance, results found in PNI are noteworthy. A rapid comparison among the number of individuals collected per sampling hour in assessments in SSF areas in southern Brazil (Sofia & Suzuki 2004: 12.66, 3.75 and 4.00 [sampling was carried out in three fragments]; Sofia et al. 2004: 2.58; Giangarelli et al. 2015: 3.50; Gonçalves et al. 2014: 3.44; Ferronato et al. 2018: 1.25, 0.75, 0.85, 0.61, 0.98, 0.11, 0.70 and 0.78 [sampling was carried out in six fragments; as they also have used both hand nets and traps simultaneously, we consider duplicate number of sampling hours] shows how few specimens were collected in PNI (this work: 0.53). In comparison to our results, the only lower number of individuals per sampling hour was found by Ferronato et al. (2018) in a 33 ha reforested area in Primeiro de Maio, northern Paraná.

But it seems to us that this remarkably low abundance in PNI is fortuitous, at least regarding *Eufriesea violacea* a common species in semideciduous forests. There are two main reasons leading us to this interpretation: (i) the occurrence in 2013 of a winter with more severe cold events than usual in southern Brazil (see Dolif Neto et al. 2016), could lead to higher mortality of bees (e.g. Bosch & Kemp 2003). This could be particularly relevant for the most common species at PNI, *Eufriesea violacea*, a univoltine species whose adults emerge in September-October (Wittmann et al. 1989, Peruquetti & Campos 1997); (ii) surveys carried out in western Paraná in subsequent years, even in small fragments, have resulted in the collection of several individuals of *Eufriesea violacea* inclusive along a single day (F.C.V. Zanella, pers. obs.).

Results found in PNI reinforces some observations on what seems to be the main patterns regarding the local faunas of orchid bees in SSF of southern Brazil: (i) species richness with values commonly ranging from seven to nine species, with decreasing values along the latitudinal gradient (mainly when compared to assessments carried out in southeastern Brazil); (ii) local faunas consisting of widespread species (e.g. *Eulaema nigrata* and *Euglossa cordata*) and species “typical of the semideciduous forests of the interior” (*sensu* Nemésio 2009) (e.g. *Euglossa pleosticta* and *Eufriesea violacea*); (iii) marked seasonality; (iv) most species presenting low populations and possibly with local extinction-colonization dynamics.

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Author Contributions

Luiz Roberto Ribeiro Faria: substantial contribution in the concept and design of the study; contribution to data collection; contribution to data analysis and interpretation; contribution to critical revision, adding intellectual content; contribution to manuscript preparation.

Betânia Cristina Neves: substantial contribution in the concept and design of the study; contribution to data collection; contribution to data analysis and interpretation; contribution to critical revision, adding intellectual content.

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Conflicts of interest

The authors declare that they have no conflict of interest related to the publication of this manuscript.

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