POLLINATION ECOLOGY OF THE TROPICAL WEED *Triumfetta semitriloba* Jacq. (TILIACEAE), IN THE SOUTH-EASTERN BRAZIL

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ABSTRACT

This work aimed to study the pollination ecology of the tropical weed *Triumfetta semitriloba* Jacq. (Tiliaceae), in Viçosa, South-eastern Brazil, during the flowering season of 1993 and 1994. Two patches located in pasture (P1 and P2) and one patch in a forest trail (P3) were chosen and ten plants on each patch were sorted. The number of opened flowers were counted during one day, in each flowering month and patch. All observed flower visitors were identified and their behavior while visiting flowers was recorded. Frequency of visits to flowered branches was obtained and some pollinator individuals were captured for analysis of pollen load. Flowers are conspicuously yellow and actinomorphic, with five nectaries around the ovary base, and opened sequentially in the afternoon. Flower phenology followed a modified steady-state Gentry's pattern. The number of opened flowers was higher in P2, but differences between months were not homogeneous between patches. Considering behaviour when collecting pollen or nectar, which permitted impregnation of stigma with pollen, visiting frequency and percent of *T. semitriloba* pollen on pollen load (100% for all of them, except for *Augochlorella michaelis* which was 81%) the following species were the mainly pollinators: *Augochloropsis cupreola*, *Augochlorella michaelis*, *Cressomiella aff. sussurans*, *Cressomiella sussurans*, *Cressomiella* sp., *Pseudocentron paulistana*, *Ceratinula* sp1, *Ceratinula* sp2 and *Ceratinula* sp3, *Melissodes sexcincta*, *Apis mellifera*, *Plebeia cf. nigriceps*, *Plebeia droryana*. Frequency of pollinators visitation was not different between patches and not uniform during anthesis. There was a higher pollinator activity between 15:00 and 17:00 hr.

Key words: pollination, *Triumfetta semitriloba*, Tiliaceae, tropical bees, weed.

RESUMO

Ecologia da Polinização da Planta Invasora, *Triumfetta semitriloba* Jacq. (Tiliaceae), no sudeste do Brasil

Este trabalho tem por objetivo estudar a ecologia da polinização da planta invasora *Triumfetta semitriloba* Jacq. (Tiliaceae), em Viçosa, MG, Brasil, durante a estação de floração de 1993 e 1994. Foram escolhidas duas manchas de plantas localizadas em pastos abandonados (P1 e P2) e uma mancha em clareira de mata (P3). Dez plantas, em cada mancha, foram sorteadas. Durante um dia de cada mês de floração foi contado o número de flores abertas por planta. Todos os visitantes florais foram identificados e registrado o comportamento. Foi obtida a freqüência de visitas aos ramos floridos e alguns polinizadores foram coletados para análise da carga de pólen. As flores de *T. semitriloba* são actinomórficas com cinco nectários em torno da base do ovário, e abrem, seqüencialmente, no período da tarde. A fenologia floral seguiu o padrão "steady-state" modificado de Gentry. O número de flores abertas foi maior em P2, mas as diferenças entre meses não foram homogêneas entre as manchas. Considerando o comportamento enquanto coletavam pólen ou néctar, a freqüência de visita e a porcentagem de pólen de *T. semitriloba* na carga polínica (100% para todas as espécies de abelhas, exceto para *Augochlorella michaelis* que foi igual a 81%) as seguintes abelhas foram consideradas como principais polinizadoras: *Augochloropsis cupreola*, *Augochlorella michaelis*, *Cressomiella aff. sussurans*, *Cressomiella sussurans*, *Cressomiella* sp., *Pseudocentron paulistana*, *Ceratinula* sp1, *Ceratinula* sp2 e *Ceratinula* sp3, *Melissodes sexcincta*, *Apis mellifera*, *Plebeia cf. nigriceps*, *Plebeia droryana*. A distribuição de freqüência de visitas dos polinizadores não foi diferente entre manchas e não foi uniforme durante a antese. Houve uma maior atividade dos visitantes entre 15 e 17 horas.

Palavras-chave: polinização, *Triumfetta semitriloba*, Tiliaceae, abelhas tropicais, plantas invasoras.

INTRODUCTION

As the “renaissance botanist” Herbert Baker realized, the study of tropical weeds could provide valuable information for understanding mechanisms of breeding systems and life history evolution (Baker, 1965; Stebbins, 1989).

Breeding system, flower morphology, pollinator traits, biomass allocated to vegetative *versus* reproductive tissues are all correlated with life history, such as growth form, pattern of development, time to first breeding, number of reproduction events, offspring characteristics (Spira, 1980; Cruden & Miller-Ward, 1981; Queller, 1984; Brunet & Charlesworth, 1995; Damgaard & Abbott, 1995). Weed species, defined as colonizers associated with human disturbance activities (Baker, 1965), are always invading new habitats. Uncertainty of abiotic and biotic conditions found in each habitat, like nutrients and the “pool” of pollinators may select self-compatible and self-pollinated breeding systems, unspecialized flower morphology, a greater investment in seed production improving colonizing ability, a low pollen/ovule ratio, a low biomass investment in attractive structures, like flowers, pollen and nectar (Baker, 1967; Abrahamson, 1975, 1979; Cruden, 1976; Graumann & Gottsberger, 1988).

Weed species are usually visited by many bee species, being the main pollen and nectar sources in highly disturbed areas, such as abandoned pastures, agricultural areas, and road sides. *Triumfetta semitriloba* Jacq (Tiliaceae) is a perennial facultative autogamous weed shrub (Collevatti *et al.*, 1997), occurring in tropical America. It is commonly found in abandoned pastures and other disturbed areas as roadsides and secondary forest boundaries and is highly resistant to drought stress, loosing almost all leaves, and resprouting when cut down (Collevatti, personal observation). Other study has already shown the importance of this plant species for many bee species in pastures (Cure *at al.*, 1993), although it lacks information about pollination ecology, such as effective pollinators and breeding system.

In this paper we present the study about pollination ecology of *T. semitriloba,* and specifically address the following issues: (1) flower morphology and anthesis; (2) flower visitors and pollinators.

MATERIAL AND METHODS

Field work was conducted on three patches in Viçosa (20°45’S, 42°50’W), in South-eastern Brazil (Minas Gerais), during the flowering season of 1993 and 1994 (March to May), a region characterized by a nutrient poor soil, highly disturbed by agricultural activities. Two patches were pasture areas: P1, with approximately 200 m^2, with 85 flowering individual; P2, a rectangular shaped area of 100 m^2, with 30 flowering plants of *T. semitriloba.* The third patch, P3, with approximately 200 m^2, was located in a secondary forest trail with 25 flowering plants of *T. semitriloba*, disposed in two parallel lines of plants, like a very narrow rectangle. All flowering plants of the three patches were marked and numbered.

Fifty flowers were randomly collected for morphological characterization. Flower anthesis was observed during one day, in each flowering month and patch. The number of opened flowers was counted periodically (30 min.), since the beginning of anthesis, at 13:00 hr, until the closure of all flowers (at about 19:00 hr). An analysis of covariance ANCOVA (Zar, 1974) was used to verify the effect of patch, month and time on the number of opened flowers. Mean differences were tested using an *a posteriori* Tukey test.

Some individuals of each flower visitor species were captured and identified, specially on the flowering season of 1993. Other individuals were eventually collected, on 1994, to confirm visual identification on the field. The activity and behavior of each flower visitor, while visiting flowers, were recorded. As visiting frequency to an individual flower was extremely low, it was observed the frequency of visits to flowering branches, in each month and patch. Five branches per plant were observed, and the frequency of visits was calculated as the number of visits per number of branches observed. A Kolmogorov-Smirnov Two Sample test was used to analyze the difference in visiting frequency between time, patches and flowering months. A Kolmogorov-Smirnov One Sample Test (Zar, 1974) was used to test uniformity of visits during anthesis time.

Percentage of *T. semitriloba* pollen grains on the pollen load of the most frequent bee species was determinate. Ten up to 15 female bees were captured per species, and pollen cleaned from scopae was stored in glacial acetic acid and counted under stereoscopic microscope.

RESULTS

T. semitriloba flowers are actinomorphic and conspicuous yellow (Fig. 1). Despite the existence of five nectaries on the base of ovary, nectar secretion is rather small, therefore it was not possible to collect nectar for analysis.

Flowers opened sequentially, from 13:00 to 16:00 or 16:30 hr, when the first opened flowers started to close (Fig. 2). The moment of complete

Fig. 1 — General aspects of *Triumfetta semitriloba* flower, with actinomorphic simetry, conspicuous yellow petals, and easily accessible anthers, stigma and ovary base, where are located five nectaries.

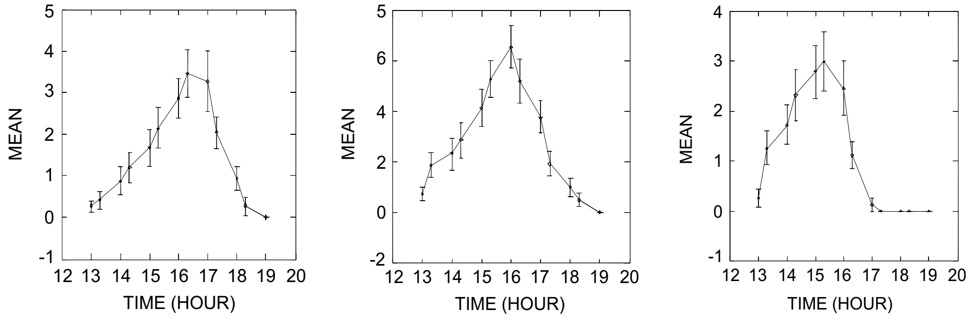

Fig. 2 — Sequential anthesis on *T. semitriloba,* in Viçosa, South-eastern Brazil. Mean and standard error of opened flowers during anthesis, for each patch (P1, P2 and P3), pooling all months.

closure differed for patches and flowering months. Flowers opened and closed early in P3, the secondary forest trail population. Number of opened flowers varied between patches, months and with time of anthesis (Table 1). Mean number of opened flowers was higher in P2 than in P1 and P3, when we get the three months of flowering (Table 2), but differences between months were not clear-cut.

Sixty three species of insects were registered on flowers of *T. semitriloba* (Appendix I). Bee species of the family Halictidae were the most abundant visitors (N = 10), followed by Megachilidae (N = 8) and Anthophoridae (N = 7) (Appendix I). Apidae and Colletidae were poorly represented. Concerning the three patches, bee species richness (S) was higher in P1 (S = 17), followed by P2 (S = 14) and P3 (S = 6). None of the bee species were found in the three patches – P1 and P2 shared some species, probably due to habitat resemblance (both were pasture areas). Considering behavior when collecting pollen or nectar, which allowed impregnation of the stigma with pollen, together with visiting frequency and percent of *T. semitriloba* pollen on pollen load (100% for all of them, except for *Augochlorella michaelis* which was 81%) the following species were the main pollinators: *Augochloropsis cupreola*, *Augochlorella michaelis*, *Cressomiella aff. sussurans*, *Cressomiella sussurans, Cressomiella* sp., *Pseudocentron paulistana*, *Ceratinula* sp1, *Ceratinula* sp2 and *Ceratinula* sp3, *Melissodes sexcincta*, *Apis mellifera*, *Plebeia cf. nigriceps*, *Plebeia droryana*. The other species were considered as eventual pollinators (low visiting frequency): *Augochloropsis* sp., *A. aurifluens*, *A. cf. argentina*, *A. cf. cleopatra*, *A. electra*, *Augochlora esox*, *A. foxiana*, *Hypanthidium rubiventris, Cressomiella bertonii, Megachile tuberculifera, Pseudocentron cf. aetheria*, or opportunists (nectar collection without pollination), *Dialictus* sp., *Xylocopa suspecta*, *Paratetrapedia* sp1 and sp2, *Ptiloglossa cf. pretiosa* and *Ptiloglossa* sp.

Frequency of bee visitation, during anthesis, was not different between patches, considering the mainly pollinators ($p > 0.10$, for all species). Pooling the patches where the species occurred, frequency of bee visitation was not uniform during anthesis (Table 3). Visitation frequency was higher between 15:00 and 17:00 hr. There was no visiting between 13:00 and 14:00 hr, and after 18:30 hr.

DISCUSSION

Triumfetta semitriloba can be considered a facultative autogamous species, ripening fruits and viable seeds even in the absence of pollinators (Collevatti *et al.,* 1997). A low pollen/ovule ratio agreed with this result (Collevatti, 1995), following Cruden (Cruden, 1976; Cruden & Miller-Ward, 1981). Other characteristics agree to the expected by theory for colonizers species: the flower presents polifilic characteristics (Faegri and van der Pijl, 1971), a low investment in attractive structures, such as nectar, pollen and showy petals (Cruden, 1976; Cruden and Miller-Ward, 1981; Graumann and Gottsberger, 1988).

Actinomorph symmetry, with periant free components allow easy access to resources (pol-

TABLE 1
Analysis of covariance (ANCOVA) for patch, flowering month and anthesis time effects on the number of opened flowers on *T. semitriloba*, in Viçosa, South-eastern Brazil.

Source	SQ	DF	F	P
Patch	14.223	2	3.596	0.028
Month	23.119	2	5.844	0.003
Time	692.853	1	350.301	< 0.001
Patch * Month	63.801	4	8.064	< 0.001
Patch * Time	9.181	2	2.321	0.099
Month * Time	11.227	2	2.838	0.059
Patch * Month * Time	20.497	4	2.591	0.036
Error	1123.435	568		

TABLE 2
Mean number of opened flowers of *T. semitriloba*, per month and patch, and standard deviation, in Viçosa, South-eastern Brazil.

	Patch - P1		Patch - P2		Patch - P3		
Month	Mean[1]	SD	Mean[1]	SD	Mean[1]	SD	N[2]
March	9.262[a]	14.574	5.892[b]	14.533	5.046[e]	5.100	65
Abril	9.769[a]	17.609	53.769[c]	64.553	2.738[f]	6.140	65
May	4.200[a]	4.874	5.062[d]	4.603	1.662[g]	1.544	65
All	7.744[A]	13.659	21.574[B]	44.412	3.149[A]	4.879	195

[1] Means followed by the same small or capital letter did not differ, by *a posteriori* Tukey test, $p > 0,05$.
[2] The total number of observations (N) in each month was equal for all patches.

TABLE 3
Visiting frequency of the main pollinators to flowered branches of *T. semitriloba*, during anthesis time, joining the months and patches.

Species	Anthesis Time									
	14:00	14.30	15.00	15.30	16:00	16:30	17:00	17:30	18:00	18:30
Augochloropsis cupreola[1]	0,0	0,4	0,6	0,4	0,6	0,4	0,6	0,4	0,0	0,0
Augochlorella michaelis[2]	0,2	0,4	0,8	0,6	0,4	0,8	0,6	0,0	0,0	0,0
Pseudocentron paulistana[3]	0,4	0,4	0,2	0,6	0,6	0,2	0,2	0,0	0,0	0,0
Cressomiella spp[4]	0,0	0,4	0,0	1,2	0,4	0,8	0,2	0,2	0,0	0,2
Melissodes sexcincta[5]	0,0	0,6	1,2	0,6	1,0	1,0	0,4	0,6	0,4	0,0
Ceratinula sp1[6]	0,0	1,2	1,8	0,8	0,6	0,0	0,0	0,0	0,0	0,0
Ceratinula sp2 and sp3[7]	0,4	0,2	1,4	1,0	0,6	0,0	0,0	0,0	0,0	0,0
Apis mellifera[8]	0,0	0,2	0,2	0,2	0,4	0,6	0,6	0,6	0,2	0,2
Plebeia droryana[9]	0,4	0,4	0,0	0,6	0,2	0,2	0,0	0,0	0,0	0,0
Plebeia cf. nigriceps[10]	0,6	1,2	0,8	0,6	0,4	0,0	0,0	0,0	0,0	0,0

Results for visiting frequency distribution uniformity: [1] $N = 270$, $md = 0.937$, $p < 0.001$; [2] $N = 40$, $md = 0.750$, $p < 0.000$; [3] $N = 240$, $md = 0.946$, $p < 0.001$; [4] frequencies correspond to the sum of the three species of *Cressomiella*; [5] $N = 348$, $md = 0.914$, $p < 0.001$; [6] $N = 91$, $md = 0.901$, $p < 0.001$; [7] frequencies correspond to the sum of the two species of *Ceratinula*; [8] $N = 348$, $md = 0.956$, $p < 0.001$; [9] $N = 70$, $md = 0.929$, $p < 0.001$; [10] $N = 60$, $md = 0.904$, $p < 0.001$.

len and nectar), and really attract many species of insects. Although individual flowers are very small to be attractive from a distance, their showy color (yellow), the distribution of individual plants within patches, and flowering synchronism within-plant and patch may result in a conspicuous resource for bee pollinators (Heinrich and Raven, 1972; Augspurger, 1980).

Flowering phenology can be classified as a modified steady state (Gentry, 1974), with a long flowering season (three months), and a high number of flowers opening every day. Variance in flower opening, between individual plants and patches, was too high due to differences in plant size or nutritional and water stress (Weiner, 1988; Wagner 1989). Plants in P1 were submitted to water stress during dry season, and lost their leaves. Patch P2 was situated along a stream and P3 in a forestry gap, and plants did not lose leaves. Besides this, P3 was similar to P1, in mean number of opened flowers, probably because of a higher allocation of resources to vegetative structures, due to a low light incidence inside the forest. It was observed that leaves in P3 were larger than on P1 and P2 (Collevatti, personal observation).

Only Apoidea species were effective pollinators. Therefore, Formicidae species such as *Zacryptocerus pusillus* and *Pseudomyrmex graci-*

lis, that visit the extrafloral nectary of *T. semitriloba* (Collevatti, 1995), visited flowers to collect nectar. Hence, while passing on the flower, some pollen grain may reach the stigma. Chrysomelidae beetles, *Pseudodiabrotica* sp1 and *Pseudodiabrotica* sp2, were the main flower herbivores, damaging the petals, sepals, anthers and stigma. It is possible that some pollen grains carried by these species reach the stigma, but pollination may be counteract by stigma damage. Activity of these species on flowers did not displace bee species, like *Augochlorella michaelis, Plebeia cf. nigriceps* or *Ceratinula* spp.

Although pollen was the main resource found in *T. semitriloba* for bees pollinators, many species visited flowers for nectar. Pollen flowers are specially visited by solitary bees (Heinrich, 1975), that gather pollen for their nest, and nectar requirement is lower than for social bees, that collect nectar for the colony. Nevertheless, flower choice may be correlated with body size, which is correlated with energetic requirements (Heinrich & Raven, 1972; Heinrich, 1975). Bees with larger body size need more energy for metabolism and flight, hence this kind of bee may be less frequent than small sized bees in flowers with low content of nectar. The pollinators of *T. semitriloba* were mainly solitary or subsocial species (Augochlorini); just three species were eusocial: *Apis mellifera*, *Plebeia droryana* and *Plebeia cf. nigriceps*. The two species of *Plebeia* foraged in groups of four or five individuals per flower. Bees of larger body size were not common, and three species, *Xylocopa suspecta, Ptiloglossa* sp. and *Ptiloglossa cf pretiosa* were not effective pollinators.

The commonest bees *Melissodes sexcincta, Pseudocentron paulistana, Cressomiella sussurans, Cressomiella aff. sussurans* and *Cressomiella* sp. (medium sized bees) collected nectar while collecting pollen. There was not a temporal switch in pollen and nectar collection. Two male individuals of *Melissodes sexcincta* were observed collecting nectar, but visited only a small number of flowers, like a sampling behavior. Even bees that collected pollen and nectar with the same frequency (*Augochloropsis cupreola* and *Ceratinula* sp1) did not switch nectar and pollen collection periods. Probably, all these species were collecting nectar in another patch of flower species, if nectar quantity of *T. semitriloba* was not sufficient (Zimmerman, 1982b; Plowright & Laverty, 1984).

Bees that collected nectar with the same or higher frequency than pollen, *Augochlorella michaelis*, *Ceratinula* sp1, *Ceratinula* sp2, *Ceratinula* sp3 and *Dialictus* sp., were bees of small body size and were collected in P3, excepting *Dialictus* sp.

Although *T. semitriloba* flowering season matches with other plant species, the main pollinators were constant to its flowers, inferring from pollen load. Flower constancy may be established by resource presentation (attractiveness), manipulation facility, reward quantity or quality (Free, 1970; Heinrich, 1975). These factors provide information about the resources that are associated to some flower characteristics, such as color (specially for bees), forming an “image search”, decreasing the cost of flower manipulation or resource recognition (Shettleworth, 1984; Krebs & Kacelnik, 1991). For *T. semitriloba* pollinators, flower constancy may be conditioned by flowering synchrony (conspicuous and abundant resource) and an easy access to resource (polifilic flower). This may explain why some generalists bee species, such as *Apis mellifera* and *Plebeia* spp. presented 100% of *T. semitriloba* pollen grains on pollen load. Many studies have shown that *A. mellifera* prefers flower constancy foraging strategy than others (e.g. cost or variance minimization or intake maximization) (Wells & Wells, 1983, 1984, 1986).

Bees visiting frequencies where not uniform but there was not a clear-cut pattern. Frequencies were low, for all species, probably due to flower opening and resource availability patterns. Flowers opened sequentially and the number of flowers increased until 16:00 hr. As flowers were opening a low number of visits depleted all pollen resource in a flower. Therefore, the high number of opened flowers did not reflected a high level of resource, since a great number of flowers were already depleted, showing that number of flowers is not a good predictor of pollen resource level (Tepedino & Staton, 1982; Zimmerman & Pleasants, 1981). Hence, flower opening pattern (sequential) and depletion of pollen by bee visits may cause a patchy distribution of resource, with “hot spot” of just opened or non-visited flowers with pollen and “cold” already visited flowers, and a low rate of visit per flower.

This pattern may have an important effect on pollinators behavior and hence, on gene flow. Optimal foraging theory predicts short distance flight, minimizing costs of flight thus, maximising fitness (Heinrich, 1975; Pyke, 1984). Distances may be shorter for bees collecting pollen (Zimmerman, 1982a). Therefore, autogamy and geitonogamy rate would be higher when bees fly to nearest neighbors, such as *T. semitriloba* pollinators do (Collevatti, 1995). Plants may increase xenogamy driving pollinators to visit more flowers and fly longer distances - by a low nectar production, a high temporal and spatial variability in nectar production, a low flower production per plant (Heinrich & Raven, 1972; Augspurger, 1980; Zimmerman, 1988; Ott *et al.,* 1985). For *T. semitriloba*, which produces many flowers per individual plant, inter-plant movement, thus rate of xenogamy, could be increased by a sequential opening and a randomly patch distribution of resource.

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APPENDIX 1

Flower visitors of *T. semitriloba*, in Viçosa, South-eastern Brazil, patches where they were encountered, resource utilized (Res.: Floral Herbivore=H; Nectar=N, Pollen=P) and total number of individuals recorded (N).

Species	Patch	Res	N[1]
HYMENOPTERA – APOIDEA			
ANTHOPHORIDAE			
Ceratinula sp.1(Moure, unpublished)	P3	P - N	35
Ceratinula sp.2	P3	P - N	ind.
Ceratinula sp. 3	P3	P - N	ind.
Melissodes sexcincta (Lepeletier, 1841)	P1 & P2	P - N	77
Paratetrapedia (Lophopedia) sp.	P1	N	1
Paratetrapedia (Paratetrapedia) sp.	P3	N	1
Xylocopa (Neoxylocopa) suspecta (Moure and Camargo, 1988)	P2	N	4
APIDAE			
Apis mellifera (Linnaeus, 1758)	P1 & P2	N - P	31
Plebeia cf. nigriceps (Friese, 1901)	P3	P	35
Plebeia droryana (Friese, 1900)	P2	P	20
Tetragonisca angustula (Latreille, 1811)	P1	N	1
COLLETIDAE			
Ptiloglossa cf. pretiosa (Friese, 1898)	P2	N	3
Ptiloglossa sp.	P1	N	3
HALICTIDAE			
Augochlora (Augochlora) foxiana (Ckll., 1900)	P1	N	1
Augochlora (Oxystoglosella) esox (Vachal, 1911)	P1	N	1
Augochlorella michaelis (Vachal, 1911)	P3	N - P	28
Augochloropsis aurifluens (Vachal, 1903)	P2	P	1
Augochloropsis cf. argentina (Friese, 1908)	P1	N	1
Augochloropsis cf. cleopatra (Scrottky, 1902)	P2	N	1
Augochloropsis cupreola (Ckll, 1900)	P1 & P2	P - N	40

APPENDIX 1 (*continuing*)

Species	Patch	Res	N[1]
HALICTIDAE (*cont.*)			
Augochloropsis electra (Smith, 1853)	P2	N	1
Augochloropsis sp.	P2	N	1
Dialictus (Chloralictus) sp.	P1 & P2	N - P	25
MEGACHILIDAE			
Cressomiella (Austromegachile) sussurans (Haliday, 1836)	P2	P - N	ind.
Cressomiella (Austromegachile) aff. sussurans	P1 & P2	P - N	ind.
Cressomiella (Austromegachile) sp.	P1	P - N	ind.
Cressomiella (Ptilossaurus) bertonii (Schrottky, 1908)	P1	N	1
Hypanthidium rubiventris (Moure)	P1	P - N	6
Megachile (Dactylomegachile) tuberculifera (Schrottky, 1913)	P1	N	1
Pseudocentron (Leptorachis) cf. aetheria (Mitchell, 1930)	P1	P	1
Pseudocentron (Leptorachis) paulistana (Schrottky, 1902)	P1 & P2	P - N	56
HYMENOPTERA – OTHER			
FORMICIDAE			
Crematogaster sp.	P1	N	15
Pseudomyrmex gracilis (F.)	P1	N	ind.
Zacryptocerus pusillus (Klug)	P1 & P2	N	ind.
CHALCIDIDAE			
Chalcididae sp1	P2	N	1
CHRYSIDIDAE			
Hedychrum sp.	P1	N	1
VESPIDAE			
Mischocyttarus sp.	P2	N	13
Polybia ignobilis (Haliday)	P1	N	6
Polybia scutellaris (White)	P1	N	4
Polybia sp.	P1	N	2
Proctonectarina sylveirae (Saussure)	P2	N	7
COLEOPTERA			
BRUCHIDAE			
Acanthocelides sp.	P1 & P2	N - H	ind.
CHRYSOMELIDAE			
Diabrotica speciosa (Germar)	P1	N - H	2
Lexiphanes sp1.	P1	N - H	1
Lexiphanes sp2.	P1	N - H	1
Nodonata sp.	P2	N - H	1
Pseudodiabrotica sp1	P3	P - H	ind.
Pseudodiabrotica sp2	P3	P - H	ind.
Sphaeropis sp.	P2	N - H	1

APPENDIX 1 (*continuing*)

Species	Patch	Res	N[1]
DIPTERA			
OTITIDAE			
Euxesta sp.	P1	N	4
TEPHRITIDAE			
Dictyotrypeta sp.	P2	N	9
Tephritidae sp1	P1 & P2	N	4
Tephritidae sp2	P2	N	7
HEMIPTERA			
MIRIDAE			
Horciasinus segnoreli	P3	N	23
NEIDIDAE			
Jalysus sp.	P3	N	11
PENTATOMIDAE			
Mormidea sp.	P3	N	1
PHYRRHOCORIDAE			
Dysdelcus sp.	P3	N	17
Hypselorotus fulvus	P3	N	26
SCUTELERIDAE			
Scuteleridae sp1	P3	N	1
TINGIDAE			
Tingidae sp1	P1 & P2	N	7
LEPIDOPTERA			
HESPERIDAE			
Urbanus sp.	P1	N	1
Hesperidae sp1	P2	N	3
PAPILIONIDAE			
Papilio andrisiades (Esper, 1788)	P2	N	1

[1] ind. (indeterminate), cases which were not possible to determine the number of individual, due to the great number of them on the flowers, or in the cases of *Cressomiella* species or *Ceratinula* sp2 and *Ceratinula* sp3, it was not possible to distinguish them on the field.

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