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Feeding habits of coypu (*Myocastor coypus* Molina 1978) in the wetlands of the Southern region of Brazil

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ABSTRACT

The aim of this study was to determine the diet of coypu (*Myocastor coypus*) in two areas (Santa Isabel do Sul wetland – Area 1, and Santa Marta Farm – Area 2) in the Southern region of Brazil, using microhistological analyses of feces. Twenty-four plant species were identified from collected feces samples. Among the identified species, nine are common in the animals' diet in both areas; the presence of *Oriza sativa* was not detected in any of the samples. Among the identified species, 84% and 54% of the coypu's diet from Areas 1 and 2, respectively, are aquatic plants. Poaceae family was most common, being found in 82% of the samples from both areas. *Paspalum distichum* (Area 1) and *Panicum tricholaenoides* (Area 2) were the most frequent species on the coypu's diet. The diet comparison for both areas indicates that feeding habits vary depending on the type of habitat, environmental conditions and food availability. The absence of rice in our analysis may be an indication for the preservation of native areas around watercourses, so to prevent coypu from invading irrigated crops.

Key words: coypu, diet, food selection, herbivore.

INTRODUCTION

In general, wild herbivores use different strategies in their diet selection according to food quality and abundance, the habitat, and the morphology and physiology of the animal (Galende and Gricera 1998). Basic studies about the diet of wild herbivores may be developed from direct observation of the animals (Barreto and Herrera 1998, Prigioni et al. 2005), analysis of the composition of stomach content samples (Quintana et al. 1994), or through microhistological analysis of feces

(Abbas 1991). The main advantages in the use of feces in this type of study are the unlimited number of samples and the non-interference in the animal habits (Quintana et al. 1994).

The study of alimentary habits using microhistological analysis of feces was originally developed by Baumgartner and Martin (1939) with squirrels. Then, it has been used by many authors with different species of herbivores, including aquatic herbivores like the Amazon manatee (Colares and Colares 2000).



et al. 2000, Guichón et al. 2003), France (Abbas 1988, 1991), and Italy (Prigioni et al. 2005).

The coypu (*Myocastor coypus*) is an indigenous semi-aquatic herbivorous rodent native from the south of South America, living near watercourses (Borgnia et al. 2000). This species has a status of population declining within its native range (IUCN 2009). The species was introduced in North America, Europe, Middle East, Africa and Japan, living in the same habitat (Abbas 1991, D’adamo et al. 2000). In some of these regions, the coypu is an exotic animal; it causes damage to crops, native flora and fauna, and drainage systems (Abbas 1988, Borgnia et al. 2000, Guichón et al. 2003). They are herbivores with nocturnal habits, with high foraging activity near burrow exits, where they feed on grasses, roots and aquatic plants (Abbas 1988, 1991, Borgnia et al. 2000). They restrict their foraging activities to the surroundings of watercourses with the purpose of reducing energetic waste in escapes from possible predators (D’adamo et al. 2000). Their feces are cylindrical, prolonged and in green tones, being easily found floating on watercourse edges as well as on land.

Although the coypu is cited as a threat to cereal plantations, not only in the places where they were introduced, but also in their natural habitat, there are few studies that try to evaluate the real impact of the herbivores to cereal plantations (Borgnia et al. 2000). Being rodents of large occurrence in flooded areas in the state of Rio Grande do Sul – these areas being used for the culture of cereals, especially irrigated rice – it became essential to carry out studies about the coypu’s alimentary habits and the possible ingestion of cultured vegetables. As a result, the objective of this study was to determine the composition of the diet and the seasonal changes in the food consumed by the coypus (*M. coypus*), as well as to investigate the interference of the species in rice (*Oriza sativa* L.) fields.

MATERIALS AND METHODS

STUDY AREA

The study took place on the Southern region of the state

and average temperature of 18°C (Nogueira-Neto 1993). Area 1 includes Santa Isabel do Sul wetlands, located in the city of Rio Grande (32°06’56’’ South latitude and 52°35’58’’ West longitude). Across the wetlands, there is a 14-km road surrounded by two channels for irrigation of rice cultures. Area 2 includes the Santa Marta Farm, a private rural property whose main activity is the culture of irrigated rice. It is located in the city of Santa Vitória do Palmar (32°50’41.10’’ South latitude and 52°39’04.77’’ West longitude). It is surrounded by an artificial channel built for irrigation, limited by rice culture on one side and by native vegetation on the other.

FECES COLLECTION

The collection of recent coypu feces was conducted monthly, during the period between December 2003 and November 2004 at Area 1, and between July 2005 and June 2006 at Area 2. During the field research, both edges of the channels and the surroundings of the floodable areas were covered on foot. Thirty-six samples were collected from Area 1, and 46 samples from Area 2. The feces samples were conserved in FAA (85% alcohol, 10% formalin at 10%, and 5% glacial acetic acid) for subsequent fecal analysis.

FECAL ANALYSIS

The fecal analysis consists in a comparison between fragments of the vegetal epidermis found in the feces of the animals with epidermal layers of previously identified plants, mounted as a photomicrographic reference collection (Storr 1961). The reference collection used in this study belongs to the Botany Laboratory of the Biological Sciences Institute (ICB) of Universidade Federal do Rio Grande (FURG). From the samples conserved in FAA, three sub-samples were taken, from which five microscope slides were prepared and analyzed based on Abbas (1991). These slides were analyzed in all their extension, noting down the type of material found and the number of relapses. For the identification of species, its anatomical characteristics, such as size, shape and types of epidermis cells, presence and



FEEDING HABITS OF COYPU

DATA TREATMENT

The data were grouped to determine the vegetal species consumed by the coypus, from both areas under study, taking seasonal variation into account. The frequency of each alimentary item was calculated according to the formula $A\% = (\text{number of fragments of item } i / \text{number of fragments observed}) \times 100$ (Abbas 1991). Diet diversity was calculated with the Shannon index (Schäfer 1980), followed by the Hutchinson test ($p < 0.05$) (Zar 1984), to define the significance of differences in resource utilization, independently from its availability.

RESULTS

From the collected feces samples, 24 plant species belonging to six families and 10 plant species belonging to five families were identified from Areas 1 and 2, respectively (Table I). Among the identified species, nine are common in the animals' diet from both areas, not being detected the presence of *Oriza sativa* in any of the samples.

Seasonally, in Area 1, the diversity of plants by feces sample ranged between 10 species in spring and 14 in winter, with 16 species in the summer and autumn (Table II). The Shannon diversity index was higher in autumn ($H=4.28$), with similarity during the rainy seasons (winter and spring) and significant differences ($p < 0.05$) in diet during others seasons (Table III).

In Area 2, two species were identified in the summer and nine in the winter, with six species in the spring and eight in the autumn (Table II). The Shannon diversity index was higher in the winter ($H=1.95$), with significant differences ($p < 0.05$) in diet diversity among the seasons (Table III). Between both study areas, the composition of the coypu's diet presented significant differences ($p < 0.05$) in all seasons.

From the identified species, 84% and 54% of the coypu's diet from Areas 1 and 2, respectively, are aquatic plants. The Poaceae family was most common, being found in 82% of the samples from both Areas. *Paspalum distichum* (Area 1) and *Panicum tricholaenoides* (Area 2) were the most frequent species in coypu's diet

trata (Asteraceae family) being the most consumed in the summer (18.6%) at Area 1 (Table II).

DISCUSSION

To herbivores, in general, seasonal variations in quantity and quality may have an important effect on the development of the species (Bronson 1989). In Brazil and Argentina, studies of the alimentary habits of coypus showed a diet that constituted of 40 species (Abbas 1991), and 31 species (Borgnia et al. 2000), respectively, while, in Italy, 24 species were identified (Prigioni et al. 2005). According to Prigioni et al. (2005), diet selection by coypus ranges seasonally according to the environmental characteristics and peculiarities of each region. The number of species identified in this study was lower, with specific differences between the two areas possibly related to the physiognomic characteristics of them. Area 1 is mainly constituted of native vegetation, while Area 2 is characterized by agricultural crops, with reduced occupation of native vegetation. Thus, the micro-habitat occurrence and the variations in the abundance, energy content and distribution relative to the distance from the water body are controlling the differentiated search of alimentary resources by the coypus.

Besides the variations in food supply, the variations in nutritional content are also observed as a function of the place and time of the year (Best 1981). The nutritional quality and digestibility of the plants are critical to herbivores, the young leaves being frequently preferred due to the lower presence of cellulose (Ricklefs 2003). Although in the spring is the season with the greatest availability of plants (personal observation), the number of species consumed by the coypus, at Area 1, was smaller. This season corresponds to the ending of the overflood phase and is characterized by presenting vegetation in the young phase, with the emergence of more palatable sprouts and soft leaves with better proteic and lipidic quality. Due to the greater food availability, the coypus begins to exhibit a more selective behavior, consuming big quantities of a smaller number of species of their preference.

In general, during dry seasons, herbivores

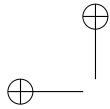


TABLE I
Species of plants identified in coypu's feces (*Myocastor coypus*) from both areas
(Area 1 – Santa Isabel do Sul wetlands; Area 2 – Santa Marta Farm), its habit and percentage of annual occurrence.
A = amphibious, E = emergent, FF = floating fasten, FL = floating free, S = submersed and T = terrestrial.

Family	Species	Plant habits	% of occurrence Area 1	% of occurrence Area 2
Asteraceae	<i>Baccharis articulata</i> (Lam) Pres	T	0.1	0
Asteraceae	<i>Baccharis trimera</i> (Less.) DC	T	0.1	0
Asteraceae	<i>Bidens laevis</i> (L.) BSP	FF / A / E	1.0	0
Asteraceae	dicotiledons not identified	A	3.5	0
Asteraceae	<i>Eclipta prostrata</i> L.	A / E	9.1	0.9
Cyperaceae	<i>Cyperus ferax</i> L.C. Rich	A / E	0.2	0
Cyperaceae	<i>Cyperus luzulae</i> (L.) Retz	A	0.2	0
Cyperaceae	<i>Cyperus polystachios</i> Rottb.	T	1.2	0
Cyperaceae	<i>Cyperus</i> sp. L.	A	0	3.1
Oenotheraceae	<i>Epilobium angustifolium</i> L.	T	0	13.3
Poaceae	<i>Cynodon dactylon</i> (L.) Persoon	T	1.7	0
Poaceae	<i>Echinochloa polystachia</i> Hitchc.	A / E	3.6	1.3
Poaceae	<i>Echinochloa</i> sp. Hitchc.	A / E	0.3	0
Poaceae	<i>Eragrostis hypnoides</i> (Lam) Briflon	A	0.3	0
Poaceae	<i>Panicum elephantipes</i> Ness	FF / A / E	10.1	31.6
Poaceae	<i>Panicum repens</i> L.	A	2.4	0
Poaceae	<i>Panicum tricholaenoides</i> Steudel	T	8.1	32.5
Poaceae	<i>Paspalidium paludivagum</i> (Hitchok et Chase) Par	FF / S / A	2.1	6.7
Poaceae	<i>Paspalum distichum</i> L.	A	22.3	0
Poaceae	<i>Paspalum urvillei</i> Stendel	T	1.4	0
Poaceae	<i>Polypogon chilensis</i> (Kunth) Pilger	T	4.7	0.2
Poaceae	<i>Setaria geniculata</i> (Lam) Beauvois	T	6.9	0
Poaceae	<i>Zizaniopsis bonariensis</i> (Bal. et Poitr.) Spegazzini	E	18.3	10.2
Polygonaceae	<i>Polygonum punctatum</i> Elliot	A / S	0.4	0.2
Pontederiaceae	<i>Eichhornia crassipes</i> (Mart.) Solms-Laubach	FL	2.1	0
Verbenaceae	<i>Phyla nodiflora</i> (H.B.K.) Moldenk	T	0.1	0

ingested is not an important factor in the coypu's diet as it has specific digestive strategies, taking the maximum advantage from the nutrients of the ingested plant (Sakaguchi and Nabata 1992). During the summer and autumn, a reduction at the overflow level and the supply of succulent plants is observed, which makes a considerable raise in the number of species (16) consumed by the coypus at in this experiment. Lots of these plants were with very low occurrence (Table II), which suggests a search, among the available plants, for more palatable species.

ber of ingested species (2 species). It was observed that the artificial rice irrigation channels are kept full during the period of seasonal drought. Therefore, water is available, consequently favoring the native vegetation by keeping the leaves succulent and palatable. In the presence of a more nutritive food item, the coypu has a more selective behavior, ingesting a smaller number of alimentary items.

The ingestion of aquatic plants by the coypus, besides being a great source of nutrients, prevents energetic costs associated with others behaviors, like the escape



FEEDING HABITS OF COYPU

TABLE II

(A) Species of plants identified in coypu's diet (*Myocastor coypus*) and percentage of contribution from each alimentary item in different seasons of the year. (B) Seasonal diversity of diet ($H' = \text{Shannon's Diversity Index}$).
Area 1 – Santa Isabel do Sul wetlands; Area 2 – Santa Marta Farm.

A) Species	Summer (%)		Autumn (%)		Winter (%)		Spring (%)	
	Area 1	Area 2	Area 1	Area 2	Area 1	Area 2	Area 1	Area 2
<i>Baccharis articulata</i>	0	0	0.5	0	0	0	0	0
<i>Baccharis trimera</i>	0	0	0.6	0	0	0	0	0
<i>Bidens laevis</i>	0	0	0	0	0	0	3.6	0
<i>Cynodon dactylon</i>	0	0	0	0	4.7	0	2.6	0
<i>Cyperus ferax</i>	0.5	0	0	0	0	0	0	0
<i>Cyperus luzulae</i>	0.6	0	0	0	0	0	0	0
<i>Cyperus polystachios</i>	0	0	0	0	0	0	4.2	0
<i>Cyperus</i> sp.	0	0	0	2.7	0	1.6	0	4.8
<i>Dicotyledonea</i>	8.5	0	3.7	0	0.6	0.0	0	0
<i>Echinochloa polystachia</i>	2.5	0	4.6	0.7	3.3	3.3	4.3	0
<i>Echinochloa</i> sp.	0.8	0	0	0	0	0	0	0
<i>Eclipta prostrata</i>	18.6	0	16.3	0.7	0	2.2	0	0
<i>Eichhornia crassipes</i>	0	0	0.8	0	9.1	0	0	0
<i>Eragrostis hypnoides</i>	0.4	0	0.7	0	0	0	0	0
<i>Epilobium angustifolium</i>	0	0	0	0	0	17.6	0	19.8
<i>Panicum elephantipes</i>	11.2	63.6	17.9	48.6	6.9	19.8	5.5	28.1
<i>Panicum repens</i>	6.1	0	0.7	0	1.9	0	0	0
<i>Panicum tricholaenoides</i>	9.9	36.4	2.5	37.8	0	32.9	16.0	28.1
<i>Paspalidium paludivagum</i>	1.7	0	2.3	2.0	4.8	14.8	0	3.4
<i>Paspalum distichum</i>	9.2	0	12.7	0	45.3	0	26.4	0
<i>Paspalum urvillei</i>	4.6	0	0	0	0.1	0	0	0
<i>Phyla nodiflora</i>	0	0	0	0	0.4	0	0	0
<i>Polygnum punctatum</i>	0	0	0.7	0.7	1.4	0	0	0
<i>Polypogon chilensis</i>	3.8	0	3.2	0	5.9	0.6	5.7	0
<i>Setaria geniculata</i>	9.7	0	4.7	0	1.3	7.1	9.8	15.9
<i>Zizaniopsis bonariensis</i>	11.9	0	27.8	6.8	13.9	0	21.7	0
B) H'	3.6	0.5	4.3	1.1	3.0	1.9	3.1	1.5

has digestive mechanisms that is suitable for the ingestion of these plants (Guichón et al. 2003). The higher consumption of aquatic vegetation, as observed in this study, is related to the type of environment in which this species occurs, where the foraging of aquatic plants is represented more as a process of habitat selection than of food choice. Besides, the adaptation of the coypus to the aquatic environment allows for the use of an advantageous alimentary supply, since most of aquatic plants lack alkaloids, tannin and lignin (Lebreton 1982).

vegetation is scarce (Abbas 1991, Guichón et al. 1999, Prigioni et al. 2005). Young individuals of coypu consume terrestrial vegetation in their diet as an integrative source, fulfilling their nutritional requirements with a lower energy investment (Prigioni et al. 2005). Area 2 is characterized as an agricultural region, where a smaller rate of overflow, the supply of aquatic vegetation is reduced, increasing the search for terrestrial vegetation by the animals. This was especially observed in the winter, possibly favored by a scarcity of



TABLE III
Values of the Hutchinson test, at 5% significance, among the seasonal diversity indexes of coypu's diet (*Myocastor coypus*) from both areas. t = test t; df = degrees of freedom.
A) Area 1 – Santa Isabel do Sul wetlands; B) Area 2 – Santa Marta Farm;
C) Comparison between both areas.

A)					
Comparison	t	df	t'	p	Result
Summer – Spring	6.873	265	1.969	< 0.05	Different diversity
Summer – Autumn	7.394	240	1.972	< 0.05	Different diversity
Summer – Winter	6.865	240	1.972	< 0.05	Different diversity
Autumn – Winter	12.271	269	1.969	< 0.05	Different diversity
Autumn – Spring	12.732	257	1.969	< 0.05	Different diversity
Winter – Spring	0.872	256	1.969	> 0.05	Similar diversity
B)					
Comparison	t	df	t'	p	Result
Summer – Spring	1.188	72	1.993	> 0.05	Similar diversity
Summer – Autumn	2.189	41	2.020	< 0.05	Different diversity
Summer – Winter	5.777	30	2.042	< 0.05	Different diversity
Autumn – Winter	2.949	155	1.976	< 0.05	Different diversity
Autumn – Spring	0.442	76	1.992	> 0.05	Similar diversity
Winter – Spring	0.556	73	1.993	> 0.05	Similar diversity
C)					
Comparison	t	df	t'	p	Result
Summer 1 – Summer 2	19.845	10	2.228	< 0.05	Different diversity
Autumn 1 – Autumn 2	21.578	129	1.978	< 0.05	Different diversity
Spring 1 – Spring 2	5.708	10	2.201	< 0.05	Different diversity
Winter 1 – Winter 2	15.495	1	12.706	< 0.05	Different diversity

*Area 1: summer 1, autumn 1, spring 1, winter 1. *Area 2: summer 2, autumn 2, spring 2, winter 2.

fields. However, at Area 1, the ingestion of terrestrial plants was low, being accentuated in the spring (24%), when the vegetation is succulent and emits new sprouts (Table II).

Studies in France, where the coypus was introduced (Abbas 1991), and in Argentina, where it is native (Borgnia et al. 2000), observed a high frequency of species of *Poaceae* in its diet. At our both study areas, there was also a predominance of *Poaceae* species at the coypu's diet. Plant consumption of this family is associated to the availability and nutritional quality of this vegetation. According to Abbas (1991), the nutritional value and the permanent availability of *Poaceae* are responsible for the coypu's preference, which also probably occurs with the animals from both areas in

with larger energy content (McIlroy 1964). According to this author, the species in this family responded to moderate pasture with growth of new nutritious sprouts. Thus, the foraging activity by the coypus is supposed to be guaranteeing the maintenance of a soft and high energetic quality vegetation. According to Abbas (1991), during the flowering of *Poaceae*, an increase in tannin content and fibers in the leaves is observed, decreasing its digestibility and reducing its consumption by herbivores. The reduction in the ingestion of *P. distichum* in the summer and *P. tricholaenoides* in the spring probably happened due to the reduction of the protein value of the current leaves during the flowering period, making the coypus ingest other plant species.

The selection of monocotyledon foraging appears



FEEDING HABITS OF COYPU

al. 1998), and capybaras (*Hydrochaeris hydrochaeris*) at Taim wetlands (Borges and Colares 2007). In Argentina, Borgnia et al. (2000) also observed a preference for monocotyledons by the coypu, attributing this fact to the presence of secondary metabolites in dicotyledons, which reduces its nutritional value. In this study, the consumption of dicotyledons was restricted to the dry months of summer and autumn, probably related to the low nutritional quality offered by forage grass during this period.

In areas where the native vegetation becomes scarce due to deforestation, the coypu may focus its feeding on the closest plantations (D'adamo et al. 2000). On the other hand, in places where the native vegetation is preserved, forming belts along the length of watercourses, the coypu does not represent a threat to the cereal plantations (Borgnia et al. 2000, Guichón et al. 2003). Although the south region of the state of Rio Grande do Sul is characterized by vast fields, marshes and irrigation channels for rice plantations, occupied by coypu's populations, *Oriza sativa* was not identified in their diet in both study areas. At Area 1, the rice plantations were 100 meters from the watercourse, while at Area 2, they were 10 meters front it, with the presence of native vegetation in this interval. Considering that the average range of the coypu may reach 2 km (Palomares et al. 1994), the absence of rice in our analysis may be an indicative that the native vegetation caters for the nutritional needs of these populations. Therefore, the preservation of native areas around watercourses is suggested, mainly in areas next to crop plantations, so as to prevent the coypu, when faced with food scarcity, from becoming a potential pest to agriculture.

In conclusion, the results of this study suggest a diet composed of aquatic plants, predominantly of the Poaceae family, and a differentiated behavior for food selection by the coypu. The comparison of its diet from both study areas (Santa Isabel do Sul wetlands and Santa Marta Farm) indicates that its feeding habits vary depending on the type of habitat, environmental conditions and alimentary availability. In overflow periods, faced with a greater plant availability, it presents a more selective

ply or quality is reduced the number of ingested raises, as to fulfill its nutritional requirements.

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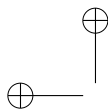
RESUMO

O objetivo deste estudo foi determinar a dieta do rato-do-banhado (*Myocastor coypus*), em duas regiões (áreas de estudo) em Santa Isabel do Sul – Área 1 e Fazenda Santa Marta (Área 2), na região sul do Brasil, utilizando microhistologia e análises de fezes. Foram identificadas 24 espécies de plantas nas amostras de fezes coletadas. Entre as espécies identificadas, nove são comuns a dieta dos animais de ambas as áreas, não sendo detectada a presença de *Oriza sativa* humana das amostras. Entre as espécies identificadas, 54% da dieta do rato-do-banhado, nas Áreas 1 e 2 respectivamente, são plantas aquáticas. A família Poaceae foi abundante, sendo encontrada em 82% das amostras de ambas as áreas. *Paspalum distichum* (Área 1) e *Panicum triviale* (Área 2), foram as espécies mais frequentes na dieta do rato-do-banhado. A comparação da dieta de ambas as áreas mostrou que a alimentação varia dependendo do tipo de condições ambientais e de disponibilidade alimentar. A presença de arroz na nossa análise pode ser um indicativo da preservação de áreas nativas ao redor de cursos d'água, para que o rato-do-banhado utilize as culturas de arroz.

Palavras-chave: rato-do-banhado, dieta, seleção de alimentos, herbivoria.

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