ENTOMOFAUNA ASSOCIATED TO THE FLORATION OF *Schinus Terebinthifolius* RADDI (ANACARDIACEAE) IN THE RIO GRANDE DO SUL STATE, BRAZIL

ENTOMOFAUNA ASSOCIADA À FLORAÇÃO DE *Schinus terebinthifolius* Raddi (Anacardiaceae) NO ESTADO DO RIO GRANDE DO SUL, BRASIL

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ABSTRACT: Considering the importance of *Schinus terebinthifolius* in Brazilian ecosystems, this study aimed to investigate the floral visiting insects, and verify their efficiency in pollen transport. Were collected 1.624 insects belonging to eight orders and 64 families on the flowers of one individual of *S. terebinthifolius*. Diptera showed higher family richness with 17, followed by Hymenoptera with 12 and Hemiptera with 11. Vespidae and Apidae, with 616 and 317 individuals respectively, were the families with the greatest number of individuals collected. 92.0% of these insects had pollen attached to their body, which confirms the importance of the individuals of these groups as pollen vector and potential pollinators.

KEYWORDS: Ecology. Flower visitors. Hymenoptera. Insects. Pollen vectors.

INTRODUCTION

Schinus terebinthifolius Raddi (Anacardiaceae), known popularly as "aroeira-vermelha" (Brazil) or "brazilian-pepper-tree" (Europe and U.S.A), is a native species from South America, varying from small crawling shrubs to medium trees (15 meters high), presenting large distribution within this continent (BACKES; IRGANG, 2002; FLEIG, 1987; FLEIG; KLEIN, 1989). Several researches about *Schinus terebinthifolius* have been done in Brazil, showing its importance to ecosystems and uses (AMORIM; SANTOS, 2003; BAGGIO, 1988; FENNER et al., 2006; LUCENA et al., 2006; MEDEIROS et al., 2007; NUNES JR. et al., 2006), floral biology (LENZI; ORTH, 2004) and floral visitors (LENZI et al., 2003; SÜHS et al. 2009).

Biodiversity conservation represents a great challenge for the human society nowadays, once ecosystems have been destroyed due to exploration of natural resources. The landscape fragmentation is one of many other consequences of this destruction, which reduces the animal flux and consequently the pollen and seeds dispersion (LOPES et al., 2007). Measuring species richness and diversity of some functional groups of animals, especially invertebrates, can contribute to evaluate fragmentation of ecosystems (KREMEN et al., 1993).

Insects represent about 75% of the planet fauna (SPEIGHT et al., 1999); large geographic distribution and great adaptation related to different habitats and alimentary habits show the excellence of this group to evidence ecosystems changes (SAMWAYS, 1995). They occupy an important place in interactions process between plants and animals (CONSTANTINO et al., 2002). Furthermore, almost all of plants species in tropical forests are pollinated by animals (BAWA, 1990; FREITAS, 1998).

Hymenoptera is the most studied and well known order, including many pollen-vector species of many species of plants (AMARAL; ALVES, 1979; BERTIN, 1989; CREPET, 1983; LENZI et al., 2003; PERCIVAL, 1965). Thus, bees are the most mentioned group in world literature, due to the their efficiency in pollination of a diverse group of flowering plants (GRISWOLD et al., 1995; WILMS et al., 1997).

Considering the importance of this species in plant succession in Brazilian ecosystems and its uses, this work aimed to describe the community of floral visitors in one individual of *Schinus terebinthifolius,* in central region of Rio Grande do Sul state, Brazil.

MATERIAL AND METHODS

Study area - The study was carried out in Santa Cruz do Sul, located in the Central Region of Rio Grande do Sul state, Brazil. The predominant forest formation is the Seasonal Deciduous Forest (IBGE, 1986), and according to Koeppen's

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classification, climate is subtropical humid. During this study, the average temperature was 25.7 ºC with 1035.4 mm of total precipitation (data obtained from the laboratory of meteorology from the University of Santa Cruz do Sul).

Species biology - The morphological aspect of *Schinus terebinthifolius* varies according to its habitat, from small crawling shrubs to medium trees (15 meters high), but, in all cases, it is a pioneer species which presents large distribution within South America (BACKES; IRGANG, 2002; FLEIG, 1987; FLEIG; KLEIN, 1989)

According to Lorenzi (1992), *Schinus terebinthifolius* has the flowering period from September to January, however we must be careful when using this data since the high plasticity of the species with its wide geographical distribution makes it produce flowers in different periods among the year, more than one time or even during the whole year without interruptions. The flowers have fragrance which is an important mechanism to attract floral visitors and possible pollinators, especially bees Lenzi; Orth (2004).

The inflorescence is a terminal and axilar panicle, with small flowers (about 5 mm diameter); these are unisexual and present similar size in both male and female flowers; having a resinous receptacle; petals are white, ovate to elliptic (1.3-2.5 mm length); anthers are oblong, having less than 1 mm of length; (FLEIG; KLEIN, 1989; LENZI; ORTH, 2004). Pollen is tricolporate, circulaperturate and subprolate, being of 1.15 the reason between the polar axis to equatorial axis; the exin is homogenous, having the same thickness in overtures with other points; sexin is thicker than nexin (TAKEDA et al., 2000).

Collection - The flower visitors were collected in one individual of *Schinus terebinthifolius* (male), located in the west board of a deciduous forest fragment at coordinates 29º41'52.50'' S - 52º26'02.50'' W, at 46 meters above sea level.

The insect's captures started in May 2006 and went on until April 2007, with collecting frequency of two days per week, totaling 72 collection days and 144 hours, during the 12 months that the plant presented flowers. The captures of flower visitors were done manually with entomological nets by one collector. The material was prepared, pinned and deposited at the Coleção Entomológica de Santa Cruz do Sul (CESC). The determination of the respective orders and families obeyed the classification adopted by Triplemorn; Johnson (2004). Some individuals from Diptera and Hymenoptera orders were identified until genera or at specific level in order to enrich the results and discussions.

Analysis - All individuals collected were analyzed through binocular stereoscope microscope (40x), to verify the presence/absence of pollen grains attached to their exoskeleton. Specimens which had pollen aggregated (not dispersed grains) in one or more structures passed to the second stage of analysis. The second stage of the analysis was done in order to verify if the pollen that was found belonged to the studied plant species. The aggregated grains were removed from the exoeskeleton with an entomological nipple, observed in binocular optical microscope (1.000x) and then compared at *S. terebinthifolius*'s pollen.

RESULTS

Collection - Were collected 1.624 insects belonging to eight orders and 66 families (Tab. 1). Diptera showed higher levels of family richness (17), followed by Hymenoptera (12) and Hemiptera (11). These groups totalized 60.7% of all families collected. Some groups(such as Hemiptera, Odonata) were found not pollinating but waiting for the pollinators at the flowers in order to eat them or feeding on leaves (Orthoptera).

The orders with the largest number of individuals were Hymenoptera (1.094; 67.4%) and Diptera (376; 23.2%). Families with higher representation were Vespidae with 616 specimens (37.9%) and Apidae with 317 (19.5%) of the total collected insects. Together, these two families accumulate more than 85.0% of specimens of Hymenoptera. Calliphoridae, with 113 individuals and Syrphidae with 86, corresponded to 6.7% and 5.3%, respectively, of the species's floral visitors and 53.0% of the individuals from Diptera order.

Hymenoptera and Diptera represent more than 90% of the total of collected individuals, showing their importance regarding to flower visitation, pollen transport and possible pollination habits of the studied specimen of *Schinus terebinthifolius*.

Within Hymenoptera, the species with higher occurrence in Vespidae was *Polistes versicolor* (Oliver, 1792) with 113 individuals collected, followed by *Polybia fastidiosuscula* Saussure, 1854 (90 individuals). In Apidae, *Tetragonisca angustula* (Latreille, 1811) was represented by 178 individuals, followed by *Apis mellifera* L. 1758 (104 individuals). These species represented 44.3% of all himenopterans. Within Diptera, the family Calliphoridae was mostly

represented by species of *Lucilia* (107 individuals), and Syrphidae, by *Ornidia obesa* Fabricius, 1775 (35 individuals). These two species accounted for 37.8% of all flies.

The activity of insects visiting flowers showed a seasonal pattern, with the largest number of individuals collected in the autumn (52.2%), followed by winter (22.5%), summer (15.1%) and spring (10.2%).

Analysis - In 732 individuals (45.0% of the total) were found grains of pollen, being 594 of the order Hymenoptera (81.1%), 92 of Diptera (12.5%), 34 of Coleoptera (4.6%), six of Hemiptera (0.8%) and only one individual of the Lepidoptera (0.1%). From these 732 individuals, 53.3% were analyzed with optical microscope (1000x) as they contained significant clusters of pollen (more than 100 grains together), in which 362 belonged to Hymenoptera, 15 to Diptera, 12 to Coleoptera and one to Lepidoptera. In eight families belonging to Hymenoptera, seven to Diptera, six to Coleoptera, two to Hemiptera and one to Lepidoptera pollen was found.

Within Hymenoptera, the family with the highest number of individuals containing pollen was Vespidae with 346, and of which 44.2% were analyzed through optical microscope to verify if the pollen was from the studied specie. Apidae had 201 specimens containing pollen, and of these, 88.0% were analyzed in optical microscope.

In Diptera, the family with the highest number of individuals containing pollen was Syrphidae with 42, with 26.2% submitted to optical microscopic analysis. Calliphoridae had 38 specimens containing pollen and of these, only three were analyzed. All individuals analyzed by optical microscope had as dominant (> 95%) the *Schinus terebinthifolius* pollen.

The insects that were analyzed in optical microscope, 43.4% had the pollen found at their faces and 23.1% in the mouth pieces. 32.7% had pollen in the propleuron and 57.1% in the legs's area. In Apidae, the aggregated pollen found at the legs was specifically found at the corbiculae.

DISCUSSION

The seasonal pattern showed in the activity of insects can be explained by the number of other species flowering in these periods, which is relative small when compared to summer and spring (where the availability of resources is higher). Thus there was a higher incidence of individuals in autumn and winter (more than 77.0%).

Vespidae and Apidae had, together, 92.0% of the individuals with pollen attached and presented the higher percentage of analyzed individuals. 88.0% of individuals in Apidae were analyzed through optical microscope, while Vespidae 44.0%. This difference can be explained due to the presence of corbiculae in bees (KEVAN; BAKER, 1983; MALASPINA et al., 1991), which frequently presented high pollen quantity. Lenzi et al. (2003) showed that bees (Apidae) were the most frequent floral visitors of *S. terebinthifolius* in their study in Santa Catarina Island, Brazil, constituting the most important component of the community of floral visitors.

Vespidae presented great number of collected individuals and a good number of pollen analysis. The local of more adhered pollen were: face, propleuron and legs (especially in fore legs femurs), according to the flower visiting behavior. In the present study, wasps were also more representative than bees and also were responsible for the pollen transport. E BARROS (1998) considered wasps as effective pollinators of three species of *Erythroxylum* in central region of Brazil, because they were more representative than bees. SÜHS et al. (2009), in the same plant individual, showed that some species of wasps were responsible for transporting the pollen of this species.

In the present study, Syrphidae is considered the most important pollen vector within Diptera, because even with low number of collected individuals, this family presented pollen adhered in 45.6% of specimens, where 26.1% were analyzed in optical microscope and presented pollen of *S. terebinthifolius*. Part of Syrphidae species are specialized in flower visitation (CORLETT, 2004; PROCTOR et al., 1996). The adults feed by pollen and/or nectar (GILBERT, 1981, 1985) due to the high energetic cost used to keep them static while flying (GILBERT, 1981; OWEN, 1991; WRATTEN et al., 1995). In the studies of Endress (1994) and Proctor et al. (1996), sirphids were the main pollinators.

Table 1. Order and family list from individuals captured at the flowers of one individual of *Schinus terebinthifolius* during the study period (May 2006 to April 2007). The used parameters were: NI (Number of individuals), PL (Local of pollen adherence), PA (Number of individuals submitted to optical microscope analysis), PLA (Local of analyzed pollen), IA (Percentage of Individuals analyzed at optical microscope). N (No pollen attached), F (Face), Pp (Propleuron), L (legs), Mp (Mouth pieces).

Order/Family	NI	PL (40x)	PA	PLA (1000x)	IA(%)
COLEOPTERA					
Chrysomelidae	25	N(18)-F(4)-L(2)-F/Pp(1)	1	F(1)	4
Cantharidae	15	N(5)-F(3)-Pp(1)-L(1)-F/Pp(2)-Pp/L(1)-F/Pp/L(2)	6	F(2)-F/Pp(2)-F/Pp/L(2)	40
Curculionidae	9	N(1)-F(5)-F/Pp(2)-F/Pp/L(1)	1	F/Pp/L(1)	12,5
Lagriidae	6	F(3)-L(1)-F/L(1)-F/Pp/L(1)	4	F(2)-L(1)-F/Pp/L(1)	67
Cerambycidae	4	N(1)-F(2)-Pp(1)	0		0
Coccinelidae	3	N(3)	0		0
Carabidae	3	N(3)	0		0
Lampyridae	1	N(1)	0		0
Scarabaeidae	1	N(1)	0		0
DIPTERA					
Calliphoridae	113	N(75)-Mp(26)-L(6)-F/Mp(1)-F/L(1)-Mp/L(3)-F/Mp/L(1)	3	Mp(2)-Mp/L(1)	2,7
Syrphidae	86	N(44)-F(7)-Mp(17)-L(3)-F/L(5)Mp/L(4)-F/Mp/L(6)	11	Mp(4)-F/L(1)-F/Mp/L(6)	13
Sarcophagidae	58	N(54)-Mp(4)	0		0
Tachinidae	47	N(39)-Mp(7)-L(1)	0		0
Muscidae	32	N(32)	0		0
Asilidae	10	N(9)-F(1)	0		0
Bibionidae	10	N(7)-F(2)-F/Pp/L(1)	1	F(1)	10
Stratiomyidae	4	N(4)	0		0
Otitidae	2	N(2)	0		0
Tephritidae	2	N(2)	0		0
Cecidomyiidae	1	N(1)	0		0
Culicidae	1	N(1)	0		0
Dolichopodidae	1	N(1)	0		0
Empididae	1	N(1)	0		0
Micropezidae	1	N(1)	0		0
Neriidae	1	N(1)	0		0
Sciaridae	1	F(1)	0		0
Undet.	5	N(5)	0		0

HEMIPTERA					
Heteroptera					
Reduviidae	14	N(8)-Mp(5)	0		0
Miridae	6	N(5)-Mp(1)	0		0
Pentatomidae	5	N(5)	0		0
Lygaeidae	3	N(3)	0		0
Coreidae	2	N(2)	0		0
Nabidae	2	N(2)	0		0
Corizidae	1	N(1)	0		0
Pyrrhocoridae	1	N(1)	0		0
HEMIPTERA					
Auchenorrhyncha					
Cercopidae	6	N(6)	0		0
Cicadellidae	6	N(6)	0		0
Membracidae	2	N(2)	0		0
HYMENOPTERA					
Vespidae	616	N(270)-F(85)-Pp(56)-L(42)-F/Pp(34)-F/L(7)-Pp/L(14)-F/Pp/L(108)	153	F(56)-Pp(31)-L(17)-F/Pp(10)-Pp/L(3)-F/Pp/L(36)	24,8
Pompilidae	31	N(18)-Pp(2)-L(1)-F/Pp(3)-Mp/Pp(3)-F/Mp/Pp(2)-F/Mp/Pp/L(2)	11	L(1)-F/Pp(2)-F/Pp(2)- Mp/Pp(2)-F/Pp/Mp(2)-F/Pp/Mp/L(2)	35,5
Tiphiidae	31	N(15)-Mp(2)-Pp(4)- L(3)-F/Mp(1)-F/Pp(1)-Pp/L(1)-Mp/Pp/L(1)-F/Mp/Pp/L(3)	6	Mp(1)-F/Mp(1)-Mp/Pp/L(1)-F/Mp/Pp/L(3)	19,4
Formicidae	10	N(10)	0		0
Apidae	317	N(116)-F(1)-Mp(15)-L(124)-F/L(9)-Mp/L(40)-F/Mp/L(12)	177	L(95)-Mp(4)-F/L(8)-Mp/L(39)-L(20)-F/Mp/L(12)	55,8
Colletidae	8	N(8)	0		0
Crabronidae	15	N(11)-F(1)-Pp(1)-F/Mp/Pp(1)-Mp/Pp/L(1)	2	Pp(1)-Mp/Pp/L(1)	13,3
Halictidae	30	N(22)-Mp(3)-L(2)-Mp/L(3)	7	Mp(2)-L(2)-Mp/L(3)	23,3
Sphecidae	8	N(3)-Mp(1)-Mp/Pp(2)-F/Pp/L(1)-F/Mp/Pp/L(1)	5	Mp(1)-Mp/Pp(2)-F/Pp/L(1)-F/Mp/Pp/L(1)	62,5
Ichneumonidae	17	N(16)-F(1)	1	F(1)	5,9
Braconidae	10	N(10)	0		0
Leucospidae	1	N(1)	0		0
LEPIDOPTERA					
Nymphalidae	8	N(7)-Mp(1)	1	Mp(1)	12,5
Hesperiidae	3	N(3)	0		0

Pieridae	3	N(3)	0	0
Lycaenidae	2	N(2)	0	0
Arctiidae	2	N(1)	0	0
Noctuidae	2	N(2)	0	0
Sessidae	2	N(2)	0	0
Geometridae	1	N(1)	0	0
Zigaenidae	1	N(1)	0	0
Undet.	5	N(5)	0	0
NEUROPTERA				
Chrysopidae	3	N(3)	0	0
ODONATA				
Libelullidae	2	N(2)	0	0
Pseudostigmatidae	2	N(2)	0	0
ORTHOPTERA				
Acrididae	1	N(1)	0	0
Proscopiidae	1	N(1)	0	0
Tettigoniidae	1	N(1)	0	0
TOTAL	1.624	N(892)-F(112)-Mp(82)Pp(65)-L(187)-F/Mp(2)-F/Pp(43)-F/L(17)-Mp/Pp(5)-Mp/L(44)-Pp/L(16)-F/Mp/Pp(3)- F/Mp/L(19)-F/Pp/L(114)- F/Mp/Pp/L(6)	390	F(62)-Mp(15)-Pp(32)-L(127)-F/Mp(1)-F/Pp(14)-F/L(9)-Mp/Pp(10)-Mp/L(43)-Pp/L(3)-F/Mp/L(18)-F/Pp/L(41)-F/Mp/Pp/L(4)

We consider that small bees, some species of wasps and flies have more probability to pollinate this species, due to their needs of floral resources and due to the pollen found at their structures. According to (ANTONINI et al., 2005; QUIRINO; MACHADO, 2001; TAURA; LAROCA, 2004), the pollination efficiency is higher in groups that present small size and/or structures to attach pollen. Furthermore, the local of pollen's adherence is also an important factor to the effectiveness of pollination (SILVA, 2006; FRACASSO; SAZIMA, 2004). Face and mouth pieces of small wasps (Vespidae) had more contact with the anthers of the studied species. On the other hand, bees presented most part of pollen adhered at their corbiculae due to their specialization in pollen collection. The question that arises now is: which one was more efficient?

CONCLUSION

This study reveals how important can one plant individual be to attract biodiversity. Hymenoptera was the most representative group, presenting more species and individuals, where Vespidae and Apidae had the most part of individuals. Nevertheless, wasps presented more species and individuals than bees, and are considered important pollen vectors of the studied species. The local of pollen adherence in wasps were different from bees, where the first group presented pollen aggregated in face, propleuron and frontal legs while bees presented pollen aggregated at their corbiculae. This can be an important factor in the question of this species's pollination. We consider that small bees, some species of wasps and flies are responsible for pollinating this species.

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RESUMO: Considerando a importância de *Schinus terebinthifolius* nos ecossistemas brasileiros, objetivou-se com este estudo, conhecer as espécies de insetos visitante florais da aroeira-vermelha, bem como avaliar quais destes realizam o transporte de pólen. Coletou-se nas flores de um indivíduo, 1.624 insetos pertencendo a oito ordens e 64 famílias. Diptera apresentou maior riqueza em nível de família com 17, seguida por Hymenoptera com 12 e Hemiptera com 11. Vespidae e Apidae, com 616 e 317 indivíduos respectivamente, foram as famílias com maior número de indivíduos coletados. 92.0% dos insetos destas famílias apresentaram pólen aderido ao seu exoesqueleto, o que comprova a importância dos indivíduos destes grupos como vetores de pólen e polinizadores potenciais.

PALAVRAS-CHAVE: Ecologia, Visitantes florais, Hymenoptera, Insetos, Vetores de pólen.

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