COMMUNITY OF MALE EUGLOSSINI BEES (HYMENOPTERA: APIDAE) IN A SECONDARY FOREST, ALCÂNTARA, MA, BRAZIL

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Received May 22, 2000 – Accepted August 18, 2000 – Distributed November 30, 2001

(With 1 figure)

ABSTRACT

From September, 92 to August, 93 bee sampling was done in a secondary forest near the Pepital River, in Alcântara, MA, in order to study the local Euglossini fauna. Five aromatic compounds were used: eucaliptol, eugenol, methyl salicylate, vanillin, and benzoate. Four hundred sixty-seven male Euglossini bees were captured, distributed in 4 genus and 19 species. *Euglossa* was the most abundant and with high diversity (302 specimens and 14 species), followed by *Eulaema* (121; 3), *Eufriesea* (41; 1), and *Exaerete* (3; 1). The species which more frequently visited the bait were *Euglossa piliventris* (141 specimens; 30.19%), *Euglossa cingulata* (113; 24.21%), *Euglossa ignita* (45; 9.64%), *Eufriesea pulchra* (41; 8.78%), and *Euglossa gaianii* (33; 7.07%) corresponding to 79.88% of the sampling universe. The bees were active throught the year, however during the rainy season more activity and diversity were observed. The most attractive essence was eucaliptol (44.32% specimens and 84.21% species). In spite of this study having been done in a forest fragment, a secondary vegetation area smaller than other areas studied in Maranhão, it showed a significant diversity rate. This result reinforces the importance of fragments in the conservation of local bee communities.

Key words: Euglossini, diversity, abundance, seasonality, chemical baits.

RESUMO

Comunidade de machos de Euglossini (Hymenoptera: Apidae) em floresta secundária, Alcântara, MA, Brasil

De setembro/92 a agosto/93, foram feitas coletas em uma área de vegetação secundária, próxima ao rio Pepital, Alcântara, MA, com o objetivo de conhecer a fauna de Euglossini local. Foram coletados 467 machos, 4 gêneros e 19 espécies. *Euglossa* foi o gênero mais abundante e com maior número de espécies (302 indivíduos, 14 espécies), seguido de *Eulaema* (121; 3), *Eufriesea* (41; 1) e *Exaerete* (3; 1). As espécies que mais se destacaram em visita às iscas-odores foram: *Euglossa piliventris* (141 ind.; 30,19% do total de abelhas coletadas), *Eulaema cingulata* (113; 24,21%), *Euglossa ignita* (45; 9,64%), *Eufriesea pulchra* (41; 8,78%) e *Euglossa gaianii* (33; 7,07%) representando 79,88% do universo amostral. Foram ativas durante todo o ano, entretanto, foram observadas maior atividade e maior diversidade de abelhas em visita às essências no período chuvoso. A essência que atraiu o maior número de espécies e indivíduos foi o Eucaliptol (84,21% e 44,32%, respectivamente). O sítio de estudos, embora apresentasse vegetação secundária, cuja área amostrada foi menor do que outras áreas já estudadas no Maranhão, revelou uma significativa diversidade de Euglossini. Tal resultado reforça a importância dos fragmentos na manutenção das comunidades de abelhas na região.

Palavras-chave: Euglossini, diversidade, abundância, sazonalidade, iscas-odores.

INTRODUCTION

Euglossine bees (Apidae: Euglossini) are an important exclusively neotropical pollinator group that are most closely related with certain angiosperm families. Without specifically trying to collect pollen, they are able to secure pollination of species of Caesalpiniaceae, Maranthaceae, Euphorbiaceae, Araceae, Gesneriaceae, Bignoniaceae, Orchidaceae and others (Armbruster & Webster, 1979; Williams & Whitthen, 1983).

Male euglossine bees are the only pollinators of some orchids, e.g. *Gongora*, *Castasctum*, and *Coryanthes*. They are attracted to the essences produced by these orchids' flowers. The collection of these essences is by special pads on the tarsi of the forelegs and storage is in the pockets in the hind tibia (Bennett, 1972).

The use of these essences is not so well understood. However, Dodson (1970), Williams (1982), and Williams & Whitthen (1983) report that they can be used as a sexual attractant.

These chemical compounds are synthesized and can be used in ecological studies about the euglossine population, which has been done by Braga (1976), Janzen *et al.* (1982), Ackerman (1983, 1989), Pearson & Dressler (1985), Powell & Powell (1987), Roubik & Ackerman (1987), Raw (1989), Armbruster & McCormick (1990), Oliveira & Campos (1995, 1996), Oliveira (1999), Rebelo & Cabral (1997), Rebelo & Garófalo (1991, 1997), and Silva & Rebelo (1999).

Janzen (1971) reports that the euglossine sampling in a single area is representative for that area, habitat, and period. However, Becker *et al.* (1991) verified that abundance of euglossini males can vary in small intervals (300-700 m) so a sampling in one site cannot be regarded as representative of all the species of the region.

Although Maranhão State presents wide diversity of natural plant formations (Brasil, 1991), concern for the composition of euglossini community only began in the last decade with the work of Gomes (1991) and Fernandes (1991) in São Luís (north of the state), Silva & Rebelo (1999) in the pre-Amazonian region (west of the state), and Rebelo & Cabral (1997) in the wet littoral of Maranhão. Most of the state continues to have unknown euglossine fauna, in spite of accelerated devastation of the natural environment.

MATERIAL AND METHODS

Study site

The study site is located on the west littoral of the Maranhão State, on the west side of São Marcos Bay, between coordinates 2°23'00''S and 44°25'00''W.

The sample site is 25 km away from Alcântara city, along the Pepital River. The weather is warm and humid with an average temperature of around 25°C (annual variation between 0.8 and 3.2°C) and pluviometric index between 1,000 and 1,800 mm (Feitosa, 1983). Medium (8-10 m) and small trees compose the vegetation. The other side of the Pepital River has a plane area saturated during the rainy period and with occurrence of *Mauritia flexuosa* (buriti), *Euterpe oleracea* (juçara), *Clusia* sp. e *Toccoca* sp.

Sample

The survey was done from September 1992 to August 1993, in intervals of 28 and 30 days. The sampling activities were performed in two consecutive days, the first from 12:00 to 6:00 p.m. and the second from 6:00 a.m. to 12:00 p.m.

Five aromatic compounds were utilized to attract the male euglossine bees: eucaliptol, eugenol, methyl salicylate, vanillin, and benzil benzoate in cotton balls attached to twine.

The chemical baits were put at an average height of 2.0 m, at an average distance of 7 m. Every two hours, the baits were filled with the respective essence. The baits were observed every hour, but to avoid over-sampling the collector remained at each essence bait for only 12 minutes per observation. The bees were captured with an entomological net, after visiting the baits and killed in a jar with ethyl acetate ($(C_4H_8)_2$). They were kept in plastic bags with identification (capture hour and bait). They are now preserved in the entomological collection of Maranhão Federal University.

The temperature, relative humidity, and rain fall data were obtained in the Metereologic Station of Ponta da Madeira Terminal – CVRD (São Luís), 20 km from the sample site.

RESULTS AND DISCUSSION

Four hundred sixty-seven male euglossini bees were captured, belonging to 4 genera and 19

species. *Euglossa* was the most abundant genera and showed the highest diversity (302 specimens and 14 species), followed by *Eulaema* (121; 3), *Eufriesea* (41; 1) and *Exaerete* (3; 1) (Table 1).

Comparing these results to those of Gomes, 1991 (1,728 specimens and 13 species), Fernandes, 1991 (428 and 9), Silva & Rebelo, 1999 (1,740 and 37), and Ferreira, 1994 (69 and 11), all done in Maranhão State, shows that the largest diversity and fauna abundance were obtained by Silva & Rebelo (1999) in a 10,000 ha area in the Forest Reserve of Vale do Rio Doce in Buriticupu, an Amazonian region of the state (Table 1). In spite of the present study having been done in a forest fragment along the Pepital River, a secondary vegetation area smaller than the study areas cited above, its results were second in specific diversity. Although Powell & Powell (1987) noted that there were fewer nisitors of the Euglossini species in accordance with fragment size, it also shows that in the absence of big forested areas, the small ones are utilized as refuges by fauna. This result reinforces the importance of developing conservation studies in fragments of natural ecosystems. This can also be argued because in 1988, 31.02% of Maranhão State's original forest areas were devastated, and 2.11% of the remaining area were located in fragments smaller than 10,000 ha, as cited by Skole & Tuckers (1993).

The species which more frequently visited the baits were *Euglossa piliventris* (141 specimens, 30.19% of the total), *Eulaema cingulata* (113, 24.2%), *Euglossa ignita* (45, 9.64%), *Eufriesea pulchra* (41, 8.78%) and *Euglossa gaianii* (33, 7.07%) corresponding to 79.88% of the sampling universe (Table 2).

TABLE 1
Frequency of male Euglossini bees collected at menthyl salicylate, eucaliptol, vanillin, eugenol and benzyl benzoate, in Alcântara, MA, from September 1992 to August 1993.

Euglossini	M. salicylate		Eucaliptol		Vanilliun		Eugenol		B. benzoate	
	N.	%	N.	%	N.	%	N.	%	N.	%
Eufriesea pulchra	40	97.56					1	2.44		
Euglossa augaspis	2	11.11	3	16.67	11	61.11	2	11.11		
Euglossa chalybeata	1	7.14	13	92.86						
Euglossa cordata			9	100						
Euglossa fimbriota			1	100						
Euglossa gaianii	21	63.64	11	33.33	1	3.03				
Euglossa ignita	10	22.22	35	77.78						
Euglossa intersecta			1	100						
Euglossa laevicincta			1	50	1	50				
Euglossa modestior			11	100						
Euglossa mourei					6	100				
Euglossa piliventris	8	5.67	115	81.56	16	11.35	2	1.42		
Euglossa townzendi					1	100				
Euglossa truncata	3	75	1	25						
Euglossa viridifrons	1	6.25	1	6.25	14	87.5				
Eulaema cingulata			2	1.77	26	23.01	85	75.22		
Eulaema meriana	3	75	1	25						
Eulaema nigrita			1	25	3	75				
Exaerete smaragdina			1	33.33			1	33.34	1	33.33
N. specimens	89	19.06	207	44.32	79	16.92	91	19.49	1	0.21

The Euglossini were active throughout the year, however during rainy period more activity and specific diversity were observed. More active specimens representing 17.13% of the total specimens sampled, occurred in March 1993, the rainiest period, and the least activity was observed in September-November 1992 (Fig. 1 and Table 3). Strong rains probably explain the reduced activity registered in April.

Euglossa piliventris was present during the whole year, especially in December (32 specimens, representing 65.31% of the total sampled during that month). The dominance of this species contradicts the results in the studies of Silva & Rebelo (1999), Powell & Powell (1987), and Oliveira & Campos (1995), in which this species was rare.

E. ignita and *E. gaianii* were active for almost the whole year, except in October and November 1992. *Euglossa augaspis* was strongly seasonal, being in activity during September and October/ 1992 and from May to August 1993. Another species with strong preference for some period of the year was *E. viridifrons*, active in December 1992 and January 1993, absent in February and active again in March and April.

Although *E. mourei*, *E. modestior*, *E. intersecta*, *E. townsendi*, *E. truncata*, *E. fimbriota,* and *E. laevicincta* were represented by few specimens, they also demonstrated evidences of seasonality. These species were active especially in April and August 1993, corresponding to the end of the rainy and beginning of the dry season.

TABLE 2
Seasonal fluctuation of Euglossini collected at scent baits in Alcântara, MA, from September 1992 to August 1993.

Euglossini	Set	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
	Season Dry				Rainy						Dry		
Eufriesea pulchra		4	6		4	7	3	3	4	4	3	3	41
Euglossa augaspis	2	2							6	3	2	3	18
Euglossa chalybeata	2	6			1				3		1	1	14
Euglossa cordata	1	1		4	1		1					1	9
Euglossa fimbriota								1					1
Euglossa gaianii	2	7		5	1	1	3	1	5	4	2	2	33
Euglossa ignita	1			1	6	2	12	4	3	5	6	5	45
Euglossa intersecta									1				1
Euglossa laevicincta										1		1	2
Euglossa modestior		1			1				2	2	2	3	11
Euglossa mourei									1	3	1	1	6
Euglossa piliventris	4	14	11	32	12	6	18	2	13	4	11	14	141
Euglossa townzendi										1			1
Euglossa truncata							3	1					4
Euglossa viridifrons				3	1		11	1					16
Eulaema cingulata	2	5	1	4	17	26	27	6	10	4	6	5	113
Eulaema meriana					1		1	1			1		4
Eulaema nigrita					1		1		1	1			4
Exaerete smaragdina		1							2				3
N. species	7	9	3	6	11	5	10	9	12	11	10	11	19
N. specimens	14	41	18	49	46	42	80	20	51	32	35	39	467

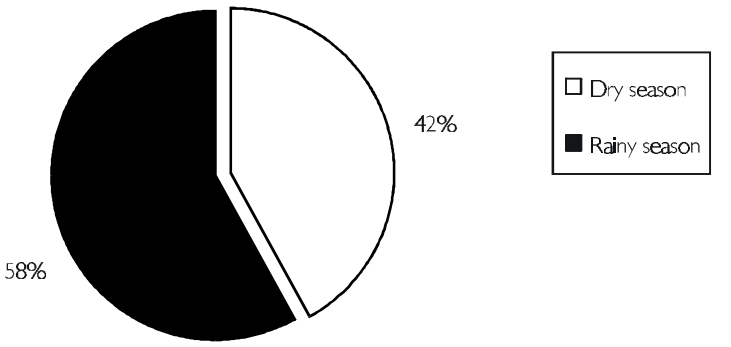

Fig. 1 — Frequency of Euglossini collected at scent baits in Alcântara, MA, in relation to the dry and rainy seasons, from September 1992 to August 1993.

TABLE 3
Frequency of Euglossini males collected at scent baits in Alcântara, MA, in relation to daily actvity (from 6:00 a.m. to 18:00 p.m.) from September 1992 to August 1993.

Euglossini	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18
Eufriesea pulchra	3	4	6	14	4	3	4	2	1			
Euglossa augaspis		2	1	4	4	3	3		1			
Euglossa chalybeata	1	3	3		2	2	1	1	1			
Euglossa cordata		1	2	2	2	1			1			
Euglossa fimbriota								1				
Euglossa gaianii	1	5	2	7	7	4	1	4	2			
Euglossa ignita	8	2	5	4	5	3	5	8	2	3		
Euglossa intersecta			1									
Euglossa laevicincta				1	1							
Euglossa modestior		3	4		3		1					
Euglossa mourei	2		1		2		1					
Euglossa piliventris	2	8	25	36	12	18	10	14	10	4	2	
Euglossa townzendi				1								
Euglossa truncata	1				1		1	1				
Euglossa viridifrons		1	1	2	6	3		2		1		
Eulaema cingulata	10	20	12	21	9	6	14	8	4	2	3	4
Eulaema meriana	1		1						2			
Eulaema nigrita			1				1			1	1	
Exaerete smaragdina			1	1				1				
N. species	9	10	15	11	13	9	11	10	9	5	3	1
N. specimens	29	49	66	93	58	43	42	42	24	11	6	4

The most abundant species of *Euglossa* (*E. piliventris, E. ignita,* and *E. gaianii*) weren't necessarily the same in other surveys in forest areas in Maranhão. Gomes (1991) and Fernandes (1991) reported *E. chalybeata* and *E. ignita* as the most abundant, a justificable similarity because they sampled the same area, the Sacavém Forest Reserve (760 ha), in São Luís. However, Silva & Rebelo (1999) obtained dominance of *E. pleostica*, *E. truncata* and *E. avicula*. Janzen *et al.* (1982)

argue that shifts of Euglossini populations and communities in different or isolated geographic habitats are acculiarly frequent.

Among the three species sampled of the genera *Eulaema*, *E. cingulata* were active during the entire sampling period, with more activity in February and March 1993. *E. nigrita* and *E. meriana* were represented by few specimens, but all were sampled in the rainy period. The low frequency of *E. nigrita*, in this area reinforces data showing this species, preference for open and dry areas (Ducke, 1902; Zucchi *et al*., 1969; Rebelo & Garófalo, 1991). In Buriticupu, transition of forest and "cerrado", *E. nigrita* was one of the most frequent bees found (Silva & Rebelo, 1999). Before this study, the only wet forest where it was frequently sampled was São Luís, where the vegetation is more similar to that of the Amazon region as observed by Gomes (1991) and Fernandes (1991).

The low abundance of *E. meriana,* as compared to that shown in Gomes (1991), Fernandes (1991), Silva & Rebelo (1999), Morato *et al.* (1992), Powell & Powell (1987) and Oliveira & Campos (1995), can be explained, as Braga (1976) argues its preference for natural forest environments.

The genus *Eufriesea* normally occurs in few months of the year (Ackerman *et al.*, 1982; Ackerman, 1983). In this study it was represented by just one species, *E. pulchra*, observed visiting the baits during almost the whole year, except in September and December 1992.

Exaerete smaragdina, parasites of euglossinis nests (Kinsey, 1979), had three specimens sampled in October 1992 and May 1993.

Janzen (1981) reported that although many euglossini populations can remain active during the entire years; they must reduce their population size and can thus remain in some sites according to the resources available.

According to Dressler (1968) and Williams & Dodson (1972), the seasonal patterns can be explained by the movement pattern of the species.

However, Ackerman (1983), in studying the diversity and seasonality of euglossini males in Central Panama, verified that seasonal patterns of nidification and emerging of the bees could propably cause the seasonal fluctuation of abundance. Zimmerman & Madrinan (1988) verified that young males visit odorific substances, because they need to collect these substances before establishing territories while old males visit nectar sources. Rebelo & Garófalo (1991) observed that 77% of the males collecting odorific substances were young. The seasonal variation in preference for odorific substances can be related to the orchid floration patterns (Oliveira & Campos, 1996).

During the day, the bees were most active between 9:00 and 10:00 o'clock (Table 3). However, the biggest diversity of species was observed between 8:00 and 9:00 o'clock.

The daily activity pattern of the specimens of *Eulaema* is unlike the general pattern observed: shows three daily peaks of activity, between 7:00 and 8:00 a.m., 9:00 and 10:00 a.m., and 12:00 and 1:00 p.m.

The most attractive essence was eucaliptol (44.32% of all captured specimens), followed by eugenol (19.49%), menthyl salicitate (19.06%), vanillin (16.92%), and benzil benzoate (0.21%). The number of specimens attracted to eucaliptol can be explained by the presence of *E. piliventris,* with 55.56% of the captured bees (Table 3).

The eucaliptol also attracted most species, 16 of the 19 sampled. It failed to attract *E. townsendi*, *E. mourei* and *Eufriesea pulchra*.

Silva & Rebelo (1999) found benzil benzoate attracted *Eufriesea pulchra*, *Exaerete smaragdina,* and *Euglossa cordata*, but in Alcântara this essence attracted only one specimen of *Exaerete smaragdina*, even with the presence of the other species mentioned above.

Table 1, shows the preference of Euglossini species for the baits exposed. *E. piliventris* was observed visiting four of the five compounds utilized, but 81.56% of these specimens were captured collecting eucaliptol. In the studies of Powell & Powell (1987), Ackerman (1989), Armbruster & McCormick (1990), Morato *et al.* (1992) and Silva & Rebelo (1999), *E. ignita*, *E. chalybeata*, *E. moestior* and *E. cordata* preferred cineol. However, in the present survey these species were more abundant in eucaliptol.

For *Euglossa gaiani*, represented by 33 specimens, 21 (63.64%) were attracted to methyl salicitate, 11 (33.33%) to eucaliptol, and only 1 (3.03%) to vanillin; this preference to methyl salicitate was observed by Powell & Powell (1987), Armruster & McCormick (1990), and Morato *et al.* (1992).

Euglossa augaspis and *E. viridifrons* also demonstrated a preference for a specific compound; 61.11% and 87.5% of their specimens were attracted to vanillin.

The other *Euglossa* species were represented by less than ten specimens, making a detailed analysis about their preferences for chemical compounds more difficult.

Eulaema cingulata was strongly attracted to eugenol, as indicated B' Janzen (1981), Janzen *et al.* (1982) and Morato *et al.* (1992). The other species of this genus were *E. meriana*, attracted to methyl salicitate and eucaliptol, and *E. nigrita*, attracted to eucaliptol and vanillin. Discussion about their preferences for the baits in the sample site is almost impossible because they were represented by a reduced number of individuals.

Eufriesea pulchra showed 97.56% of captured specimens visiting methyl salicitate; its preference for this essence is widely known as mentioned by Braga (1976), Ackerman (1989), Morato *et al.* (1992), and Silva & Rebelo (1999).

Acknowledgments — We acknowledge the Fundação de Amparo à Pesquisa no Maranhão, Fapema (in memorium), for supporting this research and Pe. Jesus Santiago Moure (Federal University of Paraná), for identifying species.

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