Microhabitat use by three species of egret (Pelecaniformes, Ardeidae) in southern Brazil

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(With 1 figure)

Abstract

In the present study, we examined the role of different habitat components and their relationship with microhabitat use by three species of egret: Cocoi heron (*Ardea cocoi*), Great egret (*Ardea alba*), and Cattle egret (*Bubulcus ibis*), in wetlands of southern Brazil. *Ardea alba* and *A. cocoi* were not habitat-specific (e.g. vegetation cover and flooding level). Conversely, *B. ibis* was associated with drier microhabitats. Relative air humidity and air temperature were the main variables which correlated with the occurrence of these species and supported the plasticity of *B. ibis* and its predominance in drier habitats.

Keywords: Aquatic birds, marsh, habitat, Taim.

Uso de micro-habitat por três espécies de garça (Pelecaniformes, Ardeidae) no sul do Brasil

Resumo

No presente estudo foi avaliado o papel de diferentes componentes do habitat e sua relação quanto ao uso do microambiente por três espécies de Ardeidae: garça-moura (*Ardea cocoi*), garça-branca-grande (*Ardea alba*) e garça-vaqueira (*Bubulcus ibis*), em banhados do extremo sul brasileiro. Aparentemente, *A. alba* e *A. cocoi* não apresentaram especificidade a algum tipo de habitat (e.g. cobertura vegetal e nível de alagamento). Por outro lado *B. ibis* revelou associações a microambientes mais secos. A temperatura do ar e umidade relativa do ar foram as principais variáveis correlacionadas com a ocorrência dessas espécies, além disso, reforçou-se a plasticidade de *B. ibis* e sua predominância em ambientes secos.

Palavras chave: Aves aquáticas, banhados, habitat, Taim.

1. Introduction

Among the many bird species found in South-American wetlands, egrets (Ardeidae) are one of the most representative in abundance and frequency of occurrence and widely distributed in Brazil (Sick, 1997). Despite the considerable number of studies on their migration, and population dynamics (Antas, 1994; Nascimento and Schultz-Neto, 2000; Accordi, 2003), the use of micro habitats by egrets is still poorly understood (Yousefi et al., 2012). Despite the relative satisfactory level of knowledge about habitat use/selection for many species of birds (Block and Brennan, 1993), there is a lack of studies concerning the use of particular parts of the entire habitat (Poletto et al., 2004; Lopes and Marini, 2006; Yousefi et al., 2012). The availability of detailed information on microhabitat use is useful for development of ecological theories or models on species distribution, migrations and even for the ecological basis for habitat management (Hutto, 1985).

The southern region of Brazil comprises large areas of marshes (Waechter, 1985) and most of the country's richness of aquatic birds. Despite that, these habitats are under strong pressure from cattle ranching and agricultural activities (Guadagnin and Laidner, 1999), therefore studies in these areas are essential. The Brazilian flooded areas encompass nearly 50% of all wetlands in South America (Naranjo, 1995), most of them located in the Coastal Lowland and the Central Depression of Rio Grande do Sul (Maltchik et al., 2003). In these areas, marshes harbour many species of resident and/or migra-

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tory aquatic birds (Belton, 1994; Diegues, 2002). In general, ardeid birds exhibit a capacity to exploit a wide range of wet habitats (Gibbs, 2000; Oliveira, 2006). However, the migratory behaviour of *Ardea alba* (Linnaeus, 1758), indicates a tendency to move to particular regions due to the abiotic aspects (Sick, 1997; Nunes and Tomas, 2004). Probably many other local factors such as vegetation cover should influence the movements and at least the habitat use by *A. alba* and other egrets such as *Ardea cocoi* (Linnaeus, 1766), and *Bubulcus ibis* (Linnaeus, 1758), that are both nomad species. However these data are not available for subtemperate neotropical wetlands. Considering this, the present study aimed at examining biotic and abiotic environmental factors associated with microhabitat use by three species of egrets in subtemperate wetlands of southern Brazil.

2. Material and Methods

2.1. Study site

The study was carried out at the Taim Ecological Station (Taim ES), located in Rio Grande do Sul state (32°50' S and 52°26' W) in the coastal region of southern Brazil. The area comprises lagoons connected to a system of marshes and temporary water bodies of an area of over 33.000 ha. The climate of the region is characterised as a transition between temperate and humid subtemperate climates, with annual average temperatures and rainfall of 17.8 °C and 1283.5 mm, respectively (Maluf, 2000). During the study, the hottest months were March and April (average air temperature = 21.1 °C ± 1.1 °C) and the coldest were July and August (average air temperature = 13.3 °C ± 2.8 °C). The climate data were obtained from the Meteorological Station of Rio Grande (#83995), situated near the study site.

2.2. Data collection

Birds were directly counted (Bibby et al., 2000) between March and September 2011 during regular surveys (one day per week) between March and September 2011. A road that crosses the study site (BR 471) was used as a transection, and which was driven along by car at a speed below 20 km/h, and birds visually detected were recorded. The road is approximately 3 m above the surrounding terrain to prevent flooding. This location, in addition to the flat relief and predominance of low vegetation, allowed the observation of birds as close as approximately 600 m from the observer. The observations were carried out in the morning between 9:00 am and 12:00 am, when birds are very active, facilitating their detection. Ten kilometres of the road were monitored (from 32°20'49.74" S to 52°32'41.21" S). Both sides of the road were surveyed, each side by one observer. To reduce bias, the observers alternated the monitored side after each sampling. Flying birds were not included, counts were conducted with the naked eye with subsequent aid of binoculars (model 8x40 Bushnell) when necessary for species identification. Nomenclature followed Bencke et al. (2010) and CRBO (2011).

To examine microhabitat selection, records of available microhabitats and those used by birds were compared. The characterisation of microhabitats was carried out with standardised photos: (a) observer at the transection facing the water body, (b) camera set up horizontally at a fixed height of 1.5 m from the ground, (c) bird in the landscape in the centre of the image. To ensure that the habitat was adequately represented in the evaluation, images of birds that contained the sky or any other "non-habitat" component in the photo (e.g. portion of the transect) were not included. All birds observed were photographed. Available microhabitats were quantified by using photographs taken every 2 km along the road. For the characterisation of used and available microhabitats, a grid with 25 squares was placed on each photo, and the type of ground cover was determined (adapted from Freitas et al., 2002; Bennetts et al., 2006). The predominant formation (> 50%) in each square was classified in one of the following categories: Tall vegetation on flooded substrate (TVFS), tall vegetation on dry substrate (TVDS), low vegetation on flooded substrate (LVFS), low vegetation on dry substrate (LVDS), floating vegetation (FV) and visible water surface (VWS). Also, each individual was recorded as on flooded, dry substrate or as roosting.

2.3. Data analysis

The use of different types of substrate (flooded, dry, and roosting) was analysed with the Kruskal Wallis test (Zar, 1999). The characterisation of the heterogeneity of the vegetation cover, as well as its association with each one of the egret species recorded, was carried out with a Principal Component Analysis (PCA), generated by the software MVSP, version 3.1 (Kovach, 1999). All records of *B. ibis* were obtained very distant from the transect, and adequate records of the habitat could not be obtained, as well as of the individuals in the image, in order to comply with methodological standards. Thus, the PCA was carried out only for *A. alba* and *A. cocoi*. The association of the presence of species in the study area with climatic variables was examined with the Spearmann correlation (Zar, 1999).

3. Results

During twenty-four field trips between March and September 2010, we obtained a total of 2001 records, 579 of *A. alba*, 624 of *A. cocoi*, and 798 of *B. ibis* (Table 1). Despite more records of *A. alba* (n = 579) on dry substrate (average = 14.84 records/day ± 17.00) than on flooded substrate (average = 8.16 records/day ± 10.42), the post hoc test for Kruskal Wallis was not significant. However, these substrates were more frequently used than perches (average = 0.48 records/day ± 0.82; $H_{[2; 75]} = 31.87$ $p < 0.01$). The same was observed for *A. cocoi* (n = 624), with a number of records on dry substrate (average = 14.60 records/day ± 14.44) not significantly dif-

Table 1 - Total number of records of *Ardea alba*, *Ardea cocoi*, and *Bubulcus ibis* sighted from March to September 2011 along 10 km transect, with corresponding averages, standard deviations, and frequency of occurrence (%) in flooded microhabitat (fm), dry microhabitat (dm) and perch (pm).

Species	N	Total (fm/dm/pm)			Average of records (fm)/trip	(dm)/trip	(pm)/trip	% fm	% dm	% pm
Ardea alba	579	202	370	7	8.16 ± 10.42	14.84 ± 17.00	0.24 ± 0.72	34.9	63.9	1.2
Ardea cocoi	624	247	365	12	9.88 ± 6.29	14.6 ± 14.44	0.48 ± 0.82	39.6	58.5	1.9
Bubulcus ibis	798	72	722	4	3.43 ± 7.79	34.38 ± 56.60	0.19 ± 0.60	9.0	90.5	0.5

ferent than that on flooded substrate (average = 9.88 records/day ± 6.29), and both were used more frequently than perches (average = 0.48 records/day ± 0.82; $H_{[2;75]} = 48.89$; $p < 0.01$). For *B. ibis* (n = 798), the number of records on dry microhabitats (average = 34.38 records/day ± 56.60) was higher than those on flooded substrate (average = 3.43 records/day ± 7.78) or perches (0.19 records/day ± 0.60; $H_{[2;63]} = 31.78$; $p < 0.001$; Table 1).

The number of individuals of *A. alba* recorded was negatively correlated with average air temperature ($r = -0.44$; $p = 0.03$) and accumulated monthly rainfall ($r = -0.69$; $p < 0.001$), but not with relative air humidity ($r = 0.19$; $p = 0.34$) and wind speed ($r = 0.05$; $p = 0.81$). For *A. cocoi*, a negative correlation was found only for the number of birds sighted and average air temperature ($r = -0.43$; $p = 0.03$), but not with accumulated rainfall ($r = -0.20$, $p = 0.33$), relative air humidity ($r = 0.11$; $p = 0.57$), or wind speed ($r = -0.19$; $p = 0.34$). For *B. ibis*, no significant correlation was found between the number of birds sighted and any of the variables tested: average air temperature ($r = 0.14$; $p = 0.55$), accumulated rainfall ($r = 0.42$; $p = 0.06$), relative air humidity ($r = 0.26$; $p = 0.24$) and wind speed ($r = -0.25$; $p = 0.27$).

We analysed 235 photo records, from which 131 were available microhabitats, 56 used microhabitats by *A. alba* and 48 by *A. cocoi* (this analysis was not carried out for *B. ibis*, see details in Material and Methods). The PCA revealed that despite the high availability of dry microhabitats, they were less frequently used than flooded ones, regardless of the type of vegetation cover (Tables 2 and 3). Both species examined were associated with microhabitats with presence of water body with floating vegetation, but also with large areas of visible water surface (Figure 1). The presence of low vegetation or shrubs seems to influence little in the selection of flooded microhabitats by egrets.

4. Discussion

Microhabitat use by *A. alba* and *A. cocoi* was similar. Both species were not selective regarding dry or flooded substrates, as also observed by other study (Gimenes and Anjos, 2011). However, these species are strongly biased toward flooded habitats (Motta-Junior, 2008; Carvalho, 2010; Gimenes and Anjos, 2011). It should be pointed out that in many studies on habitat use by egrets, little or no importance was given to analysing the use of the microhabitat (Moreno et al., 2004). Possible relationships between the pattern of vegetation cover, substrate types, flooding level and the selection of portions of the environment by studied egret species are virtually unknown (Dario, 2010). Our findings revealed that despite being present in wetlands (in a generic definition of the term "flooded habitats"), *A. alba* as well *A. cocoi* exploit substrates with or without water in a similar way, and rarely use perches to forage. On the other hand *B. ibis* exhibited preferences for dry microhabitats, possibly due to

Table 2 - Autovalues and percentages of variance explained by the six principal components of the variance in the presence and type of vegetation, flooding associated with available and used microhabitats by two species of egret (*Ardea alba* and *Ardea cocoi*) in marshes of southern Brazil.

	Axis					
	I	**II**	**III**	**IV**	**V**	**VI**
Eigenvalues	1.898	1.412	1.162	0.71	0.522	0.249
Percentage	31.886	23.718	19.514	11.932	8.775	4.175
Accumulated percentage	31.886	55.604	75.118	87.05	95.825	100

Table 3 - Autovectors of the six principal components (axis 1 to 6) of the variation in the presence of shrubs, grass, trees, barren soil, shadow projected on the ground and air humidity associated with available and used microhabitat by two species of egret (*Ardea alba* and *Ardea cocoi*) in marshes of southern Brazil. The most important variables in the first axis are in bold. TVFS = Tall vegetation on flooded substrate, TVDS = Tall vegetation on dry substrate, LVDS = Low vegetation on dry substrate, LVFS = Low vegetation on flooded substrate, FV = Floating vegetation, VWS = Visible water surface.

	Axis 1	**Axis 2**	**Axis 3**	**Axis 4**	**Axis 5**	**Axis 6**
TVFS	-0.266	-0.048	0.183	-0.598	0.520	0.515
TVDS	0.631	-0.244	0.592	0.201	-0.059	0.385
LVFS	-0.134	0.077	0.07	-0.436	-0.845	0.260
LVDS	0.478	0.207	-0.716	-0.018	0.035	0.464
FV	-0.425	-0.646	-0.228	0.423	-0.106	0.399

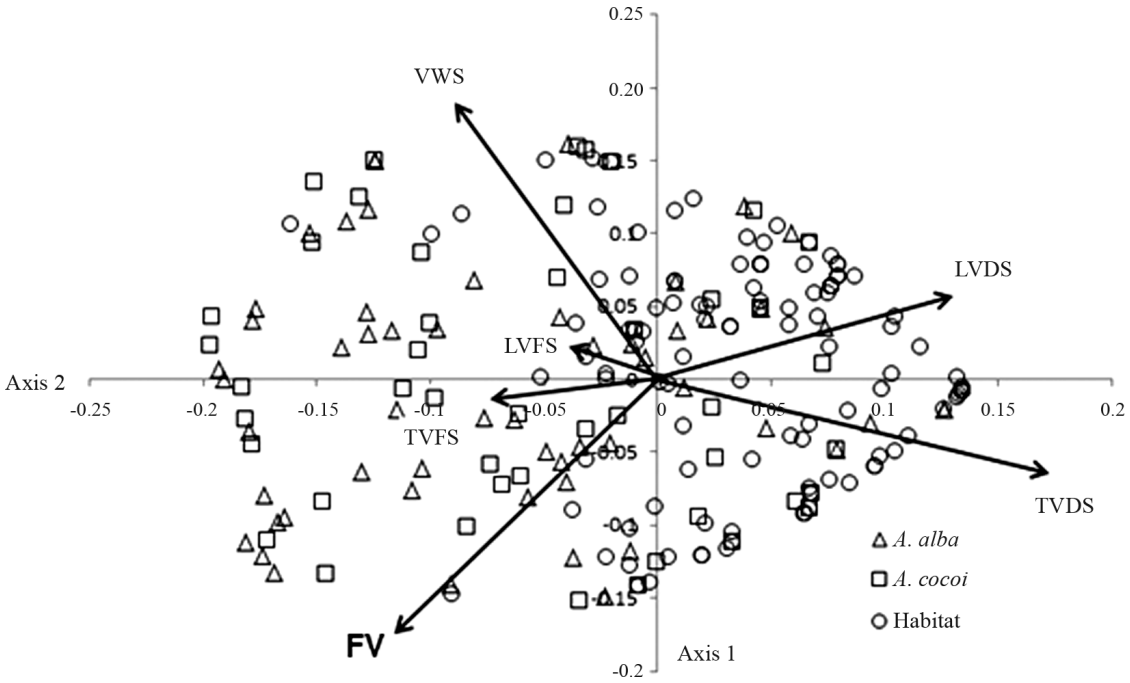

Figure 1 - Ordination diagram ("biplot") of parcels along the 1st and 2nd axes of the Principal Component Analysis (PCA), generated from the analysis of five categories of characteristics of the Taim wetland, including the BR-471 road (arrows). Vectors of category variables of chosen habitats: TVFS = Tall vegetation on flooded substrate, TVDS = Tall vegetation on dry substrate, LVDS= Low vegetation on dry substrate, LVFS = Low vegetation on flooded substrate, FV = Floating vegetation, VWS = Visible water surface. The different symbols represent microhabitats used by birds (triangle = *Ardea alba*; square = *Ardea cocoi*, circle = available microhabitats).

its association with cattle (Sick, 1997; Hofling and Camargo, 2002).

In the present study, unlike the expected, fewer individuals of *A. alba* and *A. cocoi* were observed on warmer days. Probably during very hot days, egrets seek shelter in more shaded sites that are not available in the study area, since most of the landscape is devoid of trees that could provide shade and cooler areas. We also consider the possibility that higher temperatures might decrease the access to the prey for *A. alba*. Some fishes, including a potential prey of *A. alba* at study site (*Rhamdia quelen*; Garcia et al., 2006), demonstrate lower levels of mobility during warmer days (Gomes et al., 2000). Despite being a little speculative, we believe that egrets should reduce the foraging activity during hottest days as a consequence to the effect of climatic conditions on their prey (see Stevens, 2002; Bergmann et al., 2013).

The non-interference of the variables examined was expected for *B. ibis*, as this is a species that feeds in association with cattle (Gasset et al., 2000; Bella and Azevedo-Junior, 2004). This relationship with human activities demonstrates the plasticity of this species (Leitão and Farinha, 1998), which uses a wide variety of habitats (Jenni, 1969; Pemeroy, 1975).

Although no significant differences were found regarding the use of flooded or dry substrates by *A. alba* and *A. cocoi*, the PCA indicated that both species are associated with habitats with a predominance of flooded areas, especially those with more visible water surface. The low density of shrubs in the microhabitats selected suggests the association of these species with open habitats. In general our findings revealed differences regarding microhabitat use by the three study species, indicating the presence and arrangement of water bodies as important factors for microhabitat selection by native species, although not as evident for *B. ibis*.

Our results support the hypothesis that the structure of habitats determines the structure and composition of assemblages of aquatic birds. *Ardea alba* and *A. cocoi* are ecologically similar, including regarding habitat use, as both do not exhibit a microhabitat preference and rarely use perches. Air temperature and air relative humidity are the main environmental variables correlated to the occurrence of these fishing species in the study site.

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