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The drosophilid fauna (Diptera, Drosophilidae) of the transition between the Pampa and Atlantic Forest Biomes in the state of Rio Grande do Sul, southern Brazil: first records

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ABSTRACT

Although studies on drosophilid (Diptera, Drosophilidae) assemblages have become relatively abundant in the past decades, many environments remain to be searched. The present study investigates the composition, the species abundances and the richness of the drosophilid assemblages in two localities of the municipality of Cruz Alta, northwestern region of the state of Rio Grande do Sul, a point of contact between the biomes Atlantic Forest and Pampa: (i) an urban area (2007), constituted by a domestic orchard with Citrus *trees, and (ii) a forested area, in Centro de Educação, Pesquisa e Proteção Ambiental – CEPPA (2008/2009), of Universidade de Cruz Alta, located in a fragment of riparian forest. Collections were conducted using fermented banana-baited traps and repeated periodically. A total of 7,428 individuals were caught, belonging to two subfamilies, six genera and 53 species. In the urban area, 22 species were found, from two genera (N = 2,421), while in the forested area 46 species were found, from six genera (N = 5,007). Six exotic species were found, markedly more abundant in the urban area, where they corresponded to 95% of the specimens, in comparison to 50% in the forest. Between the Neotropical species, the most common were* Drosophila maculifrons *Duda and* D. polymorpha *Dobzhansky & Pavan. Only* D. simulans *Sturtevant was captured in all samples in both localities. The present survey represents the first records for the state of Rio Grande do Sul of the* D. canalinea *and* D. virilis *species groups and the species* D. arassari *Cunha & Frota-Pessoa,* D. fuscolineata *Duda,* D. nigricruria *Patterson & Mainland,* D. papei *Bächli & Vilela,* D. senei *Vilela,* D. trifilum *Frota-Pessoa,* D. virilis *Sturtevant,* Leucophenga maculosa *(Coquillett) and* Rhinoleucophenga obesa *(Loew). Furthermore, it also represents the first record for the state of the genera* Amiota *Loew,* Leucophenga *Mik and*

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Rhinoleucophenga *Hendel and of the subfamily Steganinae. So, the present survey raises the number of drosophilid species recorded for the state from 66 to 75, the number of genera from five to eight, and subfamilies from one to two.*

Keywords: *Drosophila;* Insecta; New records; Neotropical region; Species abundances.

INTRODUCTION

When an area loses a large proportion of its original habitat and especially when the remaining habitat is severely fragmented, it will eventually lose some of its species (Myers *et al.,* 2000). As stated by Magurran (1988), the species diversity of a community is one of the most important parameters in the determination of its structural elements. Species diversity may indicate various ecological processes, and may be used as a bioindicator of changes occurred in the studied environments, which was confirmed by Mata *et al.* (2008). Explaining the species diversity of a given locality, however, remains a major challenge for ecological science, and the factors and processes that maintain the number of species in a biological system are still unknown (Krijger, 2000).

According to Powell (1997), besides man, probably no other organism has been the object of so many studies as flies from genus *Drosophila.* This author also emphasized the importance of these flies as a model to elucidate some evolutionary processes. Furthermore, Krijger (2000) defends that *Drosophila* assemblages constitute useful models to the study of the impact of the environmental heterogeneity on species diversity.

The first data on Brazilian species of drosophilids were recorded by Duda (1925) and Dobzhansky & Pavan (1943). Since then, some studies have been carried out focused on the species composition of assemblages of drosophilids from different types of environments, as the Atlantic Rain Forest (De Toni *et al.,* 2007), the Caatinga (Malogolowkin, 1951), the Cerrado (Tidon, 2006), the Amazon forest (Martins, 1987), the Chaco and the Pantanal (Sene *et al.,* 1980), the restinga (Bizzo & Sene, 1982), the Araucaria forest (Saavedra *et al.,* 1995), the mangrove forests (Schmitz *et al.,* 2007) and urban areas (Ferreira & Tidon, 2005). In the state of Rio Grande do Sul, the southernmost state of Brazil, several studies have been performed, as those by Brncic & Valente (1978) and Silva *et al.* (2005).

Although several studies on drosophilid fauna have been carried out in the past decades, the knowledge on the distribution of species and the composition and structure of the wild assemblages remains incomplete. The northwestern portion of the state of Rio Grande do Sul is still widely unexplored, and the present study aims to bridge some gaps concerning the information on the composition of drosophilid faunas in natural and disturbed environments in southern Brazil. The drosophilid fauna in the Pampa Biome is considered as one of the least known in Brazil (Gottschalk *et al.,* 2008). This biome is dominated by grassland vegetations and is naturally invaded by arboreal contingents of representatives of deciduous seasonal forests and ombrophilous dense forests, particularly in its northern and eastern portions (MMA, 2007). The locality surveyed in the present study lies exactly in the region of contact between the Pampa and Atlantic Forest Biomes. This region is characterized by a mosaic of areas with grassland vegetations and gallery forests, although the grasslands have extensively been replaced by crops (Porto, 1990). The forest vegetation of this region is also subject to intense anthropogenic influence: while in the past they predominated in large areas, especially in the slopes and valleys of the northern half of Rio Grande do Sul, today they have been reduced to some riparian forests and other fragments in wet areas (Quadros & Pillar, 1990). The present study aims at providing the first inventory of the Drosophilidae fauna of this ecotone area of high environmental complexity and that unfortunately has also been the object of high human impact. Therefore, we present data from some collections carried out in two localities of the municipality of Cruz Alta, an urban area and a forest fragment.

MATERIAL AND METHODS

Study Area

The municipality of Cruz Alta is situated in the northwestern portion of the state of Rio Grande do Sul, southern Brazil (Fig. 1A). The climate is subtropical, with a wide range of temperatures throughout the year, and altitude is about 452 m. It is located in a region of contact between two biomes: officially, 63.2% of its territory belongs to the Atlantic Forest Biome and 36.8% to the Pampa Biome.

The results obtained in the present paper are derived from collections carried out in two areas of Cruz Alta, one in an urban area (in 2007) and another in a forest fragment (in 2008 and 2009). The collection site corresponding to the urban area was a domestic orchard with orange (*Citrus sinensis*) and lemon (*Citrus limon*) trees, in the locality of Vila Rocha (28°37'40"S; 53°36'21"W) (Fig. 1B), near downtown. It is a residential area and can be classified as an area of medium urbanisation level, following the criteria developed by Ruszczyk (1986/1987). The other collection site was situated in a forest fragment at Centro de Educação, Pesquisa e Proteção Ambiental (CEPPA) of the Universidade de Cruz Alta (UNICRUZ) (28°34'11"S; 53°36'53"W) (Fig. 1C). It is a fragment of deciduous seasonal forest, formed by a riparian forest near Cambará river, in a rural area.

Collecting Methodology and Identification

The specimens collected in the urban area (Vila Rocha) were caught using two traps consisting of plastic containers (14.5 x 12.0 x 9.0 cm) with an opening of 4 cm, and containing pieces of banana as bait. The traps were hung at about 1.5 m high in the trees and kept in the field for 24 hours. This procedure was repeated for a variable number of times each month (Table 1), when favourable weather conditions permitted. Samples were collected from April 2007 to December 2007. In the forest site (CEPPA), 50 Tidon & Sene (1988)'s traps were used in each collection. Five kilograms of banana seeded with baker's yeast were distributed between the traps and used as bait. The traps were hung at trees at about 1.5 m high and kept in the field for 3 days. Five collection trips were made: (i) 09-12 May 2008, (ii) 15-18 June 2008, (iii) 23-26 August 2008, (iv) 31 October to 03 November 2008 and (v) 31 January to 03 February 2009.

The samples were taken to the laboratory and each specimen collected was identified at the lowest taxonomic category feasible. The external morphology and the male terminalia were analysed consulting specialised literature. The specimens were maintained in ethanol: distilled water: acetic acid: glycerol (6: 4:

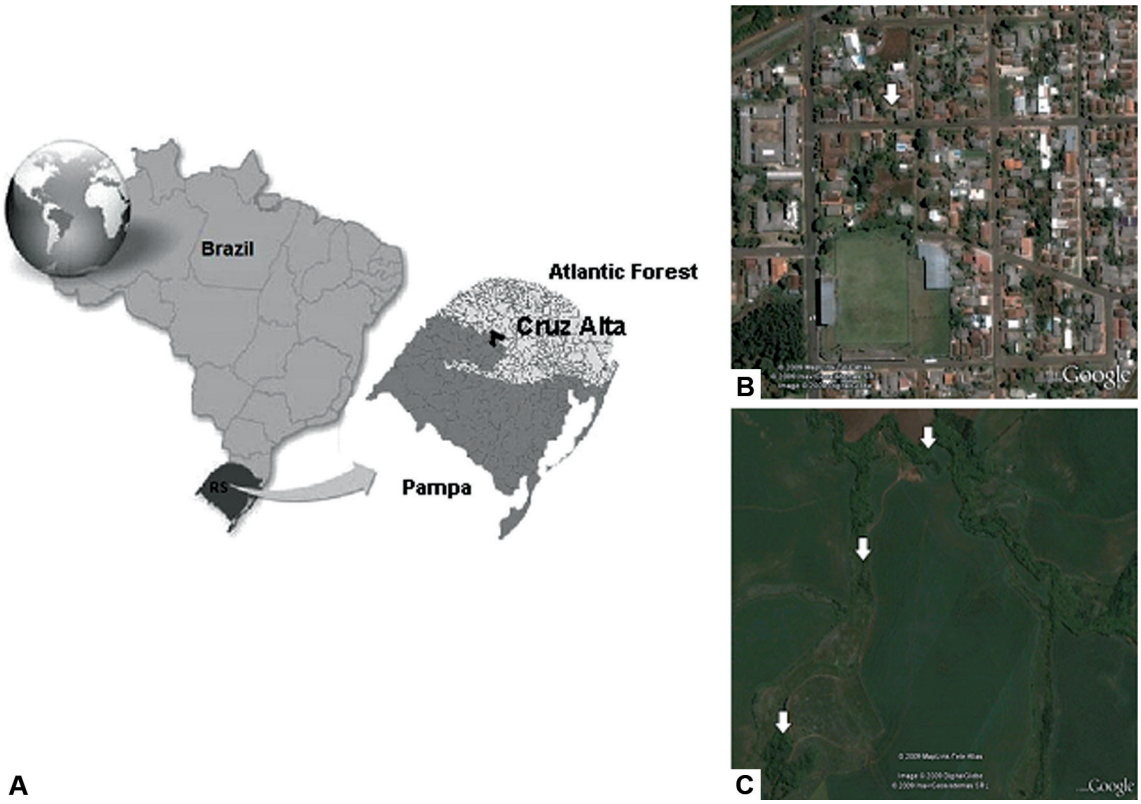

FIGURE 1: Study area: **A)** Map of Brazil and of the state of Rio Grande do Sul, showing the location of Cruz Alta, in the contact zone between the two biomes: Atlantic Forest (in the North) and Pampa (in the South). **B)** Vila Rocha, in the urban zone of Cruz Alta. **C)** Centro de Educação, Pesquisa e Proteção Ambiental (CEPPA), in a fragment of riparian forest within a rural zone. B and C in the same scale; arrows indicate points of collections.

TABLE 1: Taxonomic list and abundances of Drosophilidae species collected in Vila Rocha, in the urban area of Cruz Alta, RS, Brazil (April-December 2007). *Exotic species; ** First record in state of Rio Grande do Sul.

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	%
Subfamily Drosophilinae											
Genus *Drosophila*											
Subgenus *Dorsilopha*											
D. busckii group											
* *D. busckii*	—	1	1	16	8	—	10	1	—	37	1.53
Subgenus *Drosophila*											
D. annulimana group											
** *D. arassari*	—	—	—	—	—	1	—	—	—	1	0.04
** *D. canalinea* group											
D. sp13	—	—	—	—	—	1	—	—	—	1	0.04
D. cardini group											
D. cardini	—	6	—	1	—	—	1	—	—	8	0.33
D. polymorpha	—	—	—	1	—	—	1	2	5	9	0.37
D. guarani group											
D. maculifrons	—	1	—	8	—	1	—	—	—	10	0.41
D. ornatifrons	—	3	—	1	—	—	1	1	—	6	0.25
D. immigrans group											
* *D. immigrans*	—	5	6	56	47	101	303	18	26	562	23.21
D. pallidipennis group											
D. pallidipennis	2	—	—	—	1	—	12	—	—	15	0.62
D. repleta group											
D. buzzatii	—	—	—	—	—	—	6	—	1	7	0.29
D. mercatorum	—	—	—	3	—	—	—	—	1	4	0.17
** *D. nigricruria*	—	—	—	—	1	—	—	—	1	2	0.08
D. zottii	—	—	—	—	1	—	—	—	—	1	0.04
unidentified	—	1	—	3	3	1	5	3	4	20	0.83
D. tripunctata group											
D. mediopunctata	—	—	—	6	—	—	—	—	—	6	0.25
D. mediostriata	—	—	—	—	1	—	—	—	—	1	0.04
D. sp.14	—	—	—	1	—	—	—	—	—	1	0.04
unidentified	—	2	—	4	5	—	2	—	2	15	0.62
** *D. virilis* group											
** * *D. virilis*	—	—	—	—	1	—	—	—	—	1	0.04
Subgenus *Phloridosa*											
D. denieri	—	—	—	—	2	—	—	—	—	2	0.08
Subgenus *Sophophora*											
D. melanogaster group											
* *D. simulans*	59	61	17	50	111	268	947	65	47	1625	67.12
D. willistoni group											
D. paulistorum	—	—	—	—	—	—	1	—	—	1	0.04
D. willistoni	—	1	—	—	—	—	—	—	—	1	0.04
Genus *Zaprionus*											
Z. armatus group											
* *Z. indianus*	65	17	—	3	—	—	—	—	—	85	3.51
Total	126	98	24	153	181	373	1289	90	87	2421	
Number of Collections	3	14	2	14	4	9	14	5	4	69	

TABLE 2: Taxonomic list and abundances of Drosophilidae species collected in CEPPA, a forest fragment in Cruz Alta, RS, Brazil (May 2008 – February 2009). *Exotic species; ** First record in state of Rio Grande do Sul.

	09/v/08 – 12/v/08 Autumn	15/vi/08 – 18/ vi/08 Autumn	23/viii/08 – 26/ viii/08 Winter	31/x/08 – 03/ xi/08 Spring	31/i/09 – 03/ ii/09 Summer	Total	%
Subfamily Drosophilinae							
Subgenus *Dorsilopha*							
D. busckii group							
* *D. busckii*	—	—	3	81	1	85	1.70
Subgenus *Drosophila*							
D. annulimana group							
** *D. arassari*	—	—	17	4	2	23	0.46
D. bromeliae group							
D. type IV	—	—	—	1	—	1	0.02
D. cardini group							
D. cardini	—	—	—	—	1	1	0.02
D. polymorpha	—	8	267	145	78	498	9.95
D. coffeata group							
** *D. fuscolineata*	—	—	—	1	—	1	0.02
D. guarani group							
D. maculifrons	2	12	124	479	4	621	12.4
D. ornatifrons	1	11	77	83	4	176	3.52
unidentified	1	30	—	—	—	31	0.62
D. immigrans group							
* *D. immigrans*	—	3	78	40	—	121	2.42
D. pallidipennis group							
D. pallidipennis	—	—	14	32	5	51	1.02
D. repleta group							
D. buzzatii	—	1	—	—	—	1	0.02
D. hydei	—	—	1	1	—	2	0.04
D. mercatorum	—	3	49	13	30	95	1.90
** *D. nigricruria*	—	—	—	15	—	15	0.30
D. onca	—	—	15	16	—	31	0.62
** *D. papei*	—	—	3	—	—	3	0.06
** *D. senei*	—	—	19	17	—	36	0.72
unidentified	1	2	88	50	15	156	3.12
D. tripunctata group							
D. bandeirantorum	—	—	4	6	—	10	0.20
D. mediopicta	—	—	5	14	—	19	0.38
D. mediopunctata	9	53	18	86	—	166	3.32
D. nappae	—	—	—	14	1	15	0.30
D. paraguayensis	—	—	13	9	—	22	0.44
D. roehrae	—	1	—	—	—	1	0.02
** *D. trifilum*	—	—	—	1	—	1	0.02
unidentified	40	64	67	145	—	316	6.31
Subgenus *Sophophora*							
D. melanogaster group							
* *D. kikkawai*	—	1	—	—	—	1	0.02
* *D. simulans*	10	2	542	425	1266	2245	44.84
D. willistoni group							
D. nebulosa	—	—	—	3	1	4	0.08
D. willistoni	7	—	30	—	54	91	1.82
unidentified	—	3	—	9	24	36	0.72
Undetermined species							

TABLE 2: Continued.

	09/v/08 – 12/v/08 Autumn	15/vi/08 – 18/ vi/08 Autumn	23/viii/08 – 26/ viii/08 Winter	31/x/08 – 03/ xi/08 Spring	31/i/09 – 03/ ii/09 Summer	Total	%
D. sp.1	—	—	—	2	—	2	0.04
D. sp.2	—	—	—	1	—	1	0.02
D. sp.3	—	—	—	2	—	2	0.04
D. sp.4	—	—	—	1	—	1	0.02
D. sp.5	—	—	—	1	—	1	0.02
D. sp.6	—	—	—	3	—	3	0.06
D. sp.7	—	—	—	1	—	1	0.02
D. sp.8	—	—	—	1	—	1	0.02
D. sp.9	—	—	—	1	—	1	0.02
D. sp.10	—	—	—	1	—	1	0.02
D. sp.11	—	—	—	—	1	1	0.02
D. sp.12	—	—	—	—	1	1	0.02
Genus *Zaprionus*							
Z. armatus group							
* *Z. indianus*	—	—	—	—	51	51	1.02
Genus *Zygothrica*							
Z. vittimaculosa group							
Z. vittimaculosa	1	—	10	—	—	11	0.22
Z. sp.1	—	—	1	—	—	1	0.02
unidentified	—	2	34	1	—	37	0.74
** Subfamily Steganinae							
** Genus Amiota							
Subgenus *Amiota*							
A. sp.1	—	—	1	9	—	10	0.20
** Genus *Leucophenga*							
** *L. maculosa*	—	—	—	4	—	4	0.08
** Genus *Rhinoleucophenga*							
** *R. obesa*	—	1	—	—	—	1	0.02
Total	72	197	1480	1718	1540	5007	

1: 1). For analysis of male terminalia, specimens were treated as in Bächli *et al.* (2004), with minor modifications. Females of unidentified species, when possible, were kept alive and individualised in vials with culture medium, in order to be identified through their respective male offspring. Some specimens of *willistoni* subgroup of *Drosophila* were identified by the electrophoretic pattern of the acid phosphatase-1 (*Acph-1*) (Garcia *et al.,* 2006).

RESULTS AND DISCUSSION

Overall, 7,428 specimens of drosophilids were collected, including members of two subfamilies, six genera and 53 species. In the urban area (Vila Rocha), 22 species were found, from two genera (N = 2,421), while in the forested area (CEPPA), 46 species were found, from six genera (N = 5,007). The complete taxonomic list and the abundance of each collected species are shown in tables 1 and 2.

According to the review conducted by Gottschalk *et al.* (2008), there are 61 species of drosophilids registered in Rio Grande do Sul. Considering also other five species recorded later by Garcia *et al.* (2008), this number raises to 66. In the present survey, we collected 28 of the previously recorded species, plus nine new records and 16 unidentified species. The nine new records are: *Drosophila arassari* Cunha & Frota-Pessoa, *D. fuscolineata* Duda, *D. nigricruria* Patterson & Mainland, *D. papei* Bächli & Vilela, *D. senei* Vilela, *D. triflum* Frota-Pessoa, *D. virilis* Sturtevant, *Leucophenga maculosa* (Coquillett) and *Rhinoleucophenga obesa* (Loew). This raises the total number of described species registered in Rio Grande do Sul to 75, an increase of 13.6%. This represents also the first record of the subfamily Steganinae, the genera *Leucophenga* Mik and *Rhinoleucophenga* Hendel, and

the *D. virilis* group for the state. In the majority, the unidentified species probably represent undescribed species. Between them, there are species from the *D. canalinea* group and the genus *Amiota* Loew, taxa that had likewise not been recorded in the state before. These records show that the drosophilid fauna of Rio Grande do Sul is still incompletely known, despite being one of the most sampled areas in Brazil.

Six exotic species were found: *D. busckii* Coquillett, *D. immigrans* Sturtevant, *D. kikkawai* Burla, *D. simulans* Sturtevant, *D. virilis* Sturtevant and *Zaprionus indianus* Gupta. The number of exotic species remained the same in the two areas (five), but their abundance was, as expected, much higher in the urban area (Vila Rocha), where they accounted for 95.4% of the collected specimens, while in the forest area (CEPPA), they reached 50.0%. The assemblage of Vila Rocha was highly dominated by exotic species, the most abundant being *D. simulans* (67.1%), followed by *D. immigrans* (23.2%), *Z. indianus* (3.5%) and *D. busckii* (1.5%). Between the Neotropical species, the most abundant was *D. pallidipennis* Dobzhansky & Pavan, which however did not reach 1%. *Drosophila simulans* was the most abundant species also in the forested area (CEPPA), but with a lower relative abundance (44.8%). Contrastingly, in this site it was followed by Neotropical species: *D. maculifrons* (12.4%), *D. polymorpha* (10%), *D. ornatifrons* Duda (3.5%) and *D. mediopunctata* Dobzhansky & Pavan (3.3%). Although the two areas can not been directly compared due to differences in collecting techniques, it is probable that the environmental differences are the main factor causing the marked differences in species abundances.

Comparing these results with the drosophilid assemblages recently characterised in the city of Porto Alegre, Rio Grande do Sul (Silva *et al.,* 2005; Garcia *et al.,* 2008), and in the neighbouring state of Santa Catarina (De Toni *et al.,* 2007; Gottschalk *et al.,* 2007; Schmitz *et al.,* 2007; Döge *et al.,* 2008), some differences are remarkable. In those assemblages, *D. willistoni* Sturtevant is commonly the most abundant Neotropical species, in some cases reaching relative abundances higher than 50% in forested areas and relatively high abundances even in the cities. In the present survey, just one single individual out of 2,241 was found in the urban area. This species, however, normally raises in abundance during summer (De Toni & Hofmann, 1995), when we did not take samples in this area. However, its abundance in the other seasons was also strikingly reduced when compared to the studies cited above. Furthermore, these studies normally show a high dominance of this species in forested areas, while in the forested area sampled by us in Cruz Alta it was surpassed in abundance by various other species, being only the eighth most abundant. Curiously enough, the most abundant Neotropical species was *D. maculifrons,* which reached 12.4% in the forested area, contrasting with a very lower abundance shown in the cited papers above (in general, <1%). In turn, *Z. indianus,* soon after its recent invasion of the Brazilian territory, became the second or first most abundant species in urban assemblages. In Vila Rocha, however, its abundance (only 3.5%) is very far from that shown by *D. simulans* and is even below that of *D. immigrans,* another exotic species. Furthermore, its abundance was concentrated on the warmer periods, being even absent in many samples. This low abundance may be partially biased by the lack of summer samples in this area, although the abundances in the other seasons also seem to be markedly lower when compared to other studies. *Drosophila immigrans,* on the other hand, although frequently collected in other studies, in general shows relative abundances below 2%, contrasting with 23.2% found by us in Vila Rocha. Finally, the exotic species *D. malerkotliana* Parshad & Paika, very common in Santa Catarina and recently found in Porto Alegre (Garcia *et al.,* 2005), was not detected in Cruz Alta and may not occur in the region. Another taxon commonly present in other South-Brazilian assemblages, the Neotropical *saltans* group, was also absent here.

Below, we briefly discuss some information about each taxon collected in Cruz Alta.

Subfamily Drosophilinae

Genus *Drosophila* Fallén

Unsurprisingly, this was the most common genus in our collections (N = 7,276; 97.9%), present in all samples. It was also the genus with the highest number of species (47 out of 53), including seven new records for the state of Rio Grande do Sul.

Subgenus *Dorsilopha* Sturtevant

This small subgenus comprises only the Oriental *D. busckii* group, with four species.

Drosophila busckii group – As other members of the group, *D. busckii* has Oriental origin, but is the only one that has acquired cosmopolitan status. It was found in both collection sites.

Subgenus *Drosophila* Fallén

This is the largest subgenus of *Drosophila.* Twenty-eight species from 11 species groups were found, representing 41.5% of the specimens.

Drosophila annulimana group – This group comprises species endemic to Neotropical region found preferentially in wet forests (Tosi & Pereira, 1993). *Drosophila arassari* was found in both collection sites, with one single individual in the urban area (Vila Rocha) and 23 individuals in the forest (CEPPA), most of which in winter. The only species of the *D. annulimana* group recorded in Rio Grande do Sul before were *D. schineri* Pereira & Vilela (Loreto *et al.,* 1998) and *D. annulimana* (Garcia *et al.,* 2008).

Drosophila bromeliae group – This is a small group of flower-breeding species, rarely attracted to banana baits. One individual of an undescribed species was found in CEPPA. This species, here referred to as *D.* type IV, had previously been found by one of us (HJS) in Porto Alegre, RS.

Drosophila canalinea group – Only one female specimen was collected, in Vila Rocha, here denominated *D.* sp.13. We could not determine the species of this individual, but there is no previous record of this group in Rio Grande do Sul (Gottschalk *et al.,* 2008). Further collections of male specimens are necessary to confirm which species of the group are represented in the state.

Drosophila cardini group – This group consists of 15 Neotropical species, six of which present in Brazil, all from *Drosophila cardini* subgroup (Gottschalk *et al.,* 2008). In the present study, two of them were collected in both sites. *Drosophila cardini* Sturtevant, associated with open environments (Tidon, 2006), were more abundant in Vila Rocha, while *D. polymorpha,* a species relatively abundant in different morphoclimatic domains in Brazil (Sene *et al.,* 1980), showed an opposite pattern, being the third most abundant species in CEPPA, reaching about 10% of the sample in that site.

Drosophila coffeata group – This small and poorly known group is formed only by four Neotropical species, three of which recorded in Brazil (Gottschalk *et al.,* 2008). One species of this group was collected, represented by one single individual of *D. fuscolineata* in CEPPA, representing the new southernmost locality of its known distribution. One single species of this group were recorded in Rio Grande do Sul before, *D. pagliolii* Cordeiro (Cordeiro, 1963).

Drosophila guarani group – Two species were found: *D. maculifrons* (*D. guaramunu* subgroup) and *D. ornatifrons* (*D. guarani* subgroup). Both were more abundant in the forest (CEPPA) during winter and spring. They were, respectively, the second and fourth most abundant species in the forest fragment (CEPPA), totaling 12.4% and 3.5% of the sample in that site, respectively.

Drosophila immigrans group – It is a large Oriental group, with *D. immigrans* reaching cosmopolitan status. It was found in both collection sites, but mainly in the urban area. During winter and spring it was collected at relatively higher numbers, also in the forest fragment (CEPPA).

Drosophila pallidipennis group – One single-species group, constituted only by the Neotropical species *D. pallidipennis.* It was found in both collection sites and was the most abundant Neotropical species in Vila Rocha, though it did not reach 1% of the sample. In CEPPA, it occurred especially during winter and spring.

Drosophila repleta group – The largest Neotropical group of *Drosophila,* eight species from five subgroups were found in Cruz Alta. The three species of *D. fasciola* subgroup were found exclusively in the forest, especially during winter and spring. The collection site adopted in the present study is the new southernmost locality for *D. papei* and *D. senei.* The other species of the subgroup found was *D. onca* Dobzhansky & Pavan. The species of the *D. mulleri* subgroup, *D. buzzatii* Patterson & Wheeler and *D. nigricruria,* occurred in both sites. The most abundant species of the group were *D. mercatorum* Patterson & Mainland (*D. mercatorum* subgroup), collected especially in CEPPA. The other two species were found in low numbers, *D. hydei* Sturtevant (*D. hydei* subgroup) in CEPPA and *D. zottii* Vilela (*D. repleta* subgroup) in Vila Rocha.

Drosophila tripunctata group – With 10 species found, this was the most diverse group of our collections. Most species were found exclusively in the forest, with higher abundances during winter and spring. *Drosophila mediopunctata* was the only species to occur in both sites, but with abundances considerably higher in the forest, where it was the fifth most abundant species. *Drosophila mediostriata* Duda and *D.* sp.14 were found exclusively at Vila Rocha, but one single individual for each. The remaining species,

D. bandeirantorum Dobzhansky & Pavan, *D. mediopicta* Frota-Pessoa, *D. nappae* Vilela, Valente & Bassoda-Silva, *D. paraguayensis* Duda, *D. roehrae* Pipkin & Heed and *D. trifilum,* were exclusive from CEPPA. The collection of *D. trifilum* in Cruz Alta, as well as some collections in Porto Alegre (Carolina F. Garcia, not published), represents the first record of the species in the state. *Drosophila* sp.14 is probably an undescribed species, and is the same referred as *D.* sp.tp.5 by Döge *et al.* (2008), from Joinville, Santa Catarina.

Drosophila virilis group – A small Palearctic group that includes the cosmopolitan *D. virilis.* One single individual was caught in Vila Rocha, what represents the first record of the group and the species in Rio Grande do Sul.

Subgenus *Phloridosa* Sturtevant

Two specimens of *D. denieri* Blanchard were collected in Vila Rocha. The subgenus *Phloridosa* comprises only flower-breeding species. It is the first record of it in banana baits.

Subgenus *Sophophora* Sturtevant

Two groups and five species of this subgenus were found. Although less diverse than the subgenus *Drosophila,* it comprised 53.9% of the total sample, due to the high abundance of *D. simulans.*

Drosophila melanogaster group – This Oriental and Afrotropical group comprises some species that reached cosmopolitan status. Two of them were found in Cruz Alta. *Drosophila simulans* was strikingly the most abundant species in both collection sites (67.1% in Vila Rocha and 44.8% in CEPPA). Between the exotic species, it is the best adapted to different phytogeographic regions (Perondini *et al.,* 1979). Despite being more common in open areas, it seems that *D. simulans* can easily invade a forest fragment as CEPPA. The other species of the group found was *D. kikkawai,* with two individuals in CEPPA.

Drosophila willistoni group – Generally the main Brazilian Neotropical group of *Drosophila,* it was relatively less well prominent in Cruz Alta. *Drosophila willistoni* was found at higher abundances in CEPPA, but reached just 1.8% of that sample. Its sibling species, *D. paulistorum* Dobzhansky & Pavan, was represented by one single individual in Vila Rocha. Another species, *D. nebulosa* Sturtevant, also occurred in low numbers in CEPPA.

Undetermined Species

Twelve species, referred as *D.* sp.1, *D.* sp.2, *D.* sp.3, *D.* sp.4, *D.* sp.5, *D.* sp.6, *D.* sp.7, *D.* sp.8, *D.* sp.9, *D.* sp.10, *D.* sp.11 and *D.* sp.12 remained undetermined and not assigned to any higher taxa of *Drosophila.* These species may represent unknown or undescribed species.

Genus *Zaprionus* Coquillett

Just one species is present in Neotropical region, the exotic *Z. indianus,* belonging to the Afrotropical *Z. armatus* group.

Zaprionus armatus group – *Z. indianus* is a recent invader from the Neotropical region, recorded for the first time in 1998 in the state of São Paulo, Brazil (Vilela, 1999) and in 2000 in Rio Grande do Sul (Castro & Valente, 2001), being currently widespread. As Silva *et al.* (2005) has commented, the highest abundance of *Z. indianus* occurs in warmer seasons, which was also observed in Cruz Alta. In contrast, however, it was relatively less abundant in our collections when compared with previous studies, like that of Castro & Valente (2001), where it was as abundant as *D. simulans.*

Genus *Zygothrica* Wiedemann

Two species of this genus were found, exclusively in the forest, both of which belonging to the *Z. vittimaculosa* group. Fruit-baited traps are usually ineffective to catch species from this genus.

Zygothrica vittimaculosa group – *Z. vittimaculosa* Burla was the most common species of the genus, almost all individuals caught on a winter sample. It is the only species of the group recorded in Rio Grande do Sul. Another species of this group was found, named here *Z.* sp.1, maybe constituting a new species.

Subfamily Steganinae

Generally neglected by many researches on drosophilids, members of this subfamily are rarely

attracted to banana baits and, therefore, there is no record of the subfamily in Rio Grande do Sul. Three genera, with one species each, were found in Cruz Alta, all of which in CEPPA.

Genus *Amiota* Loew – The species found here, *A.* sp.1, is probably the same cited by Schmitz *et al.* (2007) as *A.* sp.2.

Genus *Leucophenga* Mik – It was represented here by *L. maculosa.* This species has been collected in several localities in Rio Grande do Sul. It was first seen in Arambaré (Gisele S. da Silva, unpublished) and later in Porto Alegre (Carolina F. Garcia, unpublished) and Cruz Alta.

Genus *Rhinoleucophenga* Hendel – One single individual of *R. obesa* was found, with a new southernmost locality for the species.

As seen in our results, a considerable portion of the drosophilid fauna found in Cruz Alta is poorly known, represents new records for the state or remains undescribed. The locality surveyed is an area of special interest for representing a zone of contact of the two southern Brazilian biomes, the Atlantic Forest and the Pampa. It presents, however, a high anthropogenic influence, with the original environment highly fragmented. A considerable portion of the drosophilid fauna was found only in the forest fragment and not in the urban area. Although some of the original biodiversity may be lost, and the forest fragment studied here was shown to be highly invaded by at least one exotic species, maybe it still represents a refuge for many Neotropical species. Other inventories like the present one are needed, in order to map satisfactorily the whole biodiversity of the region, and to serve as subsidies to conservation planning.

RESUMO

Embora os trabalhos com assembléias de drosofilídeos (Diptera, Drosophilidae) tenham se tornado relativamente abundantes nas últimas décadas, ainda existem ambientes a serem explorados. O presente trabalho buscou observar a composição, a abundância das espécies e a riqueza das assembléias de drosofilídeos em duas diferentes áreas do município de Cruz Alta, região Noroeste do estado do Rio Grande do Sul, e ponto de contato entre os biomas Mata Atlântica e Pampa: uma área urbana (2007), constituída por um pomar doméstico de Citrus, *e uma área de mata, no Centro de Educação, Pesquisa e Proteção Ambiental – CEPPA (2008/2009), da Universidade de Cruz Alta, situado em um fragmento de mata ciliar. As coletas foram realizadas com armadilhas contendo banana fermentada e repetidas periodicamente. Um total de 7.428 indivíduos foi coletado, pertencente a duas subfamílias e 53 espécies, de seis gêneros. Na área urbana, foram encontradas 22 espécies, de dois gêneros (N = 2.421), enquanto na área de mata foram encontradas 46 espécies, de seis gêneros (N = 5.007). Seis espécies exóticas foram encontradas, sendo mais abundantes na área urbana, onde corresponderam a 95% dos espécimes coletados, contra 50% na mata. Das espécies neotropicais, as mais abundantes foram* Drosophila maculifrons *Duda e* D. polymorpha *Dobzhansky & Pavan. Apenas* D. simulans *Sturtevant foi capturada em todas as coletas em ambos os locais. O presente trabalho apresenta o primeiro registro para o estado do Rio Grande do Sul dos grupos de espécies de* D. canalinea *e* D. virilis *e das espécies* D. arassari *Cunha & Frota-Pessoa,* D. fuscolineata *Duda,* D. nigricruria *Patterson & Mainland,* D. papei *Bächli & Vilela,* D. senei *Vilela,* D. trifilum *Frota-Pessoa,* D. virilis *Sturtevant,* Leucophenga maculosa *(Coquillett) e* Rhinoleucophenga obesa *(Loew). Além disso, também são registrados pela primeira vez no estado os gêneros* Amiota *Loew,* Leucophenga *Mik e* Rhinoleucophenga *Hendel e a subfamília Steganinae. No total, este estudo eleva de 66 para 75 o número de espécies de drosofilídeos registradas no Rio Grande do Sul, o número de gêneros de cinco para oito, e de subfamília para duas.*

Palavras-chave: Abundância de espécies; *Drosophila;* Insecta; Novos registros; Região Neotropical.

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