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Taxonomic Survey of Drosophilidae (Diptera) from Mangrove Forests of Santa Catarina Island, Southern Brazil

HERMES J. SCHMITZ [1], VERA L.S. VALENTE [1,2] AND PAULO R.P. HOFMANN [3]

[1]Programa de Pós-Graduação em Biologia Animal,hj.schmitz@gmail.com; [2]Depto. Genética, Instituto de Biociências. Lab. Drosophila, Univ. Federal do Rio Grande do Sul - UFRGS, C. postal 15053, Av. Bento Gonçalves, 9500, Bloco B, Prédio 43323, sala 210, Agronomia, 91501-970, Porto Alegre, RS

[3]Lab. Drosofilídeos, Depto. Biologia Celular, Embriologia e Genética, Centro de Ciências Biológicas, Univ. Federal de Santa Catarina - UFSC, C. postal 476, 88010-970, Trindade, Florianópolis, SC

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Levantamento Taxonômico de Drosophilidae (Diptera) de Manguezais da Ilha de Santa Catarina, Sul do Brasil

RESUMO - Assembléias de drosofilídeos têm sido caracterizadas em vários ambientes no Brasil, como Mata Atlântica, áreas urbanas, cerrados, Floresta Amazônica e outros. Este trabalho é a primeira tentativa em caracterizar a fauna de Drosophilidae nos manguezais, ambiente presente nos litorais tropicais de todo o mundo. Vinte e oito amostras foram coletadas nos três principais manguezais da ilha de Santa Catarina, utilizando-se armadilhas com isca de banana suspensas em árvores. As amostras foram obtidas nos meses de janeiro (verão), abril (outono), julho (inverno) e outubro (primavera), entre julho de 2002 e julho de 2005. O total de 82.942 indivíduos foi coletado, incluindo 69 espécies de seis gêneros – *Amiota* Loew, *Drosophila* Fallén, *Leucophenga* Mik, *Scaptodrosophila* Duda, *Zaprionus* Coquillett e *Zygothrica* Wiedemann. Mostrou-se marcante a alta abundância de *D. simulans* Sturtevant, com alguns picos pronunciados de *D. malerkotliana* Parshad & Paika nas amostras de outono. Outras espécies comuns foram *Zaprionus indianus* Gupta, *D. mediostriata* Duda e *D. willistoni* Sturtevant. Também foram coletados 45.826 espécimes da família Curtonotidae, grupo irmão de Drosophilidae, virtualmente ausente em outros ambientes. As assembléias de drosofilídeos mostraram-se bastante homogêneas entre os três manguezais pesquisados, apesar das diferenças nos ambientes que os circundam. Em geral, as espécies encontradas nos manguezais são as mesmas encontradas nos ambientes vizinhos, porém suas abundâncias são bastante modificadas, sugerindo que várias espécies estejam respondendo diferentemente às pressões ambientais em ação nos manguezais, que podem ser mais restritivas para algumas do que para outras.

PALAVRAS-CHAVE: *Drosophila*, biodiversidade, fauna de manguezais, assembléia de insetos, *Zaprionus*

ABSTRACT - Assemblages of drosophilids have been characterised in several environments of the Brazilian territory, like the Atlantic Rain Forest, urban areas, *cerrados*, the Amazon Forest, and others. The present survey is the first attempt to characterise the fauna of Drosophilidae in mangrove forests, an environment typical of tropical coasts worldwide. Twenty-eight samples were collected from the three main mangrove forests of Santa Catarina Island, southern Brazil, using banana-baited traps hung in trees. Samples were taken in January (summer), April (autumn), July (winter) and October (spring) between July 2002 and July 2005. In total, 82,942 specimens of drosophilids were caught, belonging to 69 species of six genera – *Amiota* Loew, *Drosophila* Fallén, *Leucophenga* Mik, *Scaptodrosophila* Duda, *Zaprionus* Coquillett and *Zygothrica* Wiedemann. The high abundance of *D. simulans* Sturtevant was remarkable, with some notable peaks of *D. malerkotliana* Parshad & Paika in autumn samples. Other common species were *Zaprionus indianus* Gupta, *D. mediostriata* Duda and *D. willistoni* Sturtevant. We also collected 45,826 flies of family Curtonotidae, the sister-group of Drosophilidae virtually absent in other environments. The assemblages of drosophilids were very similar in the three mangrove forests surveyed, despite the different surrounding environments. In general, the species sampled in the mangroves were the same as those observed in the surrounding environments, but in varying abundances. This suggests that drosophilids are differently affected by environmental pressures operating in mangroves.

KEY WORDS: *Drosophila*, biodiversity, fauna of mangroves, insect assemblage, *Zaprionus*

The family Drosophilidae comprises more than 3,800 species (Bächli 2006) of small flies widespread in a variety of climates and environments throughout the world. The best-known members of the family were defined by Carson (1971) as primarily consumers of yeasts and bacteria, the micro-organisms linked with the initial stages of plant material decay. Although these flies have emerged as a paradigm organism to a vast body of researches, most ecological features of natural drosophilid populations and assemblages are poorly known.

Researches on species of drosophilids in Brazil started in the 1940's, when Theodosius Dobzhansky first visited Brazil, and a research program on Neotropical species of *Drosophila* was established. Later on, many studies addressing the description and taxonomy of new drosophilid species were carried out, together with genetic and chromosomal polymorphism investigations. In addition, several aspects of the ecology of these flies were investigated.

In the subsequent decades, assemblages of drosophilids were characterised in a variety of environments of the Brazilian territory. The best-studied environment is the Atlantic Rain Forest, especially in the states of São Paulo (Dobzhansky & Pavan 1950, Val & Kaneshiro 1988, Medeiros & Klaczko 2004) and Rio Grande do Sul (Petersen 1960, Valente & Araújo 1991, Saavedra *et al.* 1995). Drosophilids inhabiting urban environments were also studied in Olímpia, São Paulo, Brazil (Bélo & Gallo 1977, Bélo & Oliveira-Filho 1978, Bélo 1979) and later in Montevideo, Uruguay (Goñi *et al.* 1997), in Porto Alegre, Rio Grande do Sul, Brazil (Silva *et al.* 2005), and in Brasília, Distrito Federal, Brazil (Ferreira & Tidon 2005). In recent years, the *Cerrado* of Central Brazil has been site of investigations (Tidon-Sklorz *et al.* 1994, Vilela & Mori 1999, Tidon 2006). Similarly, the *Caatinga* was the target of some studies on drosophilid assemblages (Tidon-Sklorz & Sene 1995), as well as the *Pantanal* (Val & Marques 1996) and *restingas* (Bizzo & Sene 1982). Drosophilids of the Amazon forest (Martins 1987, 2001), of the Argentinean Chaco (Vilela *et al.* 1980), and of the southern grasses and forests with *Araucaria* (Saavedra *et al.* 1995) have also been investigated.

In Santa Catarina state, besides a few earlier collections, this area of research was effectively inaugurated by De Toni & Hofmann (1995), who studied a site covered by the Atlantic Rain Forest in Santa Catarina Island. After that, the authors and co-workers established a research group to study assemblages of drosophilids in different environments of Santa Catarina state, including the Atlantic Rain Forest, urban environments, *restinga* and, with the present paper, mangrove forests. This last environment is a *terra incognita* in the knowledge of Drosophilidae ecology. Observed in intertidal plains of tropical and subtropical coasts around the world, mangroves form a very peculiar forest, subject to the tides, unstable soil and salinity. Such harsh conditions lead to a poorly diverse but exclusive flora, and make mangrove forests the meeting point of marine and terrestrial faunas. Finding drosophilids in this environment may be surprising, but such discovery reflects the versatility and ubiquity of these insects. The present work comes as the first effort to identify the assemblages of drosophilids in such environment.

Material and Methods

The samples were collected from the three main mangrove forests of Santa Catarina Island: Itacorubi (27°34'34"S; 48°31'23"W), a forest situated inside the most populated urban zone of the city of Florianópolis; Tavares (27°39'13"S; 48°32'12"W), bordered by regions of medium level of urbanisation, pastures and some forested areas; and Ratones (27°27'45"S; 48°30'28"W), located in Estação Ecológica de Carijós, an area where the mangrove is the main component of a complex vegetation, within a mosaic of the Atlantic Forest, *restingas*, fresh-water marshes and transitional formations. The climate of the region is Köeppen type cfa (1948), i. e., subtropical with hot summers, summer temperatures above 22°C and rainfall in excess of 30 mm in the driest month.

The mangrove forests of Santa Catarina Island have similar vegetation compositions. The forests are very homogeneous, dominated by *Avicennia schaueriana* Stapf & Leechman (Lamiales:Acanthaceae). *Laguncularia racemosa* (L.) Gaertn. (Myrtales: Combretaceae) and *Rhizophora mangle* L. (Malpighiales: Rhizophoraceae) are also present (Souza Sobrinho *et al.* 1969). These three species are the only plants that inhabit the inner woods. The forest formed exhibits very inexpressive stratification and a canopy that is neither thick nor continuous, which makes it relatively open and well-lit. The soil is muddy, salty, and periodically flooded by the tides. Owing to the low floristic diversity and the particularities of the environment, the mangrove forests seem to offer few food resources, imposing harsh abiotic conditions to the drosophilid fauna.

The sampling method consisted in capturing adult flies with banana-baited traps (Tidon & Sene 1988). In each collection, 5 kg of banana were mashed, seeded with baker's yeast and distributed in 50 traps that were hung in trees, at around 1.5 m above the ground, and kept there for 3-4 days. Trips to the mangroves were taken on foot, preferentially at low tides. The collections were done in January (summer), April (autumn), July (winter) and October (spring). Itacorubi was sampled between July 2002 and July 2005 (13 collections), Tavares from October 2003 to July 2005 (8 collections) and Ratones between January 2004 and July 2005 (seven collections).

Flies were preserved in ethanol 70% until identification by external morphology and male terminalia, as reported in the literature (Freire-Maia & Pavan 1949, Val 1982, Vilela & Bächli 1990). Females of sibling species were individually placed in culture tubes for male offspring analysis. Some of them could not be identified at species level and were therefore classified at group level (*repleta*, *tripunctata* and *saltans* groups). Some male specimens of the *willistoni* subgroup were identified at species level by morphology of the hypandrium (Malogolowkin 1952). Yet, most *willistoni* subgroup specimens were not discriminated. They were treated together for general analysis. For the analyses of male terminalia (and in some cases female spermathecae), flies were treated with potassium hydroxide (KOH) 10% and acid fuchsine, and dissected in glycerol (Wheeler & Kambysellis 1966).

Voucher specimens of the material collected were pinned (double-mounted) and deposited in the Museu de Ciências Naturais, Fundação Zoobotânica do Rio Grande do Sul, Porto Alegre (RS). Additional material is kept in microvials with ethanol 70%, or glycerol, for dissected terminalias, in the Laboratório de *Drosophila* (UFRGS).

Results and Discussion

A total of 82,942 drosophilid flies were collected in this study, and sorted in 69 species under six genera. Table 1 shows the complete species list and absolute abundances. Fifty-one species were found in Itacorubi, 48 in Tavares and 45 in Ratones. Nevertheless, these values may be the result of different number of samples.

Besides the drosophilids, we collected 45,826 specimens of flies belonging to Curtonotidae, a related family considered by Grimaldi (1990) to be the sister-group of Drosophilidae. Overall, drosophilids and curtonotids totalised 128,768 individuals, being 64% Drosophilidae and 36% Curtonotidae. Interestingly, in some occasions the number of curtonotids even surpassed the number of drosophilids. The presence and the impressive abundance of these flies may be considered an exclusive characteristic of mangrove forests, because specimens were not collected in other environments surveyed by our research team. As this taxon is not the scope of the present work, it will not be treated in detail here.

Figs 1 to 3 summarise the structure of all the samples taken, with the relative abundances of the most common species (that reached 10% in at least one sample), in each site. The high abundance of *D. simulans* Sturtevant was remarkable, with some notable peaks of *D. malerkotliana* Parshad & Paika, *D. mediostriata* Duda and *D.* sgr. *willistoni* Pavan. Except for the April samples (autumn), characterised by the increased abundance of *D. malerkotliana*, the other seasons did not show typical patterns. *D. mediostriata* exhibited very irregular oscillations, while *D.* sgr. *willistoni* and *D. repleta* Wollaston seemed to show differences more related to inter-year variations.

Some information about each taxon collected is discussed below. The order of the taxa follows the same criteria of Table 1, alphabetically organised within the higher taxonomic categories.

Subfamily Drosophilinae

Genus *Drosophila* Fallén. Fifty-eight out of the 69 species collected belonged to this genus, the most diverse Drosophilidae genus and also the best-studied and most attracted to banana-baited traps. A total of 78,484 individuals were caught, amounting to almost 95% of the sample, distributed in four subgenera.

Subgenus *Dorsilopha* Sturtevant. This subgenus comprises only three species of *busckii* group. All species have Oriental origin, but *D. busckii* Coquillett achieved cosmopolitan status and is present in the Neotropical region.

***busckii* group**. Sixteen individuals of *D. busckii* were collected. This species is found mostly associated with anthropic activities, being rare in South American natural environments (Val *et al.* 1981).

Subgenus *Drosophila* Fallén. This is the most diverse subgenus of genus *Drosophila*. Thirty-six of the species found belong to it, distributed in 11 groups, besides two ungrouped species. On the other hand, it comprised only about 9% of the individuals collected, the majority of the species being rare.

***annulimana* group.** Three species of this group were caught but in low numbers: *D. schineri* Pereira & Vilela, known only for Brazil, *D. annulimana* Duda and *D. arassari* Cunha & Frota-Pessoa, found preferentially in forests (Val *et al.* 1981). *D. annulimana* is widespread in South America. *D. arassari* is distributed only in south-eastern and southern Brazil, and in Uruguay. It is most commonly found at high altitudes (Val *et al.* 1981), but in the southern part of its distribution it can be caught at lower altitudes, as in Uruguay (150m) (Goñi *et al.* 1998) and Santa Catarina Island (300 m) (De Toni & Hofmann 1995). In the present work, it was captured at sea level, during winter.

***bromeliae* group.** Just one species of this group was caught, *D. bromelioides* Pavan & Cunha. This is a widespread species in Brazil, but is only occasionally attracted to banana baits. On the other hand, it is quite common in flowers. Contrasting to its low abundance in our trap samples, a great number of individuals were reared from flowers of *Hibiscus pernambucensis* Arruda. (Malvales: Malvaceae), *Ipomoea cairica* (L.) Sweet and *I.* aff. *chiliantha* (Solanales: Convolvulaceae), collected along the mangrove borders, even in Itacorubi, where it was absent in the traps.

***calloptera* group.** Two individuals of *D. atrata* Burla & Pavan and two of *D. quadrum* (Wiedemann) were collected in the mangroves. Val & Kaneshiro (1988) collected the same species sweeping over forest litter, over the slime flux of freshly cut or fallen fruits. Probably they are not so expressively attracted to banana baits. The species of this group seem to prefer forests (Val *et al.* 1981).

***cardini* group.** The four species collected belonging to this group are widespread in the Neotropics. The most common was *D. polymorpha* Dobzhansky & Pavan, which is relatively abundant in many kinds of environments, except in the driest ones (Sene *et al.* 1980). A total of 853 individuals of this species were collected, comprising 1% of the sample, with maximum abundances of 6% in some collections. Besides it, *D. neocardini* Streisinger was present with 44 specimens, while *D. cardini* Sturtevant, a species better adapted to driest environments, accounted for 24 individuals. The rarest species was *D. cardinoides* Dobzhansky & Pavan, with only four individuals.

***coffeata* group.** Two species of this group were found. *D. fuscolineata* Duda seems to be the most widespread species

Table 1. List of Drosophilidae species collected in the mangrove forests of Santa Catarina Island, with absolute abundances by site.

Group	Species	Itacorubi	Tavares	Ratones	Total
Subfamily Drosophilinae					
Genus *Drosophila*					
Subgenus *Dorsilopha*					
busckii	*D. busckii*	3	5	8	16
Subgenus *Drosophila*					
annulimana	*D. annulimana*	1	1	-	2
	D. arassari	1	-	-	1
	D. schineri	1	2	-	3
bromeliae	*D. bromelioides*	-	3	2	5
calloptera	*D. atrata*	2	-	-	2
	D. quadrum	-	2	-	2
cardini	*D. cardini*	12	6	6	24
	D. cardinoides	1	2	1	4
	D. neocardini	14	10	20	44
	D. polymorpha	228	213	412	853
coffeata	*D. coffeata*	-	1	-	1
	D. fuscolineata	5	1	1	7
guarani	*D. griseolineata*	9	10	26	45
	D. guaraja	1	-	-	1
	D. maculifrons	-	1	-	1
	D. ornatifrons	-	2	1	3
	D. aff. *ornatifrons*	-	-	2	2
immigrans	*D. immigrans*	13	14	1	28
pallidipennis	*D. pallidipennis*	5	7	18	30
repleta	*D. hydei*	13	20	-	33
	D. mercatorum	476	274	52	802
	D. onca	12	-	-	12
	D. pictilis	-	-	1	1
	D. repleta	528	276	72	876

Continue

Table 1. Continuation.

Group	Species	Itacorubi	Tavares	Ratones	Total
	D. zottii	3	-	3	6
	Unidentified	231	91	18	340
tripunctata	*D. cuaso*	2	2	1	5
	D. mediopicta	3	-	-	3
	D. mediopunctata	12	7	1	20
	D. mediostriata	3,256	767	33	4,056
	D. paraguayensis	7	2	2	11
	D. roehrae	2	1	1	4
	D. trapeza	-	1	-	1
	D. gr. *tripunctata* sp.	-	-	1	1
	Unidentified	55	28	13	96
virilis	*D. virilis*	2	-	-	2
Ungrouped	*D. caponei*	65	91	89	245
Ungrouped	*Drosophila* sp. 1	3	3	-	6
Subgenus *Siphlodora*					
-	*D. flexa*	6	2	4	12
Subgenus *Sophophora*					
melanogaster	*D. ananassae*	8	15	7	30
	D. kikkawai	3	1	-	4
	D. malerkotliana	6,948	1,603	8,588	17,139
	D. melanogaster	353	25	1	379
	D. simulans	15,354	19,203	11,965	46,522
saltans	*D. neoelliptica*	4	3	-	7
	D. neosaltans	-	-	1	1
	D. prosaltans	3	2	20	25
	D. sturtevanti	93	44	61	198
	Unidentified	1	4	-	5
willistoni	*D. capricorni*	48	5	15	68
	D. fumipennis	4	-	-	4
	D. nebulosa	26	14	81	121
	D. paulistorum	68	231	188	487
	D. willistoni	141	194	497	832

Continue

Table 1. Continuation.

Group	Species	Itacorubi	Tavares	Ratones	Total
	Unidentified (sgr. *willistoni*)	3,462	852	734	5,048
Unidentified					
	Drosophila sp. 2	-	-	1	1
	Drosophila sp. 3	1	-	-	1
	Drosophila sp. 4	-	-	1	1
	Drosophila sp. 5	-	1	-	1
	Drosophila sp. 6	1	1	1	3
	Drosophila sp. 7	-	-	1	1
Genus *Scaptodrosophila*					
latifasciaeformis	*S. latifasciaeformis*	13	4	12	29
Genus *Zaprionus*					
Subgenus *Zaprionus*					
armatus	*Z. indianus*	1,283	747	2,371	4,401
Genus *Zygothrica*					
Subgenus *Zygothrica*					
dispar	*Z. dispar*	-	3	-	3
	Z. prodispar	-	1	-	1
orbitalis	*Z. orbitalis*	3	1	-	4
vittimaculosa	*Z. vittimaculosa*	3	-	-	3
?	*Zygothrica* sp. 1	1	-	-	1
?	*Zygothrica* sp. 2	-	-	1	1
	Subfamily Steganinae				
Genus *Amiota*					
Subgenus *Amiota*					
?	*Amiota* sp. 1	4	-	1	5
	Amiota sp. 2	3	5	1	9
Genus *Leucophenga*					
?	*Leucophenga* sp. 1	-	-	1	1
Total		32,800	24,804	25,338	82,942

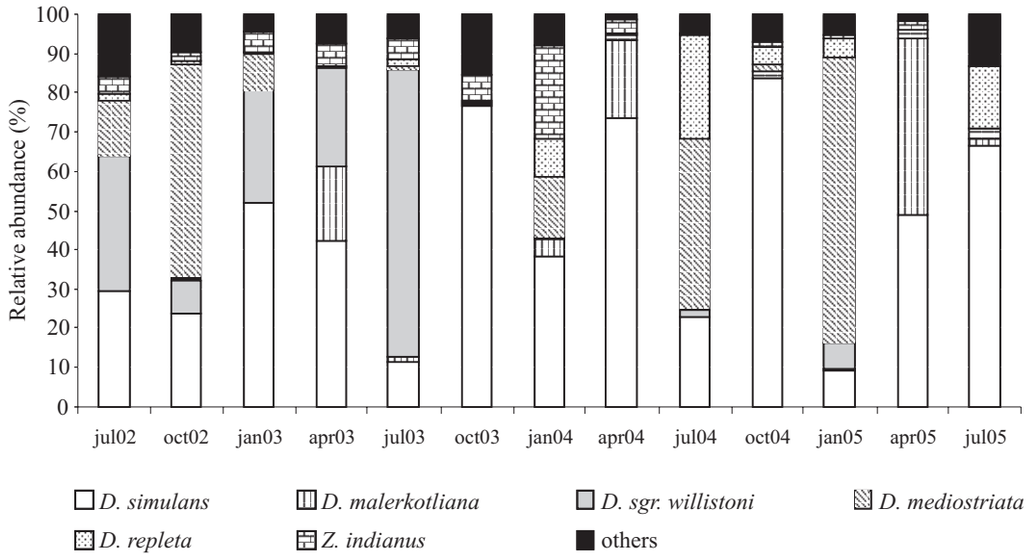

Fig. 1. Relative abundances of the most common species in samples from mangrove of Itacorubi. (*D.* = *Drosophila*, *Z.* = *Zaprionus*, sgr. = subgroup).

in the Neotropics and numbered seven specimens in our collections. Furthermore, a single individual of *D. coffeata* Williston was collected.

***guarani* group.** It has been often proposed that the subgroups of *guarani* group should be raised to group level. Two species of the *guaramunu* subgroup were found. *D. griseolineata* Duda, a widespread species in South America, was the most common, with 45 individuals. *D. maculifrons* Duda was rarer, with just one specimen. From the *guarani* subgroup, three species were found: a single specimen of *D. guaraja* King, three individuals of *D. ornatifrons* Duda and two individuals of *D.* aff. *ornatifrons*. This last species has not yet been described, and is very similar to *D. ornatifrons* in external morphology and aedeagus shape, but with slight differences in the latter.

***immigrans* group.** This group has Oriental origin, but *D. immigrans* Sturtevant is a cosmopolitan species found in the Neotropical region. So, this makes it an exotic element.

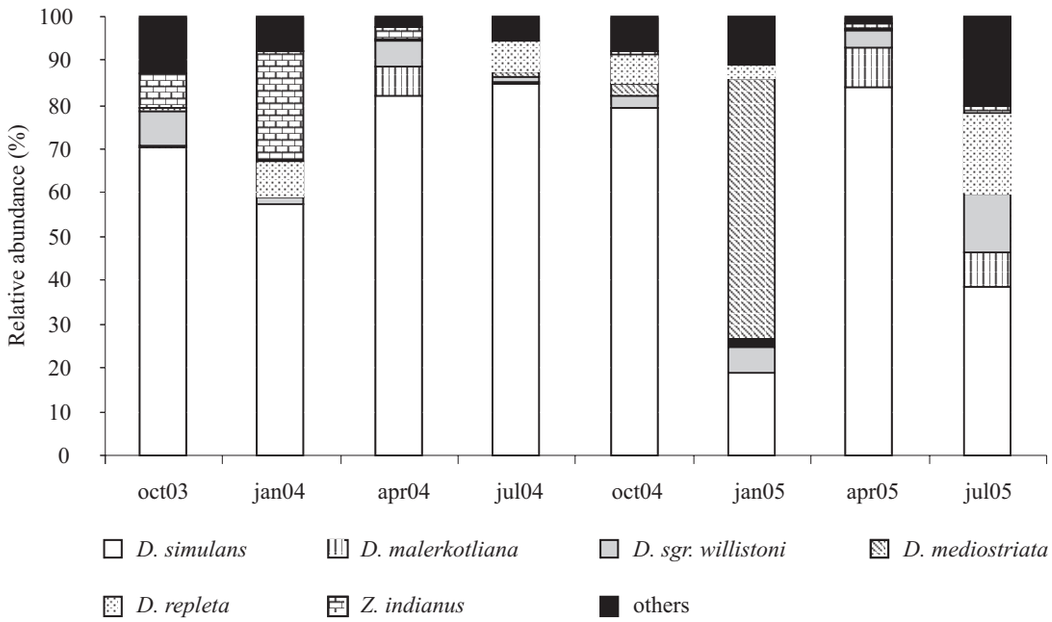

Fig. 2. Relative abundances of the most common species in samples from mangrove of Tavares. (*D.* = *Drosophila*, *Z.* = *Zaprionus*, sgr. = subgroup).

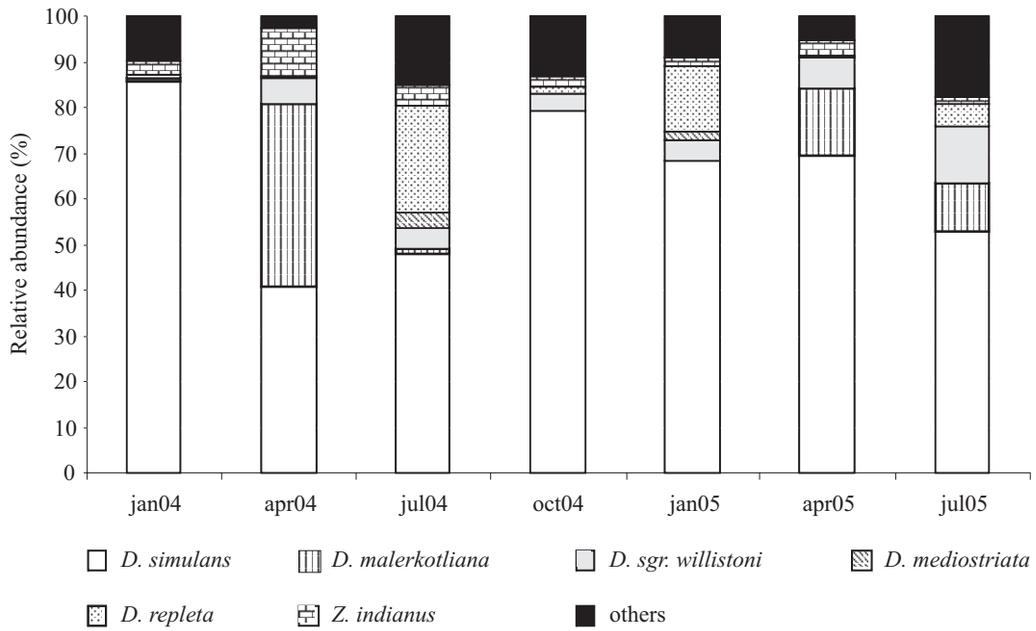

Fig. 3. Relative abundances of the most common species in samples from mangrove of Ratones. (*D.* = *Drosophila*, *Z.* = *Zaprionus*, sgr. = subgroup).

A total of 28 individuals of this species were collected in the mangroves.

***pallidipennis* group.** The only species of this group, *D. pallidipennis* Dobzhansky & Pavan, is widespread in the Neotropics and found preferentially in open formations (Val *et al.* 1981). Thirty individuals were caught in our collections.

***repleta* group.** This is the most diverse group of *Drosophila* in the Neotropics and accounted for six species of four subgroups in our collections (2.5% of the total of individuals). *D. hydei* Sturtevant (*hydei* subgroup) holds the cosmopolitan status and is rather a species associated with synanthropic and xeric environments (Vilela *et al*. 1983), with 33 individuals collected. *D. mercatorum* Patterson & Wheeler (*mercatorum* subgroup) is a widespread species, especially in open environments (Sene *et al.* 1980, Vilela *et al.* 1983), and has achieved subcosmopolitan status. It was the second most abundant species of this group in our collections, with 802 specimens, amounting to 1% of the total and reaching a maximum of 7%. The *fasciola* subgroup was represented by two rare species, *D. onca* Dobzhansky & Pavan and *D. pictilis* Wasserman. *D. onca* is a preferentially forest-dwelling fly, found in southern and south-eastern Brazil (Vilela *et al.* 1983) and *cerrados* (Tidon 2006). *D. pictilis* was represented by a single specimen. It was previously known only for Central America (Vilela 1983) and São Paulo state, in south-eastern Brazil (Medeiros & Klaczko 2004). Thus, this is the first record made for the species in Santa Catarina state, which constitutes a new southernmost record for the species. The other two species belong to the *repleta* subgroup. *D. repleta* Wollaston was the most abundant species of the group (876 individuals, 1% of total, with maximum of 26% in July 2004) (Figs. 1 to 3) and is also a cosmopolitan species, associated mainly with xeric and disturbed environments (Vilela *et al.* 1983). It is interesting to note, however, that this species was not so abundantly collected previously in Santa Catarina as it was in the mangrove forests, even when compared with urban environments (data not published). Finally, six individuals of *D. zottii* Vilela were caught. This species is found in forested areas of southern and south-eastern Brazil.

***tripunctata* group.** It was the most diverse group in our collections, with eight species. However, only *D. mediostriata* Duda was common, totalling 96.6% (4,056 specimens) of the individuals of the group. This species comprised 5% of the total sample, which can be considered a striking feature of the assemblage of drosophilids in the mangrove forests. Yet, *D. mediostriata* has exhibited low abundances in researches carried out in other environments. It showed also very strong oscillations, ranging from 0 to 72% (January 2005) of relative abundance among the samples (Figs. 1 to 3). Abundance peaks, however, were very irregular, occurring at different seasons in different years, and sometimes, in just one or two sites, but not in all of them. Its surprisingly high abundance in the mangrove forests is very probably associated with the presence of *H. pernambucensis*. This plant does not reach the inner mangrove forests, and it grows typically (yet not exclusively) along the borders of this kind of environment, being present in the three sites surveyed. Decaying flowers of this plant taken to laboratory and maintained in glass vials bred high *D. mediostriata* numbers. However, some irregularities are not easy to explain. Maybe the fluctuations in abundance

of this fly are linked to the phenology of the host plant. In some occasions *D. mediostriata* was reared in great numbers from the flowers and were rarely caught in traps; in others, few flowers were observed, but the species was common in traps. Still, at times it was also as common in flowers as in traps. At least, it was never abundant in April (autumn), when the flowers were always absent. Although *D. mediostriata* is not a true flower-breeding drosophilid, it has been already found in some other flowers (Pipkin *et al.* 1966). More commonly, the species is in fact found in fruits (De Toni *et al.* 2001). The other species of the group were collected in low numbers. *D. mediopicta* Frota-Pessoa, *D. mediopunctata* Dobzhansky & Pavan and *D. paraguayensis* Duda are widespread species in the Neotropics and commonly found in Santa Catarina state (De Toni & Hofmann 1995). On the other hand, *D. cuaso* Bächli, Vilela & Ratcov, *D. roehrae* Pipkin & Heed and *D. trapeza* Heed & Wheeler have only recently been collected in Santa Catarina. A single individual of *D.* gr. *tripunctata* sp., probably an undescribed species, was collected.

***virilis* group.** Just two individuals of *D. virilis* Sturtevant were found. It is probably native to China, but found as a domestic and exotic species around the world. It is the only species of its group to enter the Neotropical region (Throckmorton 1982).

Ungrouped species. *D. caponei* Pavan & Cunha is a species of uncertain affinities, so far known only in Brazil. A total of 245 specimens of this fly were collected in the mangroves. Another species of doubtful affinities within the subgenus *Drosophila* is *D.* sp. 1, an undescribed species.

Subgenus *Siphlodora* Patterson & Mainland. This subgenus includes just two species, and only *D. flexa* Loew is present in the Neotropical region. This species is associated to maize (*Zea mays* L. – Poales: Poaceae), being abundantly collected from the tassels of that plant, but rarely in baits (Vilela & Bächli 2000). It is found from Mexico to Brazil and Argentina, and the present study established its southernmost record, to the present state of knowledge.

Subgenus *Sophophora* Sturtevant. Three groups and 14 species of this subgenus were collected. This subgenus was also highly representative in number of individuals, with 85% of the total.

***melanogaster* group.** The *melanogaster* group is native to Oriental and Afrotropical regions, but five species are cosmopolitan or subcosmopolitan, present in the Neotropical region as exotic fauna elements. All of them were collected in this survey. Altogether, they comprised 77% of the total sample. *D. simulans* Sturtevant was by far the most abundant species, with 46,522 individuals, accounting for 56% (Figs. 1 to 3) of the total of drosophilids collected and reaching a maximum of 86% (January 2004, in Ratones). It is a very generalist and versatile species, cosmopolitan and already present in Brazil in the first collections ever carried out (Dobzhansky & Pavan 1943). *D. simulans* is most common in open and disturbed areas, but also well-adapted to the natural environments (Sene *et al.* 1980, Val *et al.* 1981). Its sibling species, *D. melanogaster* Meigen (both of them belong to *melanogaster* subgroup, originated in Afrotropical region), also cosmopolitan, synanthropic and present in Brazil for a long time, was rarer (379 individuals). The other species found were *D. kikkawai* Burla (*montium* subgroup), *D. ananassae* Doleschall and *D. malerkotliana* Parshad & Paika (*ananassae* subgroup), all of Oriental origin. The first two species were rare, but *D. malerkotliana* was the second most abundant species, comprising about 21% of the total sample (17,139 individuals). Nevertheless, its abundance varied very much, reaching up to 45% in April (autumn) samples and decreasing to lower numbers in other seasons (Figs. 1 to 3). In contrast to the other species of the group, *D. malerkotliana* invaded the Neotropics only in the 1970's (Val & Sene 1980), but as the others, it is more abundant in open and disturbed environments.

***saltans* group.** Four species were found: *D. neoelliptica* Pavan & Magalhães and *D. neosaltans* Pavan & Magalhães, which occur mainly in forests (Sene *et al.* 1980) and restricted to Brazil, and also *D. prosaltans* Duda and *D. sturtevanti* Duda, which are widespread in the Neotropics. *D. sturtevanti* was by far the most abundant of the group, with 198 specimens.

***willistoni* group.** This is one of the most conspicuous and well-studied groups of *Drosophila* of the Neotropical region. The five species collected belong to two subgroups. The *bocainensis* subgroup was represented by *D. nebulosa* Sturtevant, *D. capricorni* Dobzhansky & Pavan and *D. fumipennis* Duda. *D. nebulosa* is the only species of the group that is more abundant in open areas (Sene *et al.* 1980). The others preferentially inhabit forests. Two species of the sibling *willistoni* subgroup were found, *D. willistoni* Sturtevant and *D. paulistorum* Dobzhansky & Pavan. Taken together, this subgroup accounted for about 8% of the total sample (6,367 individuals) (Figs. 1 to 3). In general, this taxon is highly dominant in tropical and subtropical forested areas in the Neotropics (Dobzhansky & Pavan 1950). Analyses of hypandrium of some individuals (n = 1,319) showed that *D. willistoni* was more abundant (about 63%) than *D. paulistorum*. The species of the group collected here are those which, as reported by Val *et al.* (1981), frequently are caught in traps in large numbers, while the other species come to baits only occasionally. These species are also widespread in the Neotropics, especially *D. willistoni*.

Unidentified species. Besides the previous species discussed, six other *Drosophila* species of uncertain taxonomic position, and probably undescribed, were collected: *D.* sp. 2, *D.* sp. 3, *D.* sp. 4, *D.* sp. 5, *D.* sp. 6 and *D.* sp. 7. We ranked these species cautiously under genus *Drosophila*, but with some reservations, especially for *D.* sp. 5 and *D.* sp. 7.

Genus *Scaptodrosophila* Duda. This genus is composed by species found especially in the Oriental, Australasian and Afrotropical regions (Bock & Parsons 1978). Just one species was found.

***latifasciaeformis* group.** *S. latifasciaeformis* (Duda) is an exotic species, originated from Africa (Bock & Parsons 1978), present in Brazil at least since the first collections ever carried out (Dobzhansky & Pavan 1943), and frequently linked to disturbed environments.

Genus *Zaprionus* Coquillet. This genus is a dominant element of the Afrotropical drosophilid fauna. Yet, just one species, belonging to *armatus* group, is found in the Neotropics.

***armatus* group.** One species of this group, *Z. indianus* Gupta, expanded its geographical distribution recently and reached the subcosmopolitan status. Its colonisation of the Neotropical region succeeded very rapidly. *Z. indianus* Gupta was first recorded in São Paulo state (south-eastern Brazil) by Vilela (1999), where it became a pest in fig crops. Soon after, the species was found in the southern states of Santa Catarina (De Toni *et al.* 2001) and Rio Grande do Sul (Castro & Valente 2001), as well as in the *Cerrado*, Central Brazil (Tidon *et al.* 2003), in the northern state of Pará (M. Martins, personal communication), and in Uruguay (Goñi *et al.* 2001). In fact, this fly became one of the most abundant species of drosophilids in open and disturbed areas (Tidon *et al.* 2003, Silva *et al.* 2005). In the present work, we collected 4,401 individuals of *Z. indianus*, about 5% of the total sample (Figs. 1 to 3). The abundance of this fly in mangrove forests was higher than in the Atlantic Rain Forest, but lower than in the *Cerrado* (Tidon *et al.* 2003) or in urban environments (Ferreira & Tidon 2005, Silva *et al.* 2005). It is interesting to compare *Z. indianus* with *D. simulans*, the two most common species in urban areas of Santa Catarina Island (M. Gottschalk, personal communication). While the latter is also very abundant in mangrove forests, the former was more rarely observed. So, notwithstanding the impressive colonisation power shown by *Z. indianus* in its invasion of the Neotropical region, the fly yet seems to have some relative difficulty to spread to mangrove forests, as observed so far.

Genus *Zygothrica* Wiedemann. Species of this genus are strongly linked to fungi, especially bracket fungi growing in rainforests (Grimaldi 1987). *Zygothrica* species are not common in fruit baits. Just 13 individuals, belonging to six species, were collected in traps. Two of these species, each represented by a single specimen (*Z.* sp. 1 and *Z.* sp. 2) could not be identified. The other four species were ranked under three groups, listed below. An additional species, also not identified, was reared (eight individuals) from a fungus of genus *Auricularia* Bull. Ex Juss. collected in Itacorubi (as this unidentified species was not found in traps, it was not included in the general counts of this work).

***dispar* group.** Two species of this group were found: *Z. dispar* (Wiedemann) and *Z. prodispar* Duda, both of them widespread in the Neotropics.

***orbitalis* group.** Four specimens of *Z. orbitalis* (Sturtevant) were collected, a widespread species in Neotropics.

***vittimaculosa* group.** Just *Z. vittimaculosa* Burla was collected, a species already found in Santa Catarina before (Val & Kaneshiro 1988).

Subfamily Steganinae

Genus *Amiota Loew.* Two species of this genus were found. Both of them belonged to subgenus *Amiota* Loew, according to Wheeler (1952), but could not be identified at species level. We found five individuals of *A.* sp. 1 and nine of *A.* sp. 2.

Genus *Leucophenga* Mik. Only a single individual of an unidentified species of this genus was caught. Flies of this genus rarely enter banana-baited traps.

Despite the difference between the surrounding environments, the fauna of Drosophilidae of the three mangrove forests investigated was similar in respect to species composition and abundances. However, some particularities were detected. For instance, it is interesting to mention the striking abundance of flies of the related family Curtonotidae, virtually absent in all other environments so far studied by our colleagues from the Universidade Federal de Santa Catarina.

In general, the same species found in surrounding environments (urban, Atlantic forest, *restinga*) were sampled in mangrove forests. However, abundances were different, suggesting that environmental pressures operating in the mangroves are sensed as more restrictive by some species than others. The environmental pressures that can be evoked to explain these findings are humidity, salinity, wind, tidal regime, unpredictability of feeding and breeding resources, and the dispersion ability specifically exhibited by each species.

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