



## Diet of the lesser electric ray *Narcine brasiliensis* (Olfers, 1831) (Elasmobranchii, Narcinidae) in southern Brazil

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**Abstract.** The objective of this study was to describe the diet of the lesser electric ray (*Narcine brasiliensis*) in the waters along the coast of Rio Grande do Sul during summer. In February 2005, all individuals caught in bottom trawl fishing hauls of the inshore waters between latitudes 29° S and 34° S were collected. Sex and total length were recorded for each individual; stomachs were fixed in 4% formalin. Food items were identified, and the frequency of occurrence, number and weight proportions, and index of relative importance were calculated for each item. Ingested food was found in 95% of the stomachs of the collected individuals. Polychaetes constituted 97% of total prey, with *Notomastus lobatus* being the most important food item. Stomach repletion was non-different between the sexes; no correlation was found between the richness of the diet and the total body length and between wet weight of stomach content and total weight. Thus, *N. brasiliensis* caught in the waters off the coast of southern Brazil during summer feed mostly on polychaetes, which could be the result of the aggregation of rays in areas with the highest abundance of a specific prey because of prey population increase.

**Key words:** benthic organisms, food, polychaete, Rio Grande do Sul

**Resumo. Dieta da raia elétrica *Narcine brasiliensis* (Olfers 1831) (Elasmobranchii: Narcinidae) no sul do Brasil.** O objetivo desse estudo foi descrever a dieta da raia elétrica (*Narcine brasiliensis*) nas águas ao longo da costa do Rio Grande do Sul durante o verão. Em fevereiro de 2005, todos os indivíduos capturados em lances de arrasto de fundo nas águas costeiras entre as latitudes de 29° S and 34° S foram coletados. Sexo e comprimento total foram anotados para indivíduo, estômagos foram fixados em formol 4%. Itens alimentares foram identificados e a frequência de ocorrência, proporção numérica e de peso e o Índice de Importância Relativa foram calculados para cada item. Alimento ingerido foi encontrado em 95% dos estômagos. Poliquetas constituíram 97% do total de presas com *Notomastus lobatus* sendo o item alimentar mais importante. A repleção estomacal não foi diferente; não foi encontrada correlação entre a riqueza da dieta e o comprimento total e entre o peso úmido do conteúdo estomacal e o peso total. Portanto, *N. brasiliensis* capturadas nas águas na costa do sul do Brasil durante o verão se alimentam prioritariamente de poliquetas, que pode ter sido o resultado da agregação das raias em áreas com a maior abundância de uma presa específica devido a um aumento populacional.

**Palavras chave:** organismos bentônicos, alimento, poliqueta, Rio Grande do Sul

### Introduction

The lesser electric ray, *Narcine brasiliensis* (Olfers, 1831), occurs along the western coast of the Atlantic Ocean between the latitudes of 20° S in Brazil and 40° S in Argentina (Bigelow & Schroeder 1953, Figueiredo 1977, Carvalho 1999). It also occurs as a summer migrant along the continental

shelf of Rio Grande do Sul (Vooren 1998, Vianna & Vooren 2009).

In the coastal waters of southern Brazil, shrimps are commercially fished using bottom trawls (Dumont 2005) and rays and skates are caught as bycatch in large. Several of these species are threatened of extinction (Haimovici & Habiaga

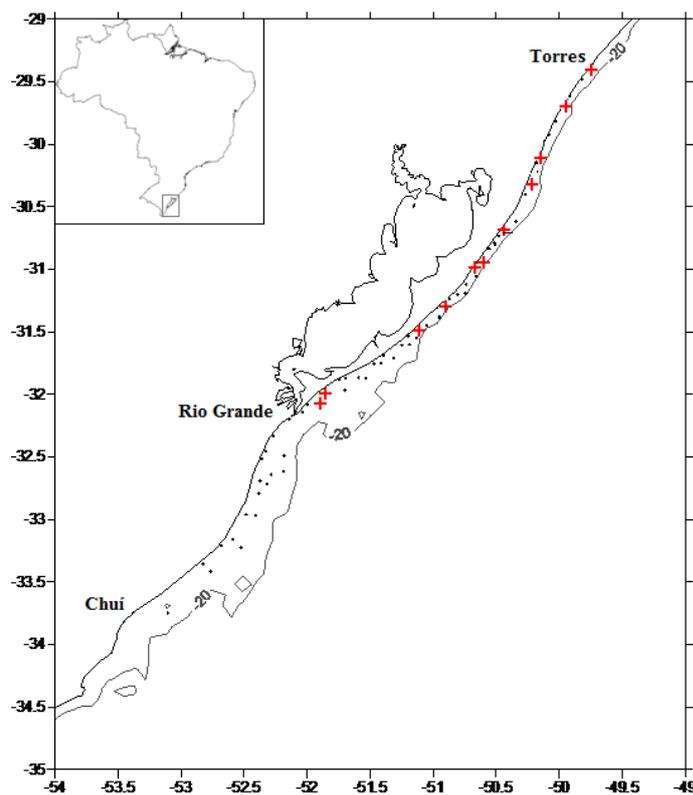
1982, Vooren *et al.* 2005). *N. brasiliensis* is not commercially fished along the southern coast of Brazil; however, it is inadvertently caught and usually discarded (Vooren *et al.* 2003). Despite the species' wide distribution along the Brazilian coast and the potential impact of the bottom-trawl fishery on its population, limited information is available on the species' life cycle, distribution and feeding habits.

Most of the information on the feeding habits of *Narcine* spp. in the Western Atlantic comes from populations of *N. bancroftii* off the coast of North America, mainly through observations of rays maintained in captivity (Rudloe 1989a) and the morphological aspects of the species' feeding apparatus (Dean & Motta 2004a, b, Dean *et al.* 2006). On the Brazilian coast, *N. brasiliensis* has been found to feed mostly on benthic worms and crustaceans (e.g., Amaral & Migotto 1980, Goitein *et al.* 1998, Bornatowski *et al.* 2006), becoming very susceptible to the impact of trawl fisheries on the

benthic environment. The present study aims to provide information on the diet of *N. brasiliensis* along the coast of Rio Grande do Sul during summer by analyzing the prey species found in the stomach contents.

### Material and methods

Specimens of *N. brasiliensis* were caught using a shrimp trawl with stretched condend mesh of 20 mm between opposite knots during a scientific fishing survey with the R. V. "Atlântico Sul" in February 2005. The survey intended to determine the abundance and spatial distribution of fishes and shrimp in the shallow coastal waters of Rio Grande do Sul, Brazil. The survey consisted of 62 trawl stations along 600 km of coastline between latitudes 29° S and 34° S at depths between 7 and 20 m (Figure 1). Fishing was done only during daylight hours, and the standard duration of the trawl hauls was 30 min (Vianna & Vooren 2009).



**Figure 1.** Rio Grande do Sul coast with bottom trawl stations during summer 2005. Dots in the figure indicate the position of each trawl station and red crosses indicate *Narcine brasiliensis* catches. Adapted from Vianna (2007).

Immediately after capture, 4% formalin was injected into the abdominal cavity of the specimens and the entire ray was then fixed in 4% formalin. The fixed specimens were later preserved in 70% ethanol. Sex and total length (TL) of the specimens

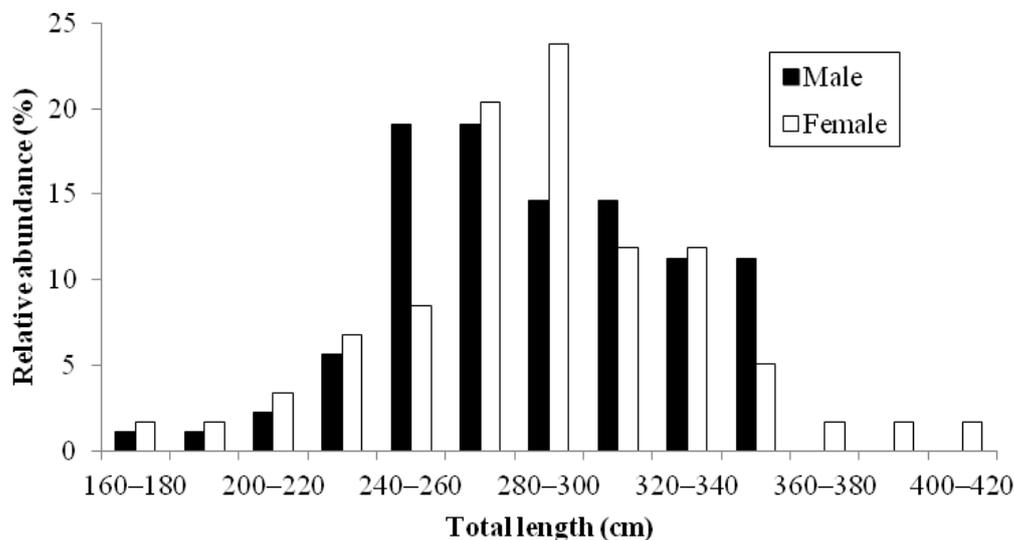
were recorded, stomachs were removed, and stomach contents were analyzed. Food items were identified to the lowest taxonomical level possible with the aid of literature (Amaral & Nonato 1982, Ewing 1984) and consultation with specialists.

Pearson correlation tests were conducted to assess the relationship between the wet weight of the stomach contents and the total weight of the ray, as well as the number of food items per stomach and the ray's TL. The importance of each food item was calculated according to Hyslop (1980), where the frequency of occurrence (%FO) was the percentage of the number of stomachs containing food in which each food item occurred, %N was number of all individuals in each food item expressed as a percentage of total individuals in all food items, and %W was the total weight of each prey item expressed as a percentage of the total wet weight of all food items. In the case of polychaetes, only the fragments containing the head of the animal were considered as prey when calculating the %N. The

index of relative importance (IRI) was calculated for the assessment of the dietary importance of each food item according to Pinkas *et al.* (1971) and Hyslop (1980). The %IRI was calculated according to Cortés (1997). The diameter of prey that had not yet been digested (i.e., all structures were present and soft tissue intact) was measured.

## Results

One hundred forty-eight *N. brasiliensis* were caught in 11 trawl stations, and all specimens (89 males and 59 females) were sampled for stomach contents. TL of *N. brasiliensis* ranged between 168 and 428 cm (Fig. 2). The average TL of females was 290.3 cm (SD = 43.5 cm), and average TL of males was 285.1 cm (SD = 39.7 cm).

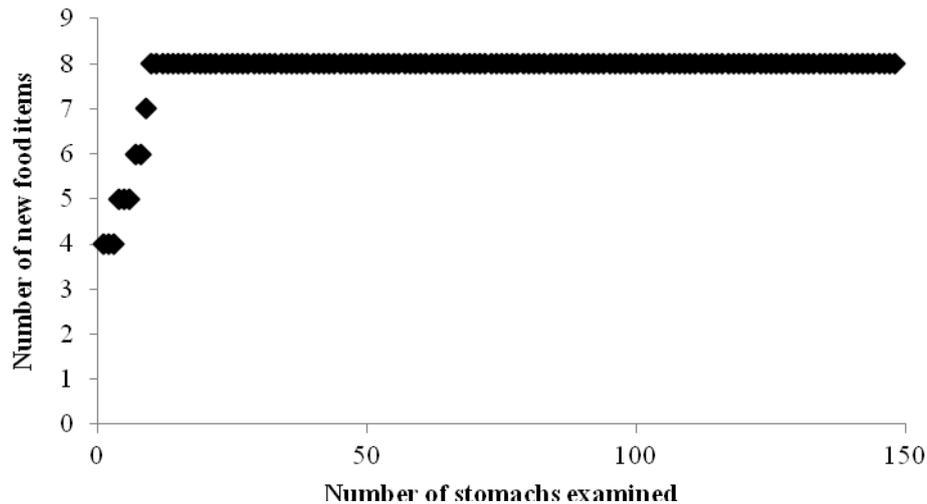


**Figure 2.** Size distribution of male and female lesser electric rays (*Narcine brasiliensis*) caught in the waters off the continental shelf of Rio Grande do Sul in February 2005.

Of the 148 stomachs examined, 95% (140) contained food. The cumulative prey curve revealed that sample size was adequate to describe the dietary composition of *N. brasiliensis* caught off the coast of Rio Grande do Sul during summer 2005 (Figure 3).

In the pooled stomach contents, polychaetes as a group constituted 97.1% of the ingested food in number and 92.0% in weight, and occurred 100% of the time. Six taxa of polychaetes occurred (Table I, Figure 4). The diameter of the ingested polychaetes varied between 2 and 7 mm with a mean of 3 mm. The main item consumed was *Notomastus lobatus*, which occurred 90.7% of the time and constituted

83.6% in number and 54.1% in weight of the ingested food with a %IRI of 95.8%. Crustaceans and fishes were ingested in small numbers (Table I). Polychaetes were the most important food group and, among these, *N. lobatus* was the major component in number regardless of sex or size of *N. brasiliensis* (Table II). No correlation was found between the wet weights of stomach contents and the total weight of the ray ( $R = 0.064$ ,  $df = 138$ ,  $p = 0.452$ ), and between the number of food items in the stomach contents and the total length of the ray ( $r = 0.016$ ,  $df = 138$ ,  $p = 0.850$ ).



**Figure 3.** Cumulative prey curve for the lesser electric ray (*Narcine brasiliensis*) caught off the coast of Rio Grande do Sul during summer 2005. Data are presented in the actual sampling order.

**Table I.** Composition of the stomach contents of 140 individuals of *Narcine brasiliensis* from Rio Grande do Sul, Brazil, in February 2005. Symbols: ni = “not identified at lower taxonomic level”; N% = percent of individuals; FO% = frequency of occurrence in percent; W% = percent wet weight; %IRI = index of relative importance in percent.

Food item	N%	FO%	W%	%IRI
<b>Polychaeta</b>				
<i>Notomastus lobatus</i>	83.6	90.7	54.1	95.8
<i>Lumbrineris</i> n.i.	2.4	7.9	21.0	1.4
<i>Glycera</i> n.i.	3.2	10.7	9.8	1.1
Onuphidae n.i.	3.8	15.7	1.9	0.7
Goniadidae n.i.	2.1	7.9	4.7	0.4
Nereididae n.i.	2.1	9.3	0.3	0.2
<b>Crustacea</b>				
Decapoda	0.9	2.9	1.2	>0.1
<b>Pisces</b>				
Anguilliformes n.i.	0.3	1.4	1.8	>0.1
<b>Unidentified items</b>	1.6	7.9	4.9	0.4
<b>Total food</b>	100	-	100	100

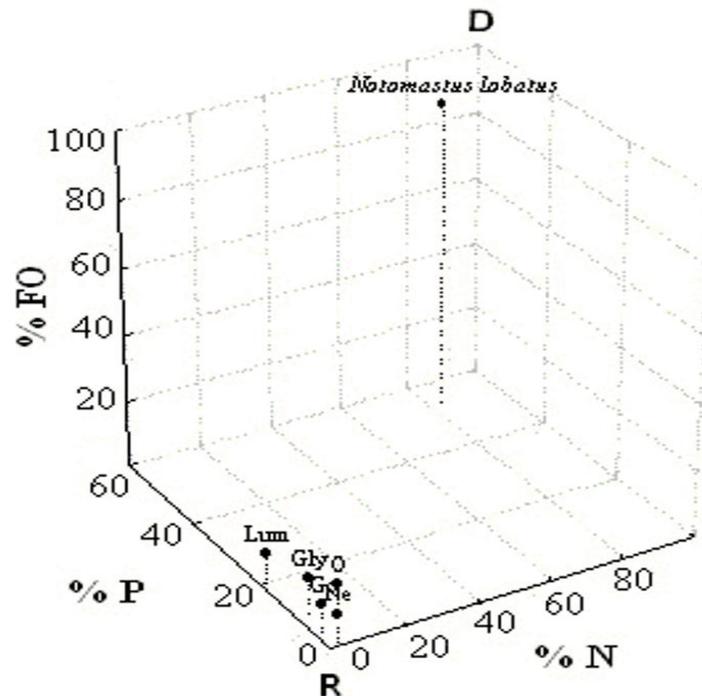
## Discussion

According to Vooren (1998) and Vianna & Vooren (2009), *N. brasiliensis* is present as a summer migrant in waters off the coast of Rio Grande do Sul and is found at depths reaching 20 m; therefore, the stomach contents that were analyzed came from a representative sample of the species' population, and the results are adequate to characterize the diet of these summer migrants.

The importance of polychaetes in the diet of the *N. brasiliensis* in this study is in accordance with previous studies on rays of the same genus (Rao 1964, Rudloe 1989a, Bulman *et al.* 2001, Moreno *et al.* 2009, Yick *et al.* 2011). In southern and southeastern Brazil, *N. brasiliensis* feeds on a wide variety of prey, including crustaceans and polychaetes (Amaral & Migotto 1980, Goiten *et al.* 1998, Bornatowski *et al.* 2006); however, the diet of

the species along the coast of Rio Grande do Sul during February 2005 had a low diversity of prey items and an extremely high abundance of only one

polychaete species. It is possible that the elevated importance as a prey species of *N. lobatus* was the result of its population boom during this period.



**Figure 4.** Tridimensional representation of the polychaete items found in the stomach contents of *Narcine brasiliensis*. D, dominant food category; R, rare food category. L, *Lumbrineris* spp.; Gl, *Glycera* spp.; O, Onuphidae; Go, Goniadidae; N, Nereidae.

**Table II.** Numerical proportion of polychaetes in relation to sex and body size of *Narcine brasiliensis* (n = number of stomach contents examined).

Polychaetes as food items	Males (n = 86)	Females (n = 54)	Body-size classes		
			15–25 cm (n = 24)	25–35 cm (n = 108)	35–45 cm (n = 8)
<i>Notomastus lobatus</i>	83.6	83.3	81.8	85.2	82.2
Other polychaetes	13.2	11.9	16.5	11.5	10.7
Total polychaetes	96.9	95.2	98.3	96.7	92.9

The only fishes that occurred in the pooled stomach contents were 2 small eels that were similar in size and shape to the polychaete prey that *N. brasiliensis* was ingesting at the time. Evidently, the rays perceived the worm-like shape and size of the small eels, which acted as a stimulus for their habitual feeding behavior aimed at benthic organisms. This observation can be supported by the results found by Arrighetti *et al.* (2005) in waters off

the coast of Mar Del Plata, Argentina, where another small electric ray and feeder on polychaetes, *Discopyge tschudii*, was reported to prey on worm-like bivalve siphons during spring and summer. Therefore, the presence of small eels in the diet of *N. brasiliensis* supports the hypothesis that this ray uses its electric organ discharge to stun prey in a manner similar to *Torpedo marmorata* (Belbenoit & Bauer 1972), given that eels are free-living fishes

(Moriarty 1978) and would quickly escape when approached by a predator.

According to the morphometrics of *N. brasiliensis* presented by Bigelow & Schroeder (1953), the range of the total length in the sample of *N. brasiliensis* in the present study corresponds to a mouth-width from 8 to 21 mm; therefore, using the suction technique, rays of all sizes were able to ingest all or most available prey that were noted as the principal food item in the pooled sample of ingested food. This might explain why there was no correlation between the length and weight of *N. brasiliensis* and between the weight of the stomach contents and number of prey.

The fact that 82% of the stomachs contained *N. lobatus* and that this polychaete constituted 84% of the total number of ingested prey species is evidence that *N. lobatus* occurred at high densities in nearly all places where *N. brasiliensis* was caught during the February 2005 trawl survey. However, during a dredge-and-grab survey of benthic invertebrates along the continental shelf of southern Brazil, *N. lobatus* were scarce (Capítoli & Bemvenuti 2004). When studying the abundance of *N. brasiliensis* in waters off the coast of Rio Grande do Sul, Vianna & Vooren (2009) suggested that the species may be aggregating in specific areas, which would explain the fact that *N. brasiliensis* occurred in only 18% of the 62 trawl stations (Vooren *et al.* 2005, Vianna & Vooren 2009). High densities of *N. brasiliensis* were also observed by Martins *et al.* (2009) in waters off the northern coast of Santa Catarina, Brazil. A similar patchy distribution has also been reported by Rudloe (1989b) for *N. bancroftii* in the coastal waters of Florida. It may be inferred that, during summer in the coastal waters of southern Brazil, *N. lobatus* is not widely distributed but instead, occurs in patches, and that *N. brasiliensis* aggregates among those patches. The results of this study support that *N. brasiliensis* feeds preferentially on polychaetes in the waters off the coast of Rio Grande do Sul during summer; however, the high abundance of *N. lobatus* in the diet may have been the result of aggregation of the ray in areas that offer the highest availability of the prey species, which is most likely a result of a population increase of this specific prey.

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