

Feeding habits and morphometry of *Iheringichthys labrosus* (Lütken, 1874) in the Uruguay River (Uruguay)

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Body size and diet of organisms are fundamental attributes which determine their ecology and natural history. *Iheringichthys labrosus* is one of the most common fish species of the Uruguay River. However, its natural history is poorly known and there is little information about its diet and interactions with other species. This paper describes the feeding habits of this species, relating feeding patterns to the size classes and morphometry of individuals and to the temporal variations. Fishes were captured in May and November of 2006 in three zones of the lower Uruguay River. A total of 101 stomach contents was analyzed (standard length: 60-224 mm). The species exhibited a broad feeding spectrum with most items belonging to the benthic community. We found significant diet differences between size classes and studied months. However, we have not found a close relationship between changes in morphometric variables and diet shifts between size classes.

O tamanho do corpo e a dieta são atributos fundamentais que determinam a ecologia e a história de vida dos organismos. *Iheringichthys labrosus* é uma das espécies mais comuns do rio Uruguai, entretanto, sua história natural é pouco conhecida e particularmente existe pouca informação sobre sua dieta e interações com outras espécies. Este artigo descreve os hábitos alimentares de *I. labrosus*, associando os padrões de alimentação com as classes de tamanho, à morfometria dos indivíduos e às variações temporais. Um total de 101 estômagos foi analisado (comprimento padrão: 60-224 mm). Os peixes foram capturados durante Maio e Novembro de 2006 em três áreas da porção inferior do rio Uruguai. *Iheringichthys labrosus* exibiu um amplo espectro alimentar, com a maioria dos componentes da dieta pertencentes à comunidade bentônica. Foram encontradas diferenças significativas na dieta em relação às classes de tamanho dos indivíduos e aos meses de estudo. No entanto, não foram encontradas relações estreitas entre as variáveis morfométricas analisadas e variações na dieta entre as classes de tamanho.

Key words: Diet, Freshwater, Natural history, Pimelodidae, Siluriformes.

Introduction

Studies on feeding habits are essential to understand species biology since they contribute to the comprehension of population trophic interactions (Deus & Petrere-Junior, 2003). Moreover, these studies are essential to evaluate the importance of organisms within the ecosystem (Pouilly *et al.*, 2006). Diet is usually considered as an attribute of the species, neglecting the large intraspecific diet variations related to differences in morphology among individuals (Raffaelli, 2007) and from resources availability among populations (Dill, 1983).

Intraspecific variations in feeding habits and particularly ontogenetic changes in diet are notable widespread among fish populations (Wootton, 1992; Lowe *et al.*, 1996; Rowe & Chisnall, 1996). Feeding abilities frequently change during fish development due to changes in morphometric traits (*e.g.* eye diameter, head length, body weight). This may determine physical constraints on prey size and food selectivity (Wainwright & Richard, 1995; Arim *et al.*, 2010). Particularly, change in mouth size and oral anatomy is considered one important determinant of intraspecific partitioning of food (Ward-Campbell & Beamish, 2005). The idea that fish

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morphology determines feeding abilities is widely accepted, however, the effect of morphology on feeding performance has been poorly studied (Kramer & Bryant, 1995a; Hjelm *et al.*, 2000; Teixeira-de Mello *et al.*, 2006). In this sense, the analysis of the feeding ecology of fish species requires a detailed consideration of ontogenetic changes in diet and the related variation in those morphological attributes associated with individual ability to prey consumption. In addition, the analysis of feeding behaviour between different time periods and environments is essential to understand species potential to adjust its diet to variations in resources availability and internal demands.

Iheringichthys labrosus (Lütken, 1874; Siluriformes, Pimelodidae) is a South American non migratory freshwater fish that is abundant in numerous reservoirs (Borges, 1989) and rivers (Abes *et al.*, 2001; Teixeira-de Mello *et al.*, 2008). The maximum total length reported for this species is 33.4 cm (Fagundes *et al.*, 2008). *Iheringichthys labrosus* shows no parental care behaviour and reproduces along the year, with multiple spawning reproductive peaks synchronized with rainy season (Santos *et al.*, 2006). This species exhibits a sub-terminal mouth, with dentigerous plates (Fugi *et al.*, 2001), thick lips and free superior margin (Abes *et al.*, 2001). It has a wide space between gill rakers, a sacciform stomach and a short intestine (Fugi *et al.*, 2001). Particularly, this species is one of the most abundant in Paraná River basin which counts with several local studies of its feeding habits (*e.g.* Fugi *et al.*, 2001; Abes *et al.*, 2001; Peretti & Andrian, 2004).

In spite of *I. labrosus* is also a very abundant species in Uruguay River basin (Bertoletti *et al.*, 1989; Teixeira-de Mello *et al.*, 2008) there is scarce information about its biology. Particularly, only one study about the diet of this species was conducted in the Ibicuí River, one of the most important tributaries of Uruguay River (Fagundes *et al.*, 2008). Previous studies have defined this species as benthivorous. However, this general classification does not account for inter-individual variations and was performed in different environmental conditions than those observed in Uruguay.

The limited available information about the biology of *I. labrosus* and the main role that this abundant species could have in the ecosystem highlights the importance to advance on the knowledge of its diet. This paper describes the feeding habits of *I. labrosus* at the Uruguay River and analyzes dietary changes between size classes and times of the year in relation to individual morphology.

Material and Methods

The study area is located in the lower section of Uruguay River, between Nuevo Berlín and Las Cañas (Río Negro province, Uruguay). In the last years average discharge and depth of the studied section are: 6231 m³s⁻¹ and 2.15 m, respectively (DINAMA, 2005). Fishes were collected during May and November of 2006 in three sample sites. Site I is located in Nuevo Berlín (NB) (32°58'52" S 58°04'06" W), site II (Y) (33°06'35" S 58°16'39" W) is located 27 km downstream of site

I, and site III (LC) (33°09'48" S 58°21'43" W) 15 km downstream of site II (Fig. 1). Environmental characteristics of each sample site are shown in Table 1. The selected sites are monitoring points commissioned by Botnia (nowadays part of UPM) for the installation of a pulp mill that started to operate in 2007. Therefore, the present information can be considered as baseline for future investigations of environmental assessment.

Specimens of *I. labrosus* analyzed were collected with eight multimesh nets of 30 m each (meshes: 5.0, 6.25, 8.0, 10.0, 12.5, 15.5, 19.5, 24, 29, 35, 43 and 55 mm knot to knot, each mesh: 2.5 m), that were simultaneously operated. Gillnets were placed from afternoon to next morning. Thirty species were collected during May, while 42 were obtained in November. *Iheringichthys labrosus* abundance represents 42.4 % and 51.1 % of the total abundance of all species, respectively for each month. Collected individuals were preserved at 0°C until laboratory analysis. Following this, some representative specimens were deposited in the Vertebrate Collection of Facultad de Ciencias, Montevideo, Uruguay (Nuevo Berlín: ZVC – P 9025, Fray Bentos: ZVC-P 9026 and Las Cañas: ZVC-P 9027).

Stomach content and data analysis

In order to achieve an acceptable confidence in items detection, we estimated the number of stomachs to be sampled to achieve at least a 0.9 probability in order to detect those items with an occurrence ≥ 0.1 . Following these criteria we used the following equation: $N = \log(1 - a) / \log(1 - P)$, being N the number of stomachs required to achieve a probability a of prey detection (0.9), when its occurrence in diet is P (0.1) (*e.g.* Arim & Naya, 2003). With this approach we estimated a minimum number of 22 stomachs for each size class. Individuals were eviscerated in the laboratory and their stomach contents were inspected under stereomicroscope and dissecting microscope. Each alimentary item was counted and classified according to their taxonomic group.



Fig. 1. Map of the study area. Samples sites are located on the Uruguay River: LC: Las Cañas, NB: Nuevo Berlín and Y: Yaguareté.

Table 1. Environmental characteristics of Uruguay River in Nuevo Berlín (NB), Yaguareté (Y) and Las Cañas (LC): dissolved oxygen (O₂), turbidity, conductivity, pH, and temperature during May (M) and November (N).

Sites	O ₂ (mgL ⁻¹)		Turbidity (NTU)		pH		Conductivity (μScm ⁻¹)		Temperature (°C)	
	M	N	M	N	M	N	M	N	M	N
NB	9.1	8.0	27	29	7.4	7.1	68	49	15.5	22.8
Y	9.0	7.8	22	29	7.7	7.1	71	59	16.0	22.8
LC	0.0	8.0	14	28	7.2	7.3	74	53	15.2	23.7

Diet analysis was performed considering two size classes. These classes were defined according to the maturity of the gonads. The size class 1 ranged from 60 to 119 mm of standard length and corresponds to individuals whose macroscopic gonad analysis does not allow to determine their sex. The size class 2 ranged from 120 to 224 mm of standard length and included individuals whose macroscopic gonad analysis allows determining their sexes. To evaluate the feeding strategy of both size classes of fishes and the importance of each prey item in diet, the graphic representation of Amundsen *et al.* (1996) was used. In this diagram the prey specific abundance (P_i : percentage of prey i comprises all prey items in only those individuals in which i prey occurs; $P_i = (\sum S_i / \sum S_i) \times 100$, were P_i is prey specific abundance, S_i the abundance of prey i in stomachs and S_i the total stomach content in only those individuals with prey i in the stomach) is plotted against the frequency of occurrence (F_i : number of stomachs in which prey i occurs, expressed as a frequency of the total number of stomachs with content). In addition, the percentage abundance of items ($\%A_i = (\sum S_i / \sum S_i) \times 100$, was $\%A_i$ is the percentage abundance of prey i , S_i the abundance of prey i in stomachs and S_i the total stomach contents of all individuals) is also presented (Hyslop, 1980).

Morphometric measures

Following Kramer & Bryant (1995b) and Lima-Junior & Goiten (2003), six morphometric variables were measured to the nearest 1mm and 0.01 g in at least 20 individuals of the total collection: standard length, intestine length, eye diameter, mouth width, head length, and body weight (Table 2). Linear regressions were performed between intestine length, body weight and head length as dependent variables and standard length as independent variable. In addition, eye diameter and mouth width were associated with head length. Regressions were evaluated with ANOVA tests and relationships were considered statistically significant when $P < 0.05$. To check if morphometric variables growth was statistically different from isometric growth, a t -test ($H_0: b = 1$ or $H_0: b = 3$ for length-length and length-weight relationships, respectively), with $\alpha = 0.05$ was performed.

Diet variations between size classes

The possible intraspecific variations in diet of fishes were inspected considering two size classes defined as described

Table 2. Morphometric variables measured in *Iheringichthys labrosus*.

Morphometric variables	Description
Standard length	Linear distance between the anterior part of the head and the last vertebra of the spinal column.
Intestine length	Measurement from cardia to anus.
Eye diameter	Horizontal diameter of the orbicular cavity.
Mouth width	Maximum horizontal measurement of the mouth when completely open.
Head length	Linear distance from the most anterior margin of the head to the most posterior margin of the opercular membrane.
Body weight	Total wet weight.

above. Correspondence analysis (CA) was used to describe the main sources of diet variation. Some prey items were excluded from the analysis because of their low occurrence ($F_i \leq 0.25$). The existence of significant differences between diet of class 1 and 2 fishes was evaluated with a Pearson Chi square test (Sokal & Rohlf, 1969). In this test the χ^2 is calculated as $\chi^2 = \sum (O-E)^2/E$, being O the observed abundances of prey items in diet and E the expected abundance when there is no association between diet and size class.

Temporal diet variations

Chi square test (equation detailed above) was used to determine temporal statistical differences in diet, separated by fishes of each size class. Correspondence analysis (CA) was used to describe the main sources of diet variation between months (May and November). This analysis include only those preys with an occurrence higher than 0.4 in at least one of the studied months.

Results

Diet analysis

Hundred and one stomach contents were analyzed (standard length: 60-224 mm), 53 from May sampling (11 of them were empty) and 48 from November sampling (4 stomachs were empty). Diet components were classified into 17 prey groups; 13 were identified at a taxonomic level and the remaining were classified as: arthropod remains, vegetal remains, sediment/debris and others (casual items: scales, seeds and unidentified items) (Table 3).

Amundsen diagrams support the generalist categorization of *I. labrosus* feeding strategy, independently of size classes of individuals. In May, this diagram showed that Copepoda was the dominant item (frequency and abundance) in diet of individuals of size class 1. However, Ostracoda, Diptera, Bivalvia, Nematoda and Gastropoda were the most frequent items, but with low values for P_i (Fig. 2a). In November, the diagram showed that Copepoda was the most abundant item, but with lower frequency than in May. Diptera was the most frequent item, followed by Nematoda, Bivalvia and Ostracoda (Fig. 2c).

Amundsen diagram for individuals of size class 2 during

Table 3. Descriptive estimations of *Iheringichthys labrosus* diet: frequency of occurrence (F) and percent abundance (% A) of prey items. Estimations were made from captures of May and November to individuals for each size class (1 and 2), from Uruguay River (Uruguay). *Immature biv.: immature bivalvia; item separately from Bivalvia group because of its high abundance, small size and low frequency of occurrence.

Food items	May				November			
	Range 1: 60 - 90 mm (N: 22)		Range 2: 120 - 75 mm (N: 20)		Range 1: 64 - 119 mm (N: 21)		Range 2: 124 - 224 mm (N: 23)	
	F	% A	F	%A	F	%A	F	%A
Diptera	0.86	8.55	1.00	44.67	0.90	10.18	0.70	76.66
Bivalvia	0.86	7.99	0.95	27.36	0.60	5.86	0.50	0.93
Immature biv.*	0.05	3.27	-	-	-	-	-	-
Gastropoda	0.50	2.67	0.90	9.12	0.15	3.09	0.73	8.86
Ostracoda	0.77	11.31	0.35	1.13	0.60	8.44	0.23	2.55
Nematoda	0.59	9.79	0.55	15.53	0.70	31.72	0.60	9.55
Copepoda	0.82	53.79	0.25	0.77	0.30	39.65	0.03	0.53
Cladocera	0.32	0.28	-	-	-	-	-	-
Trichoptera	0.09	0.09	0.20	0.58	0.05	0.06	0.30	0.28
Ephemeroptera	-	-	0.05	0.03	0.10	0.45	0.10	0.29
Hydracarina	0.23	1.59	0.20	0.21	0.05	0.06	0.20	0.14
Coleoptera	-	-	0.05	0.06	0.15	0.19	0.07	0.14
Odonata	-	-	0.05	0.06	-	-	-	-
Collembola	-	-	-	-	-	-	0.04	0.01
Other	0.18	0.67	0.20	0.46	0.15	0.25	-	-
Arthropoda remains	0.18	-	0.30	-	-	-	-	-
Vegetal remains	0.41	-	0.30	-	-	-	0.23	-
Sediment/debris	0.72	-	0.80	-	0.40	-	0.60	-

May showed Diptera as the dominant item following by Bivalvia. Gastropoda and Nematoda were frequently consumed with higher values than those observed in individuals of size class 1 (Fig. 2b). The diagram of November revealed that Diptera were the dominant item while Gastropoda, Nematoda and Bivalvia were frequent items with lower P_i (Fig. 2d).

Diet variations between size classes

The CA was resolved only with one dimension, which explained 100% of the inertia and highlights the existence of a single main gradient in *I. labrosus* diet. The feeding pattern was significantly different between size classes (total χ^2 : 9614.0, $df=7$, $P<0.0001$). Size class 1 fishes were associated to Copepoda, Cladocera, and Ostracoda, whereas fishes of size class 2 were associated to Diptera larvae (mainly Chironomidae), Gastropoda, and Trichoptera. Two food groups, Bivalvia, and Nematoda, did not show a strong relationship with size classes (Fig. 3).

Temporal diet variations

The CA for fishes of each size class was resolved with one dimension, which explained 100% of the inertia. The feeding pattern was significantly different between the studied months (total χ^2 : 406.31, $df=5$, $P<0.0001$ and total χ^2 : 2425.42, $df=4$, $P<0.0001$, for size classes 1 and 2 respectively). In size class 1, Bivalvia, Ostracoda, and Copepoda were items associated to May while Nematoda, Gastropoda and Diptera were associated to November (Fig. 4a). For size class 2, Gastropoda, Diptera, and Ostracoda were associated to May, whereas Nematoda, and Bivalvia were associated to November (Fig. 4b).

Morphometric relationships

Some of the morphometric relationships explored showed significantly different ($P<0.05$) allometric coefficient values (b) compared with the b values assuming isometric growth ($b=1$ or $b=3$, for length-length and length-weight relationships after \log_{10} - \log_{10} transformation, respectively). The intestine length decreased significantly as standard length increased ($b=0.81$, $P<0.05$). Eye diameter and mouth width showed negative allometric growth in relation to head length growth ($b=0.67$, $P<0.05$; $b=0.84$, $P<0.05$, respectively). Finally, head length and body weight showed an isometric trend with the standard length ($b=1.00$, $P>0.05$; and $b=3.01$, $P>0.05$ respectively) (Table 4).

Discussion

Diet

Iheringichthys labrosus is a common species in Uruguay River, being the most abundant in the studied period. The species showed a broad feeding spectrum, with most components belonging to benthic community. This fact indicates that *I. labrosus* is a benthophagous species in Uruguay River in agreement with the diet described before for lotic (Fugi *et al.*, 2001; Abes *et al.*, 2001; Fagundes *et al.*, 2008) and lentic Brazilian systems (Peretti & Andrian, 2004).

An interesting point to highlight is that the main prey items belonging to the Bivalvia group are invasive species: *Corbicula* sp. and *Limnoperna fortunei* (Brugnoli *et al.*, 2006). Those species can cause habitat degradation affecting biodiversity and functioning of ecosystems, and are able to promote subsequent invasions and economic and social

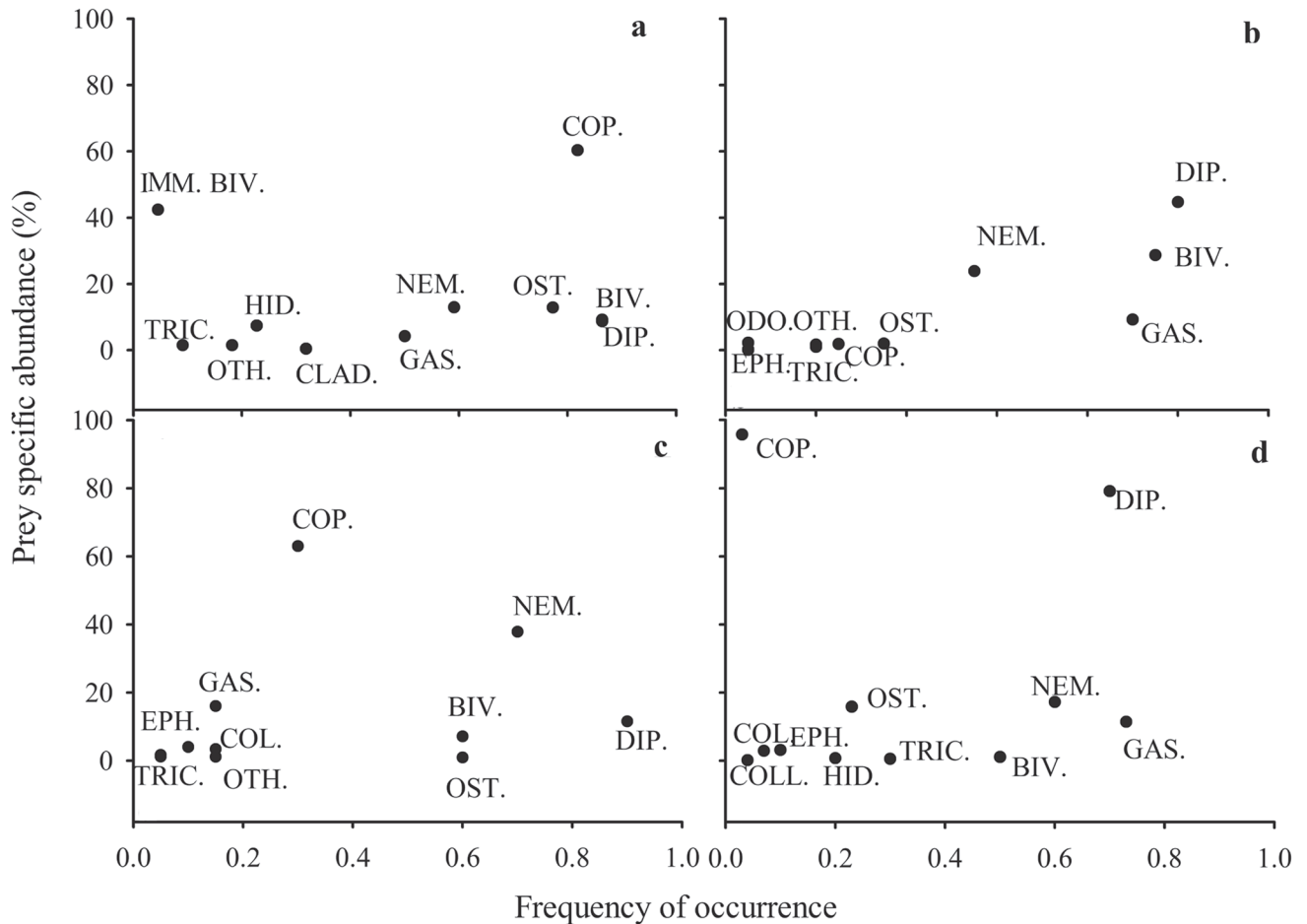


Fig. 2. Amundsen diagrams for individuals of the size class 1(a-c) and 2 (b-d). Superior diagrams correspond to individual obtained in May and inferior to individual obtained in November. COP: Copepoda, TRIC: Trichoptera, OTH: others, HYD: Hydracharina, CLAD: Cladocera, GAS: Gastropoda, NEM: Nematoda, OST: Ostracoda, BIV: Bivalvia, DIP: Diptera, EPH: Ephemeroptera, IMM. BIV: immature bivalvia, ODO: Odonata, COL: Coleoptera, COLL: Collembola.

impacts (D'Antonio *et al.*, 2001). Particularly, *L. fortunei* is responsible for changes in the benthic community of La Plata River (Darrigran *et al.*, 1998). Moreover, this species is able to cause "macrofouling" (*e.g.* filter obstructions, refrigerated systems damage, tubes diameter diminution) affecting human activities and causing economic losses (Mansur *et al.*, 2003). Trough predation, *I. labrosus* may represent a natural and abundant predator of these two harmful species of freshwater ecosystems, and could play an important role in terms of controlling dispersion ranges of these Bivalvia species. One the other hand, *I. labrosus* may act as disperser in case bivalves survive to the digestion (Cantanhêde *et al.*, 2008). In this study, however, most of these bivalves were found broken and totally digested.

Diet variations between size classes

Feeding ontogenetic changes on fish populations reduce potential intraspecific diet competition (Lima-Junior & Goiten, 2003). Despite that *I. labrosus* does not exhibit

changes in feeding strategy between sizes, there was qualitative and quantitative diet changes associated to growth. The main difference is given for microcrustaceans preference (Copepoda, Cladocera, Ostracoda) by fishes belonging to size class 1 and this fact has been frequently reported (*e.g.* García-Berthou & Moreno-Amich, 2000; Hjelm *et al.*, 2000; Canto-Maza & Vega-Cendejas, 2007). This seems to be related to the high availability and easy access of those preys for small juvenile fishes with scarce mobility (Cassemiro *et al.*, 2008). In other way, juvenile fishes may maximize the growth and survival because of their vulnerability in early stages of life (Pilatti & Vanni, 2007). In that sense, Microcrustaceans are abundant preys, which may constitute an important protein and queratine source (Canto-Maza & Vega-Cendejas, 2007).

Bivalvia, Diptera larvae, Gastropoda, and Nematoda were important preys of all size fishes, however, they were more associated to size class 2. Probably, this reflects the greater success of larger fishes to catch those preys. It is well known

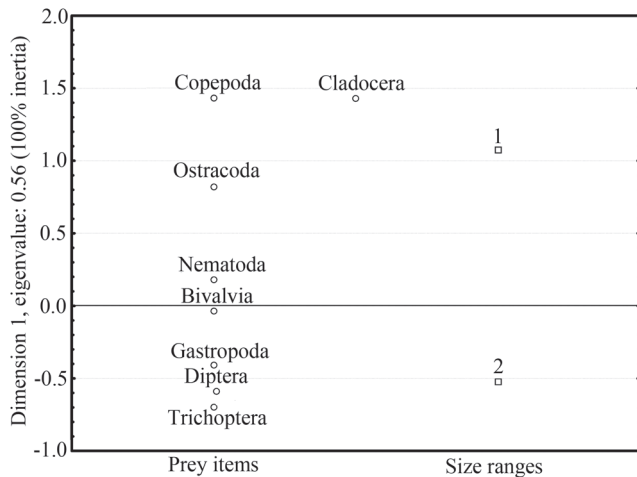


Fig. 3. Correspondence analysis between prey items (circles) and fish size ranges (squares), 1 and 2. Note that the analysis resolved in only one dimension.

that capture efficiency increases through ontogeny in response to nutritional demand increment (Adriaens *et al.*, 2001).

Temporal diet variations

The tendency of diet variation was different in both size classes. This fact may indicate temporal diet segregation between size classes, which may be related to seasonal differences in energetic requirements. In addition, differences between months can be related to changes in prey availability (Stoner, 1980) or in feeding behaviour, due to changes in physiological requirements related for example to temperature (Magnan *et al.*, 1994), being difficult to determine the main cause of variation.

Morphometric relationships

Iheringichthys labrosus intestine length shows negative allometry through development. Relative intestine length reflects diet quality (Al-Hussaini, 1947; Horn, 1989). In this context, allometric intestine growth could be associated to qualitative diet changes through fish development (*e.g.* Teixeira-de Mello *et al.*, 2006). However, we did not find diet changes between size classes which may explain the negative allometry found for intestine growth. Nevertheless, a possible explanation could be related to energetic constraints associated to body size, because larger individuals have higher energetic demands (Mc Nab, 2002) and the maintenance of large structures as the intestine, implies elevated and, in this case, probably unnecessary energetic costs.

The eye diameter development showed negative allometric growth, indicating that smaller individuals have proportionally larger eyes. Assuming that larger eyes imply a better vision, one possible explanation is that juvenile fishes need enhanced vision to detect little preys like microcrustaceans. At the same time, an improved vision could be useful to perceive predators in this fragile stage of life.

However, considering eye diameter, negative allometric growth seems to be a very common characteristic for most fish species, independently if they are typically visual predators or not (Piet, 1998). This kind of growth seems to emerge from different selective pressures independent of visual abilities (Lima-Junior & Goiten, 2003). In addition, the eye size of Siluriformes probably does not play an important role in feeding search, because they have alternative sensorial mechanisms like whiskers or gills for searching resources (Fink & Fink, 1979; Gregory, 1993).

Mouth width shows a negative growth that indicates a relative size reduction through ontogeny. However, the increment in absolute size of mouth's predator is one of the main causes for prey size variations (Piet, 1998). This may determine the type of prey that fishes can access according to their body size. This fact could explain, at least partially, the qualitative differences found between fish size classes.

Finally, this species showed an isometric trend between head length and body weight in relation to standard length, which indicates a proportional increment of those variables with the increment in length. The weight-length relationship

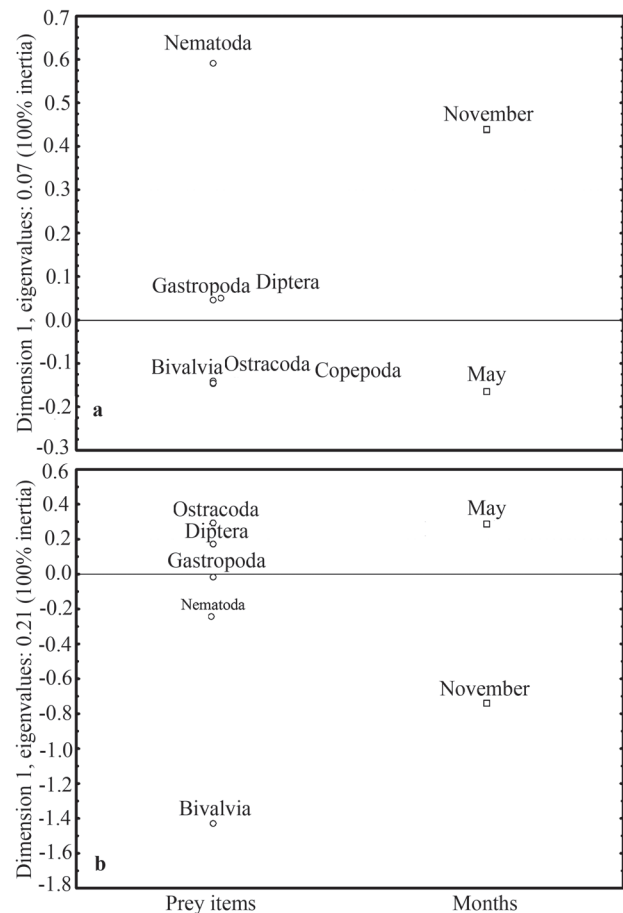


Fig. 4. Correspondence analysis between prey items (circles) and studied months (squares). (a) Prey items of individuals of the size class 1 (b) Prey items of individuals of the size class 2. Note that the analysis resolved in only one dimension.

Table 4. Morphometric traits measured for *Iheringichthys labrosus*. n= number of individuals considered for measures, max = maximum, min = minimum, a = intercept of relationship, b = slope of relationship, S.E. = standard error, r² = coefficient of determination. *significantly different (t-test; P < 0.05) allometric coefficient values (b) compared with the b values assuming isometric growth (b=1 or b=3, for length-length and length-weight relationships); ^aAllometric negative growth; ^bIsometric growth.

Morphometric variables	n	Mean ± S.E.	Parameters of the relationship				
			Min.	Max.	a ± S.E.	b ± S.E.	r ²
S. length	103	123.6 ± 4.6	62.0	224.0	-	-	-
I. length	90	170.9 ± 8.2	45.0	310.0	1.96 (± 0.05)	0.81* (± 0.02)	0.92 ^a
B. weight	103	67.2 ± 4.4	26.6	174.0	0.02 (± 0.07)	3.01 (± 0.06)	0.99 ^b
H. length	31	35.3 ± 2.5	16.0	62.0	0.30 (± 0.1)	1.00 (± 0.05)	0.93 ^b
E. diameter	31	7.8 ± 0.4	4.0	12.0	0.71 (± 0.07)	0.67* (± 0.04)	0.90 ^a
M. width	27	6.3 ± 0.4	3.0	10.0	0.32 (± 0.14)	0.84* (± 0.09)	0.91 ^a

differed from that reported previously by Teixeira-de Mello *et al.* (2008) in Uruguay River, and from Holzbach *et al.* (2009) in Piquiri River. Both studies indicated a positive allometric growth for this species. These differences highlight the dependence of weight-length relationship with local conditions and seasonality, and eventually to the existence of local morphs associated to them.

This is the first work that studies *Iheringichthys labrosus* diet and morphometry in the lower Uruguay River. Our results support that *I. labrosus* feeds on a wide spectrum of benthic organisms. The generalist diet of this fish confers high resistance to potential resource changes, and may explain the high abundance of *I. labrosus* in the Uruguay River basin. This species shows quantitative and qualitative diet variations between size classes. This may reflect different energetic demands, biological priorities and different abilities to capture preys through fish development. However, we did not find a clear connection between diet shifts and morphometric changes. Therefore, in this particular case, the allometric growth of certain structures related to feeding does not seem to be related to diet variations, suggesting that other external or internal pressures may operate on morphometric variables.

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