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Mangrove Bird Community of Paranaguá Bay - Paraná, Brazil

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ABSTRACT

This study describes the mangrove bird community of Paranaguá Bay in Paraná - South Brazil. Seasonal surveys were conducted during September 1997 to September 1998 at three sites in Paranaguá Bay. Frequencies and abundances of birds were registered in 200m transects and one hour point counts. A total of 81 bird species were observed in the three sampling sites. Most of the bird species in Paranaguá mangroves are fruits, seeds and arthropods consumers, and predators of flying insects. The most frequent and abundant species were Egretta caerulea, Ceryle torquata, Chloroceryle amazona, Pitangus sulphuratus, Turdus amaurochalinus *and* Parula pitiayumi. *The bird community of these three sites is composed mainly by forest bird species. The mangroves of Paranaguá Bay shelter one of the richest avifauna of Brazilian mangroves. Differences between sampling sites could be related to the proximity of the Paranaguá city and human impacts in the areas. Only in the most disturbed site* were *observed* Passer domesticus *and large flocks of* Coragyps atratus. *This study contributed to the knowledge of mangrove communities, and could be an important basis to fluvial-marine conservation plans in Paraná- Brazil.*

Key words: Mangroves, Birds, Community, Paraná, Paranaguá - Bay

INTRODUCTION

Mangroves are one of the most productive ecosystems of the world, providing shelter and feeding sites for many animal species (Mann, 1982). However, mangroves have been relatively less studied in the Neotropics (e.g. McNeil et al., 1985; Olivares, 1988; Martin, 1992; Lamparelli et al., 1997). There is little knowledge about South Atlantic mangrove avifauna, and most of the information about Neotropical mangrove birds comes from North America (Odum, 1982; Davis and Ogden, 1994), and Central America (Haverschmidt, 1965; ffrench, 1966; Tostain, 1986; Warkentin and Hernandez, 1995; Casler and Este, 1996; Lefebvre and Poulin, 1997, 2000).

In Brazil, few papers were published about mangrove birds, (Marcondes-Machado and Monteiro-Filho, 1990; Rodrigues, 1993; Hass 1996; Matos, 1996). About eight published studies described the bird communities of mangroves and associated habitats (Araújo and Maciel, 1977; Aveline, 1980; Roth and Scott, 1987; Novaes and Lima, 1992; Moraes, 1995; Alves et al., 1997; Olmos and Silva e Silva, 2001). Four of these papers described specifically the mangrove bird communities of Southeast and South Brazil (Araújo and Maciel, 1977; Moraes, 1995; Alves et al., 1997; Olmos and Silva-e-Silva, 2001). Two of these studies focused on bird communities of Rio de Janeiro (Araújo and Maciel, 1977; Alves et al., 1997). Olmos and Silva e Silva (2001) described

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in detail the avifauna of Santos and Cubatão mangroves, in São Paulo State. Despite of the fact that the estuarine complex of Iguape-Cananéia - Paranaguá is the biggest in South and Southeast Brazil (Herz, 1991), only Moraes (1995) focused on the community of birds associated to these environments.

The present study characterized the mangrove bird community of Paranaguá Bay, describing and comparing three sampling sites. Beyond contributing to understand this ecosystem, the results presented here could be the basis of conservation plans of fluvial-marine habitats in Paraná Sate - Brazil.

METHODS

Study sites

This study was conducted in Paranaguá Bay, in the coast of Paraná, South Brazil. The climate in the region is subtropical humid mesothermic with hot summer (Cfa), according to the Köeppen's classification. The annual average temperature varies between 20^o and 22^o C and precipitation between 2,000 to 2,500 mm per year. The most humid seasons are summer and autumn (Soares et al., 1997). The sampling sites were selected at three main rivers of Paranaguá Bay (Fig. 1), considering the distance of the city and the harbor of Paranaguá, the accessibility and mangrove physiognomy.

The first site (1) was located in a primary forest in the Guaraguaçu river, with non-altered forests, marshes and mangroves. The sampling point (752016, 7167993 UTM) at the *Floresta do Palmito* Reserve was approximately 6 km from the mouth of the river and 10 km from the Paranaguá harbor, included in one of the bigger areas of primary mangroves and *Restinga* forests in Paraná. The site 2, in Correias river, was 4 km up the mouth (750753, 7172043 UTM). The Correias river and Itiberê river surround the island of Valadares (4.03 km^2). In 1996, the village of Valadares occupied almost 90% of the island, with a population estimated in 9,750 inhabitants (IBGE 1996). The Correias river is located 3 km east from Paranaguá harbor. Besides the influence of the village, it is indirectly influenced by sewage from Paranaguá city and tides carrying residues from the harbor and industries. Small trees are used for domestic construction in the local settlements. The third site (3) is located in Emboguaçú river (746292, 7174575 UTM), 2km from the mouth of the river and three km from Paranaguá harbor. The river flows west of Paranaguá city, inhabited by more than 120.000 people in 1996 (IBGE, 1996). Besides the embankments and industrial pollutants, the Emboguaçu river is influenced directly by the habitants that exploit wood and crustaceans, capture birds, and allow sewer water into this river.

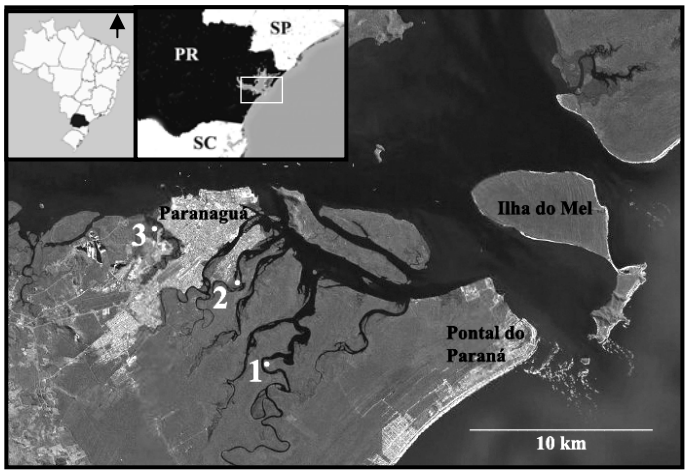

Figure 1 - Study sites (white numbers). Satellite image MDA EarthSat 2005.

Samplings

The three study sites were sampled one time per season form September 1997 to August 1998, for nine hours on each site only on non-rainy days. Transects (200 X 20 meters) were covered at each site early in the morning (between 6:00 and 8:00) and afternoon (between 16:00 and 18:00). One hour point counts was also conducted an area covering approximately 1ha. These surveys were after the morning transects (between 8:00 and 10:00) and before the evening transects (between 15:00 and 17:00). The birds observed were classified by species and vegetation stratum. To get a more complete list of bird species, was also included any additional species observed in the study sites. These additional species were used only in frequencies analysis.

Frequencies, relative abundance and density of each species were analyzed. The frequency indicated the percentage of sample units (season) when each species was present in each site. The relative abundance was calculated with the number of individuals observed by transect divided by the total of minutes of samplings and the number of individuals (of each species) per session of observation in a point count. The density was the number of individuals observed in transect per sample site (10.000 m^2).

The richness between seasons and sites were compared by Kruskal-Wallis (KW) and Dunn tests due to the non-parametric nature of the data. To classify the bird species in guilds, was followed the Moraes categorization (1998), and to classify the birds in relation to migratory movements was followed Olmos and Silva-e-Silva (2001). Was followed the taxonomy of Sick (1997).

The rarefaction curve of species were calculated with incidence data with the software estimates.

RESULTS

A total of 81 bird species were registered in the three mangrove sites (Table 1). Most of these birds were considered to live in forest habitats (43%), followed by aquatic birds (27%), and generalist species (15%). The birds observed in these mangroves were included mainly in the orders Passeriformes (37.8%), Ciconiiformes (8.5%), Falconiformes (7.3%), and Charadriiformes (7.3%). On average, were observed 32 species in the spring, 33 in the summer, 28 in the autumn, and 33 species in the winter. The richness did not differ statistically between seasons or sites (KW = 2.939; and KW = 1.911; both with $p > 0.05$), and the rarefation curve of species did not reach an asymptote (Fig. 2).

The birds, which consumed fruits, seeds, and arthropods and the aerial insectivores species were the most common in these environment (both with 11.1%). Also a relative high percentage of generalist aquatic species (8.6%) were registered. Most of the birds in Paranaguá mangroves were considered resident (59 species); 13 species migrating regionally, 3 from North, 2 locally, and 4 of them had no information. It was detected that 50.6% of bird species registered in Paranaguá Bay mangroves also occurred in *Restinga* Atlantic Forests around the sites. Mangrove specialists represented 26%.

The most frequent species in the three sites were *Egretta caerulea*, *Ceryle torquata*, *Chloroceryle amazona*, *Pitangus sulphuratus* and *Parula pitiayumi*. Species recorded with more than 90% of frequency were *Coragyps atratus, Aramides cajanea, Troglodytes aedon, Turdus amaurochalinus, Ramphocelus bresilius* and *Cacicus haemorrous*. More than a half of all bird species were observed only in one or two samplings. By point count methods were registered 60 species (Table 1). The most abundant species were *Pitangus sulphuratus** (Relative Abundance RA=3.1), *Charadrius semipalmatus* (RA=1.5), *Egreta caerulea* (RA=1.4), *Ceryle torquata** (RA=1.25) and *Turdus amaurochalinus* (RA=1.25). Species with asterisks were present in all samplings. The average in point count methods were 68 individuals in the spring, 56 in the summer, 78 in the autumn and 75 in the winter. These values were not statistically different (KW = 0.578; $p>0.05$). Medians of 50.5 individuals in Guaraguaçú site, 68.5 in Correias, and 108.5 in Emboguaçú site were observed, and the variation between sites were statistically different (KW = 6.986; $p<0.05$ / Dunn = $p<0.05$ Guaraguaçú < Emboguaçú).

A total of 39 species were observed in all transects (Table 1). The most abundant and frequent species registered were *Turdus amaurochalinus* (RA=5), *Parula pitiayumi* (RA=3.6) and *Pitangus sulphuratus* (RA=2.9). Medians of 40 individuals were observed in the spring, 24 in the summer, 34 in the autumn, and 47 in the winter. These medians were not statistically different (KW = 2.702; $p>0.05$). Medians of 25 individuals were observed

in Guaraguaçú site, 35 in Correias, and 40 in Emboguaçú site; the variation between sites was not statistically different (KW = 1.631; p>0.05).
A total of 50 bird species were registered in Emboguaçu river site, near Paranaguá harbor. Forty-five of these species were residents. The most abundant species in this site were *Tyrannus melancholicus*, *Passer domesticus*, *T. amaurochalinus*, *Coragyps atratus*, and *P. sulphuratus*. The species *P. sulphuratus* and *T. amaurochalinus* also presented the higher densities (0.0027 individuals/m^2, and 0.0025 ind/m^2 respectivelly).

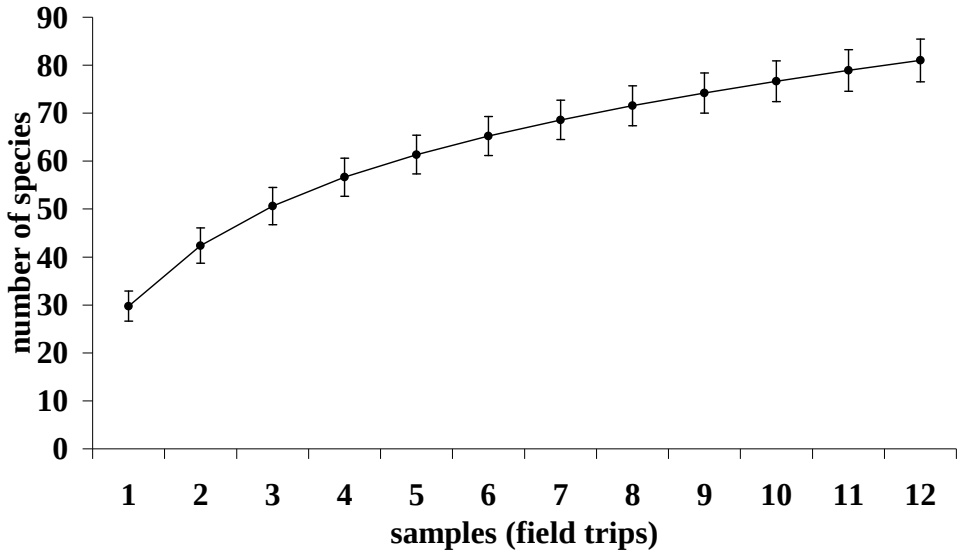

Figure 2 - Rarefaction curve of species. Bars represent standard deviaton

Table 1 - **Species of birds in mangroves of Paranaguá Bay - PR**. **F** (%), Frequencies of species (percentage of samplings where each species were observed, including additional observations); **RA PC** (individuals/hour), Relative Abundance in Point Counts; **RA Tr** (individuals/hour), Relative Abundance in Transects; **Migr**, Migration, R - residents, L - species that moves locally for reproduction, M - species that migrate regionally or intertropics, N - Neartic migratory species (adapted from Olmos and Silva-e-Silva 2001); **Guilds**, CFSAco, Consumers of Fruits, Seeds and Arthropods of canopy, CFSAte, Consumers of Fruits, Seeds and Arthropods of all strata, CFSco Consumers of Fruits, Seeds of canopy, CGEca, Aquatic Generalist Consumers , CGEso Terrestrial Generalist Consumers, CGEte Generalist Consumers in all strata, CNEte Consumers of Nectar in all strata, PINco Predators of Invertebrates in canopy, PINca Predators of Invertebrates in the water, PINso Terrestrial Predators of Invertebrates, PINsu Predator of Invertebrates in understory, PINtr Predator of Invertebrates in tree trunks, PISea Predator of Insects in the air, PIVte Predator of Invertebrates and Vertebrates in all strata, PPEca Predators of fishes (adapted from Moraes 1995). **Sites**, G - Guaraguaçú Site, C - Correias Site, E - Emboguacú Site.

Species	F (%)	RA PC (ind/h)	RA Tr (ind/h)	Migr	Guilds	Sites
Phalacrocorax brasilianus	58,33	0,56		R	PPEca	GCE
Ardea cocoi	33,33	0,03		R	CGEca	GC
Casmerodius albus	50,00	0,08		R	CGEca	GCE
Egretta thula	58,33	0,22		R	CGEca	GCE
Egretta caerulea	**100,00**	**1,36**	0,13	R	CGEca	GCE
Butorides striatus	50,00	0,22	0,11	R	CGEca	GCE
Nycticorax nycticorax	58,33	0,14	0,05	R	CGEca	GCE
Nyctanassa violacea	25,00	0,03		R	CGEca	G

(Cont. ...)

(Cont. Table 1)

Species	F (%)	RA PC (ind/h)	RA Tr (ind/h)	Migr	Guilds	Sites
Platalea ajaja	41,67	0,08		R	PINca	GCE
Coragyps atratus	**100,00**	0,72	0,41	R	CGEte	GCE
Cathartes aura	50,00			R	CGEso	C
Anas bahamensis	8,33			L	PINca	C
Cairina moschata	50,00	0,03		R	PINca	GCE
Rupornis magnirostris	8,33			R	PIVte	C
Micrastur ruficollis	8,33			R	PIVte	G
Milvago chimachima	66,67	0,19	0,17	R	CGEte	GCE
Polyborus plancus	16,67	0,06		R	CGEso	GCE
Aramides cajanea	91,67	0,83	0,29	R	CGEso	GCE
Vanellus chilensis	58,33	0,19		M	PINso	GCE
Charadrius semipalmatus	33,33	**1,50**		N	PINso	GC
Tringa flavipes	8,33	0,03		N	PINso	C
Tringa melanoleuca	8,33			N	PINso	C
Actitis macularia	50,00	0,64		N	PINso	GCE
Rynchops niger	8,33			M	PPEca	C
Columba cayennensis	33,33	0,19	0,11	M	CFSco	GCE
Columbina talpacoti	41,67	0,31		R	CGEso	CE
Leptotila rufaxilla	25,00	0,03	0,06	R	CFSco	C
Forpus xanthopterygius	8,33	0,03		R	CFSco	E
Pionus maximiliani	25,00			R	CFSco	C
Amazona braziliensis	66,67	0,17	0,66	R	CFSco	GC
Coccyzus melacoryphus	8,33	0,08		L	PINsu	C
Tapera naevia	8,33			R	PINsu	C
Tyto alba	8,33			R	PIVte	G
Otus choliba	50,00			R	PIVte	CG
Asio stygius	16,67			R	PIVte	GE
Nyctibius griseus	8,33			R?	PISea	G
Lurocalis semitorquatus	8,33			R	PISea	C
Chordeiles acutipennis	16,67			M	PISea	GE
Nyctidromus albicollis	16,67			R	PISea	GC
Streptoprocne zonaris	8,33			?	PISea	E
Chaetura meridionalis	41,67	0,22	0,08	M	PISea	CE
Amazilia versicolor	33,33	0,06	0,13	R	CNEte	CE
Aphantochroa cirrhochloris	66,67	0,17	0,63	R	CNEte	GCE
Ceryle torquata	**100,00**	**1,25**	0,54	R	PPEca	GCE
Chloroceryle amazona	**100,00**	**1,17**	0,30	R	PPEca	GCE
Chloroceryle americana	75,00	0,69	0,18	R	PPEca	GCE
Chloroceryle aenea	16,67	0,03		R	PPEca	GE
Picumnus cirratus	8,33		0,05	R	PINtr	G
Dryocopus lineatus	16,67	0,06	0,05	R	PINtr	C
Melanerpes candidus	8,33	0,11		R	PINtr	E
Veniliornis spilogaster	16,67		0,19	R	PINtr	GE
Thamnophilus caerulescens	16,67	0,03	0,05	R	PINsu	G
Camptostoma obsoletum	25,00	0,11		M	PINco	GC
Elaenia mesoleuca	8,33	0,14	0,22	?	PINco	E
Serpophaga subcristata	8,33			R	PINco	E
Attila rufus	8,33			R	PINco	G
Myiarchus ferox	50,00	0,28	0,93	R	PINco	GCE

(Cont. ...)

(Cont. Table 1)

Species	F (%)	RA PC (ind/h)	RA Tr (ind/h)	Migr	Guilds	Sites
Pitangus sulphuratus	**100,00**	**3,11**	**2,91**	R	CFSAte	GCE
Legatus leucophaius	16,67		0,06	R	CFSco	CG
Tyrannus savanna	8,33	0,03		M	CFSAco	E
Tyrannus melancholicus	41,67	**1,17**	**1,51**	M	CFSAco	GCE
Progne chalybea	25,00	0,08		M	PISea	GCE
Notiochelidon cyanoleuca	58,33	0,44	0,24	M	PISea	GCE
Stelgidopteryx ruficollis	25,00	0,67	0,28	R	PISea	GCE
Cyanocorax caeruleus	41,67	0,11	0,43	?	CFSAte	GCE
Troglodytes musculus	91,67	0,33	**1,40**	R	PINsu	GCE
Turdus rufiventris	75,00	0,75	0,36	M	CFSAte	GCE
Turdus amaurochalinus	91,67	**1,25**	**5,00**	M	CFSAte	GCE
Vireo chivi	25,00	0,08	0,27	R	CFSAte	GCE
Parula pitiayumi	**100,00**	1,06	**3,58**	R	CFSAco	GCE
Geothlypis aequinoctalis	8,33			R	PINsu	G
Ramphocelus bresilius	91,67	0,97	0,74	R	CFSAte	GCE
Thraupis sayaca	33,33	0,31	0,53	R	CFSAco	CE
Tangara cyanocephala	8,33	0,14		R	CFSAco	E
Tangara peruviana	8,33	0,17	0,08	R	CFSAco	E
Conirostrum bicolor	8,33		0,28	R	PINsu	C
Tersina viridis	8,33	0,08		R	CFSAco	E
Cacicus haemorrhous	91,67	0,92	**1,11**	R	CFSAco	GCE
Cacicus chrysopterus	8,33		0,03	R	CFSAco	G
Molothrus bonariensis	8,33			M	CGEte	C
Passer domesticus	33,33	0,83	**1,03**	R	CGEte	E

In Correias river site (4 km from the harbor), were observed 57 bird species (47 residents, 8 migratory and 2 unknown). The most abundant species in point counts were *Stelgidopteryx ruficollis*, *Pitangus sulphuratus*, and *Ramphocelus bresilius.* In the transects, *Troglodytes aedon*, *S. ruficollis*, *Conirostum bicolor*, *Myiarchus ferox*, and *Turdus amaurochalinus.* The species *T. amaurochalinus* and *P. pitiayumi* occurred in higher densities (0.0051 ind/m^2 and 0.0017 ind/m^2 respectivelly).

Were observed 52 species of birds in Guaraguaçú site; 6 of these are migratory. The most abundant species were *Phalacrocorax brasilianus*, *Ceryle torquata*, *Tyrannus melancholicus*, *Pitangus sulphuratus* and *Cacicus haemorrhous*. In the autumn were observed large flocks of *Charadrius semipalmatus*, and higher abundances of *Parula pitiayumi*. The species with higher densities were *P. pitiayumi* and *C. haemorrhous* (0,0037 ind/m2 and 0,0021 ind/ m^2 respectively). Only in this site were registered *Nyctanassa violacea*.

DISCUSSION

The mangrove bird community of Paranaguá Bay is one of the richest of Brazil, and is composed mainly by forest bird species. These characteristics affect directly guild composition and species predomination, when compared with other studies.

The mangrove avifauna of Paranaguá Bay is richer than the observed in the mangroves of Guanabara Bay in Rio de Janeiro. In the two studies accomplished in that site, were registered 67 and 34 species of birds (Araújo and Maciel, 1977; Alves et al., 1997). In these mangroves predominated aquatic birds (with more than 50% in both studies) different of the results presented here. The avifauna described here is also richer than the observed in mangroves of Colombia (77 species; Naranjo, 1997); Venezuela, (72 species; Cassler and Este, 1996) and French Guiana (75 species; Tostain, 1986). These other mangroves shelter distinct bird communities, in relation to composition and higher percentages of aquatic bird species. In French Guiana mangroves, were

observed bird families never observed in the mangroves of south and southeast Brazil, as Ramphastidae, Dendrocolaptidae and Cotingidae (Tostain, 1986).

Other mangroves sites presented richer avifauna than Paranaguá. The mangroves of Santos, in São Paulo, less than 500 km north, were registered 200 bird species (Olmos and Silva-e-Silva, 2001). In the mangroves of Panamá were registered 104 specie of birds (Lefebvre and Poulin, 1997), in Suriname were observed 87 species (Haverschimidt, 1965), and in Trinidad 94 species of birds (ffrench, 1966). The avifauna of Santos is one of the richest mangrove communities, and it is composed by more than 50% of aquatic bird species (Olmos and Silva-e-Silva, 2001). On the other hand, the mangrove bird communities of Panamá, Suriname and Trinidad are composed by a high percentage of forest dependent birds, as the results presented here.

Possible explanations for these results could be the proximity and extension of the forests around mangroves. These forests proportionate the occurrence of transient species that consequently colonize the mangroves. This hypothesis is also proposed by Olmos and Silva-e-Silva (2001) that also considered the high diversity of the forests around mangroves and the physiognomy complexity of mangroves in Panamá, Suriname e Trinidad (Lefebvre and Poulin, 1997; Haverschimidt, 1965; ffrench, 1966). Olmos and Silva-e-Silva (2001) also discussed about the possibility of increasing richness of forest birds in southern mangroves (as Cananéia-Iguape-Paranaguá), because it is still surrounded by a large extension of Atlantic Forests. Our results reinforce this hypothesis showing that birds that migrate regionally compose 13% of Paranaguá mangrove bird community, and that 50.6% of bird species are also occurring in *Restinga* around sites. The predominance of consumers of fruits, seeds and arthropods also shows the importance of *Restinga* forests around mangroves that proportionate fruits, seeds and an invertebrate community sustaining the avifauna.

High frequencies of *E. caerulea* and *C. torquata*, and seasonal abundance of migratory birds as *Charadrius semipalmatus, Tringa flavipes, Tringa melanoleuca* and *Actitis macularia* were also registered in other studies (Olmos and Silva e Silva 2001; Moraes 1995). These observations reinforce the importance of the sites to the maintenance of feasible populations of these species. It is also important to emphasize the presence of *Amazona brasiliensis*, *Tangara peruviana*, and *Conirostrum bicolor*, species limited to south and southeast coast of Brazil and considered as nationally or regionally endangered (Birdlife 2000).

The differences of abundance and species composition between the sampling sites could be associated to human impacts and physiognomy of mangroves. The higher number of individuals in the mangrove near Paranaguá city could be directly related to the occupation of *Restinga* forests and other nearby mangrove sites, increasing the density of small areas. Other cause could be the differences in physiognomy promoted by the continuous exploitation of these areas. As a possible consequence of these impacts, were registered only in Emboguaçu site, the presence of large flocks of *Coragyps atratus* and *Passer domesticus* in the mangroves. Smaller abundance of frugivorous species as *Parula pitiayumi* and *Turdus amaurochalinus* could be a result of niches substitution by that generalist species.

The results of this study are contributing to increase the knowledge about mangroves avifauna. Moreover, this paper is also contributing to understand that the composition of mangrove bird communities could be directly associated to physiognomy, conservation of mangrove sites, and extension of around forests. Therefore, were emphasized the importance of conservation of mangroves in Paranaguá Bay. These environments are extremely relevant to local avifauna, not only to resident species, but also to migratory and endangered birds in Brazil.

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RESUMO

Este estudo teve como objetivos caracterizar a comunidade de aves de manguezais na baía de Paranaguá e comparar descritivamente a comunidade das três áreas amostradas, diferentes em relação à proximidade de centros urbanos. Foram amostradas sazonalmente, entre setembro de 1997 a setembro 1998, três áreas de manguezais a diferentes distâncias da cidade e do porto de Paranaguá. A avifauna foi registrada em transectos de 200m no interior dos manguezais e em observações de 1 hora em pontos fixos. Foram determinadas freqüência, abundancia relativa e densidade de espécies em cada área. Foram observadas 81 espécies de aves nas três áreas de manguezais. As guildas mais significativas foram das espécies consumidoras de frutos, sementes e artrópodos de copa e das predadoras de insetos em vôo. As espécies mais freqüentes e abundantes foram *Egretta caerulea*, *Ceryle torquata*, *Chloroceryle amazona*, *Pitangus sulphuratus Turdus amaurochalinus* e *Parula pitiayumi*. Esta comunidade é uma das mais ricas dos manguezais brasileiros atualmente estudados e se destaca por ser composta principalmente por aves que também ocorrem nas florestas de restinga ao redor. Algumas diferenças entre as áreas amostradas podem ser decorrentes dos impactos ocasionados pela proximidade dos centros urbanos. Além de contribuir significativamente para o conhecimento deste ecossistema, os resultados do presente estudo poderão servir de base para planos de conservação dos ambientes de influencia flúvio-marinha no estado do Paraná.

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