A R T I C L E

DIETARY ADAPTABILITY OF THE GIANT OTTER, *Pteronura brasiliensis* (MAMMALIA: MUSTELIDAE), IN TWO FLOODPLAIN SYSTEMS IN THE PANTANAL WETLAND, MATO GROSSO STATE, BRAZIL

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Abstract: The giant otter, *Pteronura brasiliensis*, is an almost exclusively piscivorous mammal of the family Mustelidae, and an endangered species. The present study compared the diet of the giant otter in two floodplain systems of the Pantanal wetland, a permanent lake and a river branch, in the Poconé and Barão de Melgaço wetlands in the Brazilian state of Mato Grosso. Samples were collected during the dry seasons, with 43 spraints being collected from the lake and 31 from the river branch. The fish species present in the samples were identified based on the comparison of bone fragments found in the spraints with specimens of fish collected from the two floodplain systems. The diets were composed primarily of fish of the families Erythrinidae (94.6%), Cichlidae (91.9%), Pimelodidae (70.3%), Callichthyidae (63.5%), and Doradidae (60.8%). Catfish (Siluriformes) were more abundant in the samples from the lake, while characins (Characiformes) were well represented in the river branch. While the siluriform family Callichthyidae was a prominent component of the otter diet in both study areas, it has been rarely recorded in previous studies of *P. brasiliensis* in either the Amazon or Pantanal regions. Most of the fish recorded in the diet of the otter are not targeted by commercial fisheries in Mato Grosso. The varying characteristics of different aquatic systems are important determinants of the composition of the local fish fauna and are thus relevant to the feeding ecology of the giant otter in the Pantanal wetland.

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INTRODUCTION

The giant otter, *Pteronura brasiliensis* (Gmelin, 1788), is a predominantly piscivorous mammal, which feeds opportunistically on the most abundant fish found near the margins of rivers and lakes (Duplaix, 1980; Schweizer, 1992; Carter and Rosas, 1997; Paglia et al., 2012; Duplaix et al., 2015). These otters rarely consume other types of prey (Cabral et al., 2010; Silva et al., 2013). Most studies of the feeding ecology of the giant otter are based on the identification and quantification of the hard parts of prey species found in spraints (Laidler, 1984; Rosas et al., 1999; Rosas-Ribeiro et al., 2012), although some direct observations have been possible (Duplaix, 1980). However, direct observation is logistically more complex and costly than fecal analysis (Carter et al., 1999).

Excessive hunting for the fur trade has had a fundamental impact on giant otter numbers (Carter and Rosas, 1997), and in 2000, the conservation status of *P. brasiliensis* was upgraded from "Vulnerable" to "Endangered" by the International Union for Conservation of Nature (Duplaix et al., 2008), and the species has remained in this category ever since (Groenendijk et al., 2015). The ongoing accumulation of human pressures and habitat loss in South America is the principal threat to this species (Groenendijk et al., 2015). Tourism and conflicts with fishers have also had an important impact on the species in the Pantanal wetland of Brazil (Rosas et al., 2008). In Brazil, *P. brasiliensis* is classified as "Vulnerable" in the Official List of Species of Brazil Threatened with Extinction (MMA, 2018).

This degree of threat reinforces the need for ecological studies that consolidate the understanding of the ecology of *P. brasiliensis* and provide an important database for the conservation of the giant otter. While the giant otter populations persist within the historical range of the species, the illegal fur trade, conflicts with fisheries, mining, the construction of dams, tourism, deforestation, and climate change have all intensified the pressures on the populations remaining in the wild (Duplaix et al. 2015).

Giant otter populations in the Pantanal wetland have been the focus of a number of important studies, including genetics and conservation (Garcia et al., 2007; Pickles et al., 2012), habitat characteristics (Camilo-Alves and Desbiez 2005), contamination by mercury (Fonseca et al., 2005), and ethology (Leuchtenberger and Mourão, 2008; Leuchtenberger et al., 2013). Schweizer (1992), Rosas et al. (1999) and Leuchtenberger et al., (2020) have provided some data on the diet of the giant otter in the southern Pantanal, but systematic studies of the species' diet and other aspects of its ecology in the northern Pantanal are scarce. In addition, the relative contribution of lakes and creeks to the diet of *P. brasiliensis* has been poorly documented, not only in the Pantanal, but also in other regions.

The present study compares the diets of *P. brasiliensis* in two different types of aquatic system that are common in the northern Pantanal wetland in the state of Mato Grosso, Brazil. One type of system is the permanent lakes, known locally as "*baías*", while the other is branches of rivers, known as "*corixos*". The study analyzes differences between these systems in the taxonomic composition of the *P. brasiliensis* diet in these two systems during the dry season. The data were also compared with those collected in previous studies of the diet of

giant otters in the Amazon regions (Cabral et al., 2010); Rosas-Ribeiro et al., 2012; Silva et al., 2013) and Pantanal (Rosas et al., 1999; Leuchtenberger et al., 2020).

MATERIAL AND METHODS

Study area

The present study was conducted in the northern Pantanal, in the southwestern extreme of the Brazilian state of Mato Grosso, which covers a total area of 147,574 km^2 of wetland habitats, formed by the Paraguay River and its tributaries (15º30'–22º30' S, 54º45'–58º30' W). The Pantanal encompasses an enormous diversity of riparian habitats and forest fragments that are flooded either permanently or over the course of the annual flood cycle (Alho et al., 2008). The drainage capacity of the floodplain is greatly reduced, with water accumulating in depressions, forming lakes (*baías*) or being flooded permanently. During the flood period, the water flows slowly through channels known locally as "*corixos*" or along shallow runoffs, known as "*vazantes*" (Alho and Sabino 2012).

The annual flood pulse of the Pantanal floodplain is the principal driver of changes in the composition of the local fish communities, with a high level of species turnover occurring between the flood and dry seasons. This marked temporal gradient in the hydrological cycle provokes a large-scale response in the local fish communities to the annual flood pulse (Pains da Silva et al., 2010).

The study was conducted in two distinct types of habitat, a permanent lake and a river branch. While small drainage channels or river branches (*corixos*) persist on the floodplain during the dry season, connecting rivers and lakes, in general, the permanent lakes (*baías*) only receive an inflow of water during the flood season and remain isolated from other bodies of water in the dry season (Nunes da Cunha and Junk, 2004).

Baía das Pedras (16º24'36.7" S, 56º21'08.6" W) is one of the lakes found in a locality known as Pirizal, in the Poconé wetland, in the municipality of Nossa Senhora do Livramento. This lake is connected to the Piraim River, a right-margin tributary of the Cuiabá River, during the flood season, when it receives an increased load of organic matter, which has a considerable impact on the structure of the ecosystem (Nogueira et al., 2002). Baía das Pedras Lake has a surface area of 2.08 ha and a perimeter of 10,750 m, with a maximum depth of 6.2 m, mean depth of 1.04 m, maximum effective width of 100 m, and maximum effective length of 274 m (Nogueira et al., 2002).

The *Corixo* Espírito Santo is part of the SESC Private Natural Heritage Reserve, which, in turn, is located within the SESC–Pantanal Ecological Station (16–17º S, 56–57º W), with a total area of 106,588 ha, located in the northern Pantanal wetland (Antas et al., 2011). The length of this *corixo* is regulated by the flood pulse. In the dry season of 2002, the *corixo* had a length of 13 kilometers (16º31' S, 56º17' W to 16º34' S, 56º21' W), with two small branches of one kilometer in length (16º33'53" S, 56º20' W and 16º33' S, 56º20' W). This *corixo* is 100–200 m wide during the dry season, with gently sloping margins covered predominantly by dense arboreal and shrubby vegetation. In some stretches, there are sandy beaches and flat sandbanks covered with grass as far as the waterline (Figure 1).

A giant otter group has been observed in Baía das Pedras Lake (Pinho, JB., personal communication). In addition, recent sightings of active giant otter dens and individuals have been found in Corixo Espírito Santo (Neves, C.C. personnal communication), and thus they are relevent to conservation of *P. brasiliensis* in the Pantanal This biome has been affected by progressive loss of natural habitat through deforestation and fires. More than 20,000 fire alerts were registered in 2020; three times the historical average (1998-2020) (INPE, 2020). From 1988 to 2019, Mato Grosso state had already deforested 146,140 km^2 of natural habitat

(Shimabukuro et al., 2020), a lost natural cover area equivalent to Pantanal along the last 30 years.

The vegetation cover of the study area is predominantly savannah, with diverse phytophysiognomies in both floodable and non-flooded areas. The fauna is diverse and abundant and includes a number of endangered species (Alho et al., 2019). The flood-pulse reflects the cycle of rainy and dry seasons typical of the Pantanal wetland (Ivory et al., 2019). Therefore, extreme climatic events (Thielen et al., 2020) and conversion of natural ecosystems (Colman et al. 2019) are altering patterns of the hydrological and sediment dynamics, disrupting local ecology and the socioeconomic relationships of the basin (Schulz et al., 2019). Two larger rivers, the Cuiabá River and the São Lourenço River, are found in the marginal areas of the Natural Heritage Private Reserve (Antas et al., 2016).

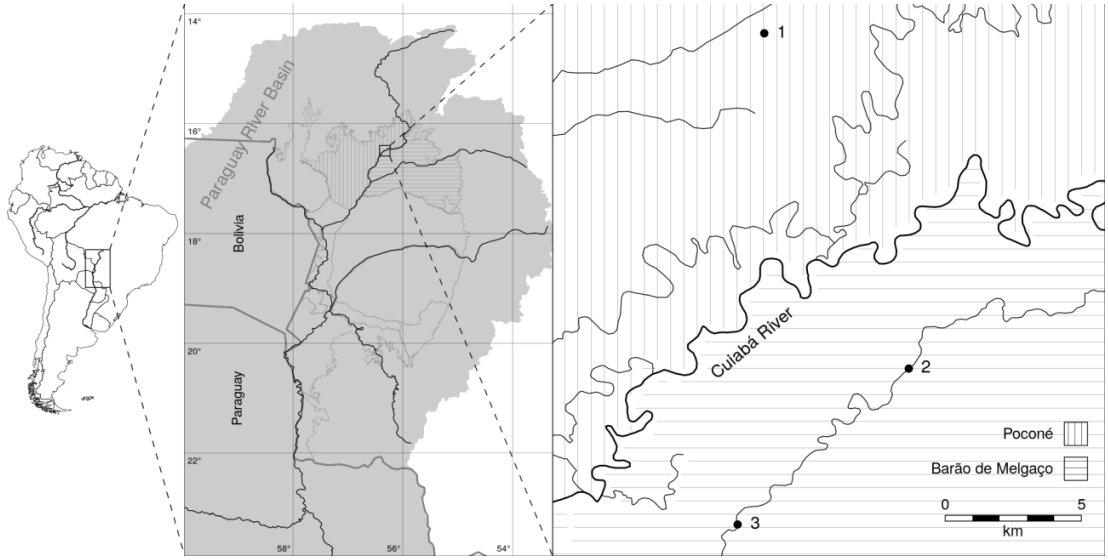

Figure 1. Map of the study area showing the subdivisions of the Pantanal and location of the study localities at Baía das Pedras (1), in the Pantanal of Poconé, and *Corixo* Espírito Santo (2 e 3), in the Pantanal of Barão de Melgaço. Source: Adapted from Silva and Abdon, (1998).

Spraint collection and analysis

The diet of the giant otter was compared between sites based on the analysis of spraints collected from otter latrines during the dry seasons (July to December) of 2002 and 2003. Each sample was placed in a numbered plastic bag, and then washed and dried for the identification of the components (animal fragments), following Rosas et al. (1999). Only fresh spraints, recognized by their characteristic color and odor, were collected, with a total of 74 samples being accumulated over the study period.

In Baía das Pedras Lake spraints were collected from a group of eight giant otters (four adults and four cubs) in four communal latrines. In *Corixo* Espírito Santo spraints were collected from groups, being a group of eight individuals (five adults and three cubs) and other group consisted five adult individuals from 14 giant otter communal latrines.

The fragments of fish found in the spraints were sorted and analyzed, with the species being identified using taxonomic keys (Britski et al., 1999), comparisons with fish specimens collected from the study area, and consultation with specialists.

The fragments analyzed for identification were divided into five types of structure: scales, opercula, mandibles, vertebrae, and miscellaneous bone structures (vertebrae, skull and fin bones, and carapaces). The molluscs (*Pomacea*) were identified from their carapaces,

and the crustaceans from their appendages (Magalhães, 2000). Only fragments longer than 1 cm were considered, in order to minimize the probability of overestimating the number of items present in each sample. The fragments of fish bones identified in this analysis were deposited in a reference collection at the vertebrate collection of the Bioscience Institute of the Federal University of Mato Grosso in Cuiabá (Brazil).

The percentage of occurrence of each prey group was determined for all the spraints. A contingency table (*G* test) was used to test the hypothesis that the composition of the diet (prey categories) is independent of the environment (lake *vs.* river branch). The *G* test, with Williams' correction (Zar, 1996), was chosen for this analysis because some cells of the contingency table had expected frequencies of 5 or less. This procedure was complemented with an analysis of the residuals, to determine the probabilistic contribution of each cell (i.e., the prey categories).

The frequencies of items of the three orders of fish (Characiformes, Siluriformes and Perciformes) found in the spraints collected in the present study were also compared with the corresponding frequencies recorded in the Amazon (Rosas et al., 1999; Cabral et al., 2010; Rosas-Ribeiro et al., 2012; Silva et al., 2013) and Pantanal regions (Rosas et al., 1999; Leuchtenberger et al., 2020). This analysis was also based on the *G* test, as described above following a calculate *p*-value partitioning chi-square test. The analyses were run in BioEstat 5.0 (Ayres et al., 2007).

RESULTS

Seventy-four giant otter spraints (43 from Baía das Pedras Lake and 31 from the *Corixo* Espírito Santo) were analyzed here (Table 1). In both areas, the diet was composed of fish, crustaceans, and molluscs. Fish were present in 100% of the samples at both sites. Crustaceans were found in four samples (9.3%) from Baía das Pedras, and molluscs were found in nine samples (20.9%). At *Corixo* Espírito Santo, crustaceans and molluscs were each found in only a single sample (3.2%).

The five most frequent families of fish recorded at both sites were the Erythrinidae (found in 94.6% of the spraints), Cichlidae (91.9%), Pimelodidae (70.3%), Callicthyidae (63.5%), and Doradidae (60.8%). The contributions of the different taxa to the otter diet varied between sites, however. At Baía das Pedras, three fish orders (Characiformes, Siluriformes and Perciformes) were recorded in the spraints. In the case of the Characiformes, the family Erythrinidae, represented primarily by *Hoplias malabaricus* (Bloch, 1794), was present in 95.3% of the samples, followed by the family Serrasalmidae (67.4%). The order Siluriformes was well represented by three families, the Callicthyidae (97.7% of the samples), Doradidae (95.3%), and Pimelodidae (93.0%), while the order Perciformes was represented only by the family Cichlidae, which was present in 100% of the samples and was the most frequent prey category in the Baía das Pedras samples.

At *Corixo* Espírito Santo, characiforms were recorded in all 31 samples and this order was represented primarily by the family Erythrinidae (93.5% of the samples), followed by the Serrasalmidae (48.4%). In contrast with Baía das Pedras, siluriforms were present in only 54.8% of the samples, with pimelodids being found in 38.7%. of the spraints, while the Doradidae and Callicthyidae were each present in 12.9% of the samples. The only perciform family recorded at this site was the Cichlidae, present in 25 samples (80.6%).

Table 1. Frequency of the different food items identified in the spraints of the giant otter (*P. brasiliensis*) collected from a lake, Baía das Pedras (BPS), and river branch, *Corixo* Espírito Santo (CES), in the SESC-Pantanal Natural Heritage Private Reserve in the Pantanal wetland, Mato Grosso state, Brazil, during the dry seasons of 2002 and 2003. The classification and nomenclature of the fish are based on Britski et al., (1999). In parenthesis the percentage of spraints containing each item.

Food item	BPS 43 (x%)	CES 31 (x%)
Fish		
Characiformes		
Characidae	1 (2.3)	1 (3.2)
Bryconinae	1 (2.3)	1 (3.2)
Triportheinae	-	2 (6.4)
Cynopotaminae	-	3(9.7)
Characinae	-	1 (3.2)
Acestrorhychinae	3 (7.0)	3 (9.7)
Serrasalmidae	29 (67.4)	15 (48.4)
Prochilodontidae	-	1 (3.2)
Curimatidae	1 (2.3)	2 (6.4)
Anostomidae	1 (2.3)	1 (3.2)
Erythrinidae	41 (95.3)	29 (93.5)
Siluriformes		
Pimelodidae	40 (93.0)	12 (38.7)
Auchenipteridae	19 (44.2)	-
Doradidae	41 (95.3)	4 (12.9)
Callicthyidae	42 (97.7)	4 (12.9)
Loricariidae	26 (60.5)	1 (3.2)
Perciformes		
Cichlidae	43 (100.0)	25 (80.6)
Crustaceans		
Trichodactylidae	4 (9.3)	1 (3.2)
Molluscs		
Ampullaridae	9 (20.9)	1 (3.2)

Significant differences were found between the lake and *corixo* in the numbers of the principal items found in the spraints (*G* test, 14 x 2 contingency table; $G = 52.919$; $P < 0.0001$). The results of the residual analysis indicate that the spraints from the lake had a higher frequency of siluriforms and relatively lower frequency of perciforms and erythrinids (Characiformes) than the *corixo* (Table 2). The frequencies of the other characiforms were similar at the two sites (Table 3).

In the inter-study comparison, characiforms were commonly found in all eight study areas, being present more than 77 percent of the spraints analyzed. Perciforms were also common in the present study, and at Xixuaú Creek, Balbina reservoir, Jaú National Park and in the Corumbá Pantanal, although this order was relatively uncommon in the samples from the Aquidauana River and Juruá River. The differences among sites were highly significant (*G* test 3 x 8 contingency table; $G = 191.5082$; $P<0.0001$). The spraints from Baia das Pedras had proportionally more siluriforms than those from all the other study areas (residuals significant at $P<0.01$). By contrast, *Corixo* Espirito Santo had a significantly lower proportion of siluriforms than others Pantanal regions (residuals significant at $P<0.05$).

Table 2. Results of the residual analysis of the comparison of the individual contributions of each type of prey to the diet of the giant otter between the two study between two environments (lake *vs.* river branch) in the Pantanal wetland, Mato Grosso, Brazil.

Item			Residual		*p*	Conclusion
			Lake	River Branch		
Fish	Characiformes	Characidae	-1.435	1.435	ns	Lake = River branch
		Serrasalmidae	-1.499	1.499	ns	Lake = River branch
		Prochilodontidae	-1.740	1.740	ns	Lake = River branch
		Curimatidae	-1.681	1.681	ns	Lake = River branch
		Anostomidae	-0.824	0.824	ns	Lake = River branch
		Erythrinidae	**-3.529**	**3.529**	**	**Lake < River branch**
	Siluriformes	Pimelodidae	0.322	-0.322	ns	Lake = River branch
		Auchenipteridae	**2.570**	**-2.570**	*	**Lake > River branch**
		Doradidae	**2.634**	**-2.634**	**	**Lake > River branch**
		Callichthyidae	**2.699**	**-2.699**	**	**Lake > River branch**
		Loricaridae	**2.635**	**-2.635**	**	**Lake > River branch**
	Perciformes	**Cichlidae**	**-2.491**	**2.491**	*	**Lake < River branch**
Crustaceans		Trichodactylidae	**0.254**	**-0.254**	**ns**	Lake = River branch
Molluscs		Ampullaridae	**1.102**	**-1.102**	**ns**	Lake = River branch

Significant results are highlighted in bold script: $P< 0.05$* = residual ≥ 1.96; $P< 0.01$** = residual ≥ 2.576; ns (non-significant = residual < 1.96.

Table 3. Frequency of occurrence (number of times a prey item was recorded in the spraints) of the three principal orders of fish consumed by the giant otter (*Pteronura brasiliensis*) at eight Brazilian study localities: Baía das Pedras and *Corixo* Espírito Santo (present study); Xixuaú Creek and Aquidauana River (Rosas et al. 1999), Balbina reservoir (Cabral et al., 2010); Juruá River (Rosas-Ribeiro, et al., 2012), the PARNA Jaú (Silva et al., 2013) and Corumbá Pantanal (Leuchtenberger et al., 2020). The percentage of spraints containing each item is shown in parentheses.

Site	Taxonomic order of fish			Study
	Characiformes	Perciformes	Siluriformes	
Xixuaú Cove (RR)	32 (100)	36 (97.3)	2 (20.0)	Rosas et al., (1999)
Aquidauana River (MS)	6 (100)	4 (33.3)	2 (66.6)	Rosas et al., (1999)
Balbina Dam (AM)	197 (77.5)	236 (92.9)	16 (6.3)	Cabral et al., (2010)
Juruá River (AM)	92 (86.6)	25 (23.6)	31 (29.1)	Rosas-Ribeiro et al., (2012)
Jaú National Park (AM)	69 (84.1)	75 (91.5)	18 (22.0)	Silva et al., (2013)
Corumbá Pantanal (MS)	136 (100)	126 (92.9)	97 (71.4)	Leuchtenberger et al. (2020)
Corixo Espírito Santo (MT)	29 (95.3)	25 (80.6)	12 (38.7)	Present study
Baía das Pedras Lake (MT)	41 (95.3)	43 (100)	42 (97.7)	Present study

The chi-square analysis showed that Baía das Pedras Lake and the *Corixo* Espírito Santo are significantly distinct to Characiformes and Siluriformes order (χ^2 = 17.1301; P<0.0001). We also observed statistically significant findings on the relationship among the order of fish and other studies in the Pantanal region (χ^2 = 24.4962; P<0.0001). In the integrated data analysis for all studies in the Amazon and Pantanal regions, there was variation in frequency of occurrence of taxonomic orders with highly significant chi-square value (χ^2 = 174.4825; P<0.0001).

DISCUSSION

The results of the present study on two floodplain systems of Pantanal (lake and river branch) indicate that fish is the main source of food for the giant otter, as reported in the previous study of Carter and Rosas (1997), Silva et al. (2013) and Leuchtenberger et al.

(2020). The analyses also confirmed the occasional predation of crustaceans and molluscs (Rosas et al., 2008; Silva et al., 2013; Leuchtenberger et al., 2020).

As in previous studies (Duplaix, 1980; Schweizer, 1992; Rosas et al., 1999; Cabral et al., 2010; Silva et al., 2013; Leuchtenberger et al., 2020), the findings of the present study indicate that the diet of the *P. brasiliensis* populations is composed primarily of fish belonging to the orders Characiformes, Perciformes, and Siluriformes. Cichlids were the principal category of prey at Baía das Pedras, while erythrinids predominated at *Corixo* Espírito Santo. Previous studies have also emphasized the importance of the erythrinid genus *Hoplias* (Duplaix, 1980; Laidler, 1984; Schweizer, 1992; Cabral et al., 2010; Rosas-Ribeiro et al., 2012; Silva et al., 2013; Becerra-Cardona et al., 2015; Trujillo et al., 2015, Leuchtenberger et al., 2020) and cichlids (Laidler, 1984; Rosas et al., 1999; Cabral et al., 2010; Silva et al., 2013; Trujillo et al., 2015, Leuchtenberger et al., 2020) in the diet of the giant otter.

The principal difference in the prey categories between Baía das Pedras and *Corixo* Espírito Santo was the greater frequency of the siluriform families Auchenipteridae, Callicthyidae, Doradidae and Loricariidae in the former environment. Siluriforms are nocturnal and seek refuge on the bottom or in crevices during the day (Kirchheim and Goulart, 2010), although Britski et al. (1999) found that many species are active during the day, especially in turbid waters.

The turbidity of the water has differential effects on the abundance of different fish groups, with the abundance of siluriforms and gymnotiforms increasing in more turbid waters, whereas characiforms and cichlids are more common in more transparent water (Castro et al., 2018). Fish species with sensorial adaptions for conditions of reduced luminosity will tend to predominate in more turbid waters, while visually-oriented species will be more dominant in clearer water, which benefit their foraging strategies (Rodríguez and Lewis Jr., 1997; Kirchheim and Goulart, 2010). At Baía das Pedras, the more restricted lacustrine environment is associated with the accumulation of feces and decomposition of organic matter derived from the high density of fish, waterbirds, and caiman, *Caiman yacare* (Daudin, 1802) (Nogueira et al., 2002), what connected to an exacerbated decline in the level of the water over the course of the dry season, contribute to the turbidity of the aquatic environment and may be driven the differences observed in the giant otter diet between the different floodplain systems.

Although relatively common in the Pantanal, callichthyids were not consumed frequently at *Corixo* Espírito Santo (12.4%). On the other hand, this group of fish has been found in 50% of the spraints collected from Corumbá Pantanal (Leuchtenberger et al., 2020) and was the second most common fish family from Baía das Pedras (97.7%). The different habitat characteristics probably influenced the occurrence of callicthyids between *Corixo* Espírito Santo and Baía das Pedras. However, it is difficult to determine, from the fecal analyses, to what extent feeding preferences or specializations, or the relative availability of prey, influence the composition of the giant otter diet (Rosas et al., 1999), in particular considering that callicthyids are much less common (Rosas-Ribeiro et al., 2012; Silva et al., 2013) or even absent (Cabral et al., 2010) from the giant otter diet in some Amazonian environments. The sedentary and slow swimming behavior of the callicthyids (Britski et al., 1999), associated with the unique rocky substrates of the Baía das Pedras site (Nogueira et al. 2002), may facilitate the capture of these fish at this site, in contrast with the conditions found at the *Corixo* Espírito Santo. Overall, then, the relative importance of callicthyids in the diet of the giant otters in the present study, in comparison with other localities, may reflect the greater availability of these fish in the shallower parts of the Baía das Pedras, a scenario

reinforced by the limnological intensification of the water turbidity during the dry season. More detailed studies will be required to determine the depletion of the availability of other prey taxa in this habitat.

The tendency for an increase in the consumption of loricariid catfish with the intensification of the dry season at Baía das Pedras, may be related to the predominance in this lake of limnophilic taxa, which are tolerant of low oxygen concentrations, and are forced to retreat into remnant pools as the water level decreases during the dry season (Junk et al., 2006). It is important to note that, during the dry season, isolated habitats become increasingly subject to distinct selective pressures that exacerbate the heterogeneity of the remaining aquatic habitats (Thomaz et al., 2007). The morphological differences found in distinct fish species permit their differential exploitation of both feeding resources and physical habitats, which permits the coexistence of the different species (Agostinho et al., 2007; Shibatta et al., 2007). The fish species composition may also vary among the different phases of the flood pulse, depending on the duration and intensity of the hydrological cycle (Alho et al., 2008).

The variation in the frequency of occurrence of the fish of the three principal study orders (Characiformes, Siluriformes, and Perciformes) among the different Brazilian sites (Baía das Pedras, *Corixo* Espírito Santo, Aquidauana River, Xixuaú Creek, Balbina reservoir, Juruá River and the Jaú National Park) may reflect differences in the availability of these prey groups in the different habitats, in particular where lotic and lentic systems favor the predominance of distinct groups of fish. The seasonal variation in the limnological conditions found in different aquatic environments may also influence the diversity and abundance of fish species, with the conditions prevailing in specific habitats favoring certain fish groups (Castro et al., 2018). The composition of the fish community may also vary seasonally, depending on the duration and intensity of the flood pulse (Alho et al., 2008).

The giant otter will also adapt to the local availability of fish, and its food sources typically correspond to both the relative abundance of different fish taxa and their behavioral characteristics.

The fish families that were most common in the giant otter spraints collected in the present study (Erythrinidae, Cichlidae, Pimelodidae, Callicthyidae, and Doradidae) contrast broadly with the principal families exploited the commercial fishing in Mato Grosso, that is, the Pimelodidae, Characidae, Prochilodontidae, and Anostomidae (Mateus et al., 2004; Catella et al., 2008).

The results of the present study indicate that the distinct characteristics of the environment at Baía das Pedras and *Corixo* Espírito Santo may have a significant influence on the otter diet, even within a local area and during the same period, which reinforces the considerable adaptability and versatility of the giant otter under varying environmental conditions. The diversity and abundance of fish species is also influenced by the flood pulse, which determines the availability of habitats favorable for foraging, feeding, and taking shelter (Moura and Val, 2019). In this context, seasonal oscillations in hydrological conditions derived from human activities, such as hydroelectric dams, the modification of river channels or climate change, may also impact the patterns of fish abundance and diversity, by reducing conditions favorable for the local ichthyofauna (Leite et al., 2018).

The adaptability of giant otters to extreme seasonal and environmental conditions reflects the ecological flexibility of *P. brasiliensis*, although Duplaix et al. (2015) concluded that giant otters prefer aquatic environments with more transparent water, which favors their visually-oriented foraging behavior. This means that, *a priori*, they will normally avoid

environments with more turbid waters, which may nevertheless be exploited as a seasonal alternative.

In the Pantanal, fishery resources are fundamental components of the ecosystem and its genetic heritage, while also providing important sources of subsistence and income for the local human population, as well as supporting sports fishing activities and the trade in ornamental fish (Alho and Sabino, 2012). These multiple interests imply that humans and giant otters are potential competitors (Leuchtenberger et al., 2020), even though little evidence of direct interactions between fishers and otters was found in the present study. However, giant otters do consume some species that are important subsistence resources (*Hoplias malabaricus*) and will adapt to the availability of different species in a given environment or period, and may, in particular, target bait fish in some areas, overlapping with local economic interests. While commercial and sports fisheries are selective of their target species, the negative impact of these activities on fish stocks is a conservation concern (Junk et al., 2006), and will accentuate the potential threats to the conservation of the giant otter in the Pantanal, which is already under pressure from cattle ranching, the construction of hydroelectric dams, the expansion of the agricultural frontier in the Cerrado, the contamination of aquatic systems, and climate change.

The current occurrence of the giant otters that encompasses the area of study demonstrates the importance of local habitat features as present in the Baía das Pedras Lake and *Corixo* Espírito Santo for conservation of *Pteronura brasiliensis* in the Pantanal biome, particularly in perceived face threat scenario related to deforestation, fires and change of extreme events in regional climate.

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RÉSUMÉ

ADAPTABILITÉ ALIMENTAIRE DE LA LOUTRE GÉANTE, *Pteronura brasiliensis,* (MAMMIFÈRES: MUSTÉLIDÉS), DANS DEUX RESEAUX DE PLAINES INONDABLES DE LA ZONE HUMIDE DU PANTANAL, DANS L'ÉTAT DU MATO GROSSO, AU BRÉSIL

La loutre géante, *Pteronura brasiliensis,* est un mammifère presque exclusivement piscivore de la famille des Mustélidés, et une espèce en voie de disparition. La présente étude compare le régime alimentaire de la loutre géante dans deux réseaux de plaines inondables de la zone humide du Pantanal, un lac permanent et un méandre de la rivière, dans les zones humides de Poconé et Barão de Melgaço dans l'État brésilien du Mato Grosso. Des échantillons ont été collectés pendant la saison sèche, avec 43 épreintes prélevées dans le lac et 31 dans le méandre de la rivière. Les espèces de poissons présentes dans les échantillons ont été identifiées sur base de la comparaison de fragments d'os trouvés dans les épreintes avec des spécimens de poissons collectés dans les deux réseaux de plaines inondables. Les régimes alimentaires étaient composés principalement de poissons des familles d'Erythrinidés (94,6%), de Cichlidés (91,9%), de Pimelodidés (70,3%), de Callichthyidés (63,5%), et de Doradidés (60,8%). Les poissons-chats (Siluriformes) étaient plus abondants dans les échantillons du lac, tandis que les characins (Characiformes) étaient bien représentés dans le méandre de la rivière. Alors que la famille des Callichthyidés (siluriformes) était une composante importante du régime alimentaire des loutres dans les deux zones d'étude, elle a rarement été signalée dans des études antérieures sur *P. brasiliensis* dans les régions de l'Amazone ou du Pantanal. La plupart des poissons signalés dans le régime alimentaire de la loutre ne sont pas ciblés par les pêcheries commerciales du Mato Grosso. Les caractéristiques variables des différents systèmes aquatiques sont des déterminants importants de la composition de la faune piscicole locale et sont donc pertinentes pour l'écologie alimentaire de la loutre géante dans la zone humide du Pantanal.

RESUMEN

ADAPTIBILIDAD DIETARIA DE LA NUTRIA GIGANTE, *Pteronura brasiliensis* (MAMMALIA: MUSTELIDAE), EN DOS SISTEMAS DE PLANICIES DE INUNDACIÓN EN EL PANTANAL, ESTADO DE MATOGROSSO, BRASIL

La Nutria Gigante, *Pteronura brasiliensis,* es un mamífero casi exclusivamente piscívoro de la Familia Mustelidae, y una especie en peligro de extinción. El presente estudio comparó la dieta de las nutrias gigantes en dos sistemas de planicies inundables del Pantanal, un lago permanente y un brazo del rio, en los humedales Poconé y Barão de Melgaço, en el estado brasileño de Mato Grosso. Las muestras se recolectaron durante las estaciones secas, con 43 heces recolectadas del lago y 31 del brazo del río. Las especies de peces en las muestras de heces se identificaron en base a la comparación de fragmentos de huesos con los especímenes de peces recolectados en los dos sistemas de planicies de inundación. Las dietas estuvieron compuestas principalmente por peces de la familia Erythrinidae (94.6%), Cichlidae (91.9%), Pimelodidae (70.3%), Callichthyidae (63.5%) y Doradidae (60.8%). Los bagres (Siluriformes) fueron más abundantes en las muestras del lago, mientras que los Characiformes estaban bien representados en el brazo del río. Si bien la família Callichthyidae fue un componente destacado de la dieta de las nutrias gigantes en las dos áreas de estudio, rara vez se había registrado en estudios previos de *P. brasiliensis* en las regiones de la Amazonia o del Pantanal. La mayoría de los peces registrados en

la dieta no son de interés de las pesquerías comerciales en Mato Grosso. Las distintas características de los diferentes sistemas acuáticos son importantes determinantes de la composición de la fauna íctica local y, por lo tanto, son relevantes para la ecología alimentaria de las nutrias gigantes en el Pantanal.

RESUMO

ADAPTABILIDADE NA DIETA DE ARIRANHAS, *Pteronura brasiliensis* (MAMMALIA: MUSTELIDAE), EM DOIS SISTEMAS DA PLANÍCIE DE INUNDAÇÃO DO PANTANAL, MATO GROSSO, BRASIL

A ariranha, *Pteronura brasiliensis*, é um mamífero quase exclusivamente piscívoro da Família Mustelidae e uma espécie em perigo de extinção. O presente estudo comparou a dieta das ariranhas em dois sistemas hídricos da planície inundável do Pantanal, uma lagoa permanente (baía) e um canal de rio (corixo), nos pantanais de Poconé e Barão de Melgaço, no estado de Mato Grosso. As amostras foram coletadas durante a estação de seca, com 43 fezes sendo registradas na baía e 31 no corixo. As espécies de peixes nos restos fecais foram identificadas com base na comparação de fragmentos ósseos dos espécimes de peixes coletados nos sistemas pantaneiros. As dietas foram representadas principalmente por peixes das famílias Erythrinidae (94.6%), Cichlidae (91.9%), Pimelodidae (70.3%), Callichthyidae (63.5%) e Doradidae (60.8%). Os Siluriformes foram mais abundantes nas amostras da baía, enquanto os Characiformes mais representados no corixo. A família Callichthyidae foi um item importante na dieta das ariranhas nas áreas de estudo, especialmente na baía, apesar de raramente ser registrada em outros estudos na região Amazônica e do Pantanal. A maioria dos peixes registrados na dieta das ariranhas não é alvo da pesca comercial no Mato Grosso. As distintas características dos sistemas aquáticos são importantes determinantes da composição da ictiofauna local e, portanto, relevantes para ecologia alimentar das ariranhas na planície do Pantanal.